第８章

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8.1 議事録

8.1.1　第１回ステアリングコミッティ議事録

The Study
on
Enhancing Efficiency of Operating
Thermal Power Plants in NTPC-India

Minutes of Meeting **of** **First Steering Committee: Review of Inception Report** **JICA, JICA Study Team ,** **Ministry of Power (MOP), NTPC**

5/2/09.
PANKAJ BHARTIYA (AGM)

Mr. D.K.Agrawal
General Manager
NTPC Limited
India

Mr. Noriyuki Shimizu
Leader
JICA Study Team
Japan

DATE	:	**2nd-3rd February, 2009**
VENUE	:	**NTPC MCM Room, Core 6, Scope Complex, Delhi**

Confirmation of Contents of Inception Report

General:

Draft Inception report of The Study on Enhancing Efficiency of Operating Power Plants' was reviewed and necessary corrections incorporated.

JICA Study Team (JICA-ST) explained outline of the Inception Report to NTPC, the study items and total schedule (Fig 4-1) and confirmed contents of report page by page.

JICA-ST pointed out that the study report will be compiled as a manual or guideline which will be submitted to JICA and/or NTPC as one of the deliverables of this study.

In response to NTPC's inquiry, JICA-ST informed that the study period is two (2) years, therefore, after the period JICA-ST will not be able to support additional clarifications.

JICA explained that NTPC should inform specific follow up works to Indian government if required, JICA will consider this matter.

Specific issues discussed are listed below:

1) Page 3, (2) "know-how"

In response to the NTPC's inquiry, JICA-ST replied that the meaning of know-how is proprietary information belonging to Service Company, therefore JICA-ST is not able to transfer such technology.

2) Page 5, Progress Report

In response to the NTPC's inquiry, JICA-ST replied that the report will be submitted as early as possible to JICA and NTPC, however Schedule date is Oct. 2009.

3) Page 6, 4) Performance Test

JICA-ST requested that performance tests will be carried out at three (3) candidate units in series to minimize transportation cost and test witness period.

NTPC explained that they will execute performance tests in association with JICA-ST expert at the three (3) units.

JICA-ST desired for a list of Offline test equipment used by CenPEEP in performance testing and an outline of the activities conducted jointly by CenPEEP and USAID.

NTPC requested that a copy of typical test procedures including input & output data used by Japanese utilities be provided.JICA-ST agreed to provide English version of test

procedures used in Japan by May'09.
Alongwith test procedure, NTPC requested JICA-ST to define the necessary data list expected for the performance testing by NTPC after the unit overhaul.

4) Page 7, 8) Operation & Maintenance

In response to the NTPC's inquiry, JICA-ST replied that the survey of O&M at power stations would be conducted by interview and discussion of the staff utilizing tables in the Inception Report.
NTPC suggested that JICA-ST should provide a copy of questionnaire to be used during interviews and additional items required in advance for timely collection of all the information.

5) Page 7, 10) Workshop

NTPC requested that duration of each workshop by JICA-ST should be two days instead of one day.JICA-ST agreed

6) Page 7, 11) Seminar

JICA desired that participants from state utilities in power sector (SEB) should also be invited to the seminars under the study.
NTPC will coordinate with SEB staff for participation in the seminars.

7) Page 7, 12) Training

NTPC requested that for counter part training in Japan the number of participants in each team should be increased to six (6) from proposed number of four (4) participants in the Inception Report. This is in order to accommodate participants from all the three candidate stations and Corporate team.

JICA responded that number of trainees are not fixed, therefore they will study NTPC request and inform the result as soon as possible.

8) Page 7, 14) CDM

JICA pointed out that NTPC has experience in CDM application for hydro and super critical boiler. JICA-ST asked NTPC to arrange a meeting with NTPC CDM section. NTPC agreed to arrange a meeting during next visit of JICA-ST.
NTPC requested that after formulation of PDD, JICA team will help in making presentation of proposal to designated authorities, if its within the study period.

9) Page 10, (4) Benefit to be provided by NTPC

NTPC and JICA-ST requested MOP for assistance of the items mentioned in (3),& (4).

For exemption of customs duty, if required, and waiver of tax on income of Japanese experts during visit in India, MOP suggested that NTPC to prepare a letter and submit to MOP which will be processed for approval in accordance with the commitments/guarantees given in the mutually agreed and signed SOW. JICA-India will also provide support, if required, for this purpose.

10) Page 10, (4), 6) Securement of required budgets on the India

NTPC explained that budget for replacement/renovation of equipment requires necessary approvals of Competent Authority .

11) Page 11, 12) Custom Clearance

For the equipment to be brought on returnable basis by JICA-ST for field investigation, Custom clearance, handling, local transportation, repacking and dispatch after completion of work in India will be handled by agents appointed by JICA Study team. NTPC will provide support for the same, if required.

12) Page 11, 13) Arrangement

NTPC explained arrangement of transportation and accommodation etc. to be carried out as follows;

- Program from Delhi to nominated power station and movement between different stations(Booking detailsto be provided by NTPC
- Local Transportation: by NTPC at power stations
- Accommodation: by NTPC at power stations

13) Page 11, (5) Communication

The both parties agreed the following e-mail correspondence method;

- All communications to JICA-ST should be addressed to identified area expert and Mr. Shimizu and a copy marked to other members.
- A copy of all communication will also be sent to Resident Director, J Power in India.
- All communications to NTPC should be addressed to Mr. D.K.Agrawal, GM (CenPEEP) and copy marked to members of Counter Part team.

Both parties agreed to prepare communication table describing name, e-mail address and position.

14) Page 13, Clause 3.2.1, 2) Review of the contents of the cases of efficiency improvements of coal fired thermal power stations in Japan

NTPC requested to provide cases of efficiency improvements in Japan published in international conference, if possible.

JICA-ST agreed to look for such reports and provide to NTPC, if possible.

15) Page 14, 3) Preparation for the selection of model power station

Selection of the candidate units will be based on boiler & Turbine inspection opportunities during the study window (Oct-Dec 2009). JICA-ST requested to have opportunities of back-to-back inspection of model units in view of logistics. NTPC will review the schedule & short list five units in Kick Off II meeting, out of which three model units will be selected for Study.

JICA-ST has desired a set of _Technical & Commercial information for NTPC power stations as per the formats in Inception report. . NTPC agreed to provide the available information. JICA-ST also explained that minimum requirement for selection for unit is availability of design data

16) Page 15, c) Scope of Investigation

In response to the JICA-ST's inquiry, NTPC replied that the necessary data for selection of the candidate units will be provided by end of March 2009.

17) Page 16, b) Comprehending NTPC's efforts for efficiency improvements

In response to the JICA-ST's inquiry, NTPC replied that the list and outline of USAID activities is to be provided within two (2) weeks.

18) Page 16, (4) Kick off Meeting-2

JICA-ST suggested that Kick-off meeting-2 could be scheduled from 24th to 26th February 2009. NTPC will confirm the same.

19) Page 28, Table - 1

JICA-ST asked MOP to fulfill necessary data in the "Table -1 Check List of Questionnaires". MOP representative explained that the JICA-ST can access necessary information from the MOP, Central Electricity Authority (CEA) &Central Electricity Regulatory Commision (CERC) web sites. If any other information is required, JICA-ST should inform alongwith purpose of the information and the same would be considered and provided as appropriate.

20) Page 18 , 1)-2, a) Remaining Life Assessment (RLA) for boiler tubes

JICA-ST explained that RLA requires plant overhaul shutdown to inspect the necessary portion of Boiler or Turbine (dismantle of turbine casing), collection of sample materials replica for evaluation.

In response to the NTPC's inquiry, JICA-ST informed performance test is not related to RLA and those are executed separately.

JICA-ST pointed out period of RLA and typical overhaul period as follows;

- Turbine RLA: 15days, Boiler RLA: 6days
- Performance test: 1 day

NTPC informed that typical overhaul durations are as follows

- Turbine Overhaul: 30-35 days, Boiler Overhaul: 10 to 20 days

21) Page 19, d) Assessment of main pumps

NTPC requested to assess performance of turbine of Turbine driven BFP (T-BFP) and pump.

JICA-ST informed Japanese electric power companies have no experience to measure T-BFP performance, therefore JICA-ST proposed to evaluate the parameters . JICA-ST also informed that sub-vendor is able to assess performance of only motor driven pumps.

22) Additional assessment items (Priority List of Issues)

NTPC submitted attached "Priority List of Issues" to JICA-ST for further consideration of this study. JICA-ST reviewed additional assessment items and pointed out as follows;

- Item 1 is difficult to assess by JICA-ST, therefore we will confirm whether some sub-vendor can provide necessary service or not, subject to cost of service being confirmed by JICA. Details to be finalized at kickoff-meeting -2 (Item 1 is applicable to one (1) Unit).
- Item 2 is already included in this study, however some modification is required. Feed water piping assessment is to be studied and informed to NTPC at kickoff-meeting -2. As for efficiency restoration and upgrading, JICA-ST will include study and recommendation only, and not including supplying equipment.
- Item 3, 6, 7, 8 already included in this study
- Item 4 already included in this study (parameter assessment)

- Item 5 is to be applied this study, however details will be discussed at kickoff-meeting -2
- Item 9 is to be applied this study (Item 9 is applicable to two (2) Units)

23) Page 22, Clause 3.3 Training program for Counterpart Members (Training in Japan)

NTPC made some suggestions to make training programs more effective and requested that number of days of plant tour should be increased to have useful exposure to field exercises in the power plants. JICA-ST will consider the request.

24) JICA-ST plans to outsource RLA study. NTPC requested that reputed agencies in Japan may be commissioned so as to provide exposure to Japanese practices.

25) NTPC finds many items of interest from the presentations made in the Workshop. NTPC is compiling a list of items and requests for technical information on those subjects. JICA-ST agreed to consider the request and will help obtain information as far as possible.

Attachments

(1) Attachment-1: Agenda
(2) Attachment-2: List of Attendance
(3) Attachment-3: Briefing of Workshop
(4) Attachment-4: Priority List of Issues
(5) Attachment-5: Inception Report (corrected draft)

The Study
on
Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

Attachments to the Minutes of Meeting
of
First Steering Committee: Review of Inception Report

JICA, JICA Study Team ,
Ministry of Power (MOP), NTPC

Attachments

(1) Attachment-1: Agenda
(2) Attachment-2: List of Attendance
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Attachment -1

NTPC-JICA Project on Energy Efficiency

Steering Committee Meeting

February 2^{nd}, 2009

Venue: NTPC MCM Room, Scope Complex

Agenda

1.	Welcome address by **Mr. A.K. Mohindru**, GM -NTPC	1000-1005
2	Address by **Mr. Yukihiro Fukuda**, Counsellor, Embassy of Japan, New Delhi	1005-1007
3	Address by **Mr. K.C. Sharma**, Under Secretary, Ministry of Power, GOI	1007-1010
4	Address by **Ms. Adachi Fumio**, Deputy Director, Industrial Development Department, JICA	1010-1012
5	Brief of Kick-off Workshop by **Mr. Pankaj Bhartiya**, NTPC - CenPEEP	1012-1017
6	Observations by **Mr. Noriyuki Shimuzu**, J-Power and JICA Study Team Leader	1017-1022
7	Vote of Thanks	1022-1024

Departure of Counsellor, Embassy of Japan at 1025 Hrs.

Meeting to continue for rest of the day at Scope and further at Noida on February 03,2009 to discuss the Inception Report.

Attachment-2

STEERING COMMITTEE MEETING : FEBRUARY 2-3, 2009
LIST OF ATTENDIES

MOP

(1) Mr.K.C.Sharma (partly)

NTPC

(1) Mr. A.K. Mohindru
(2) Mr. B.M. Singh
(3) Mr. Pankaj Bhartiya
(4) Mr. S. Bandopadhyay
(5) Mr. A.K.Mittal
(6) Mr. M.K.S.Kutty
(7) Mr. A.K.Arora
(8) Mr. Surendra Prasad
(9) Mr. Subodh Kumar
(10) Mr. Partha Nag
(11) Mr. U.S.Verma

JICA

(1) Ms. Fumio Adachi
(2) Mr. Azumi Kakegawa
(3) Mr. Keiji Katai
(4) Ms. Shashi Khanna

JICA Study Team

(1) Mr. Noriyuki Shimizu
(2) Mr. Morikuni Miyagi
(3) Mr. Nobuchika Koizumi
(4) Mr. Takashi Fujimori
(5) Mr. Hiroshi Okame
(6) Mr. Hiroyuki Hayakawa
(7) Mr. Tatsuya Morooka
(8) Mr. Makoto Yotsumoto
(9) Mr. Shinji Kuba

J Power

(1) Mr. Shigeru Kondo

Attachment 3

Summary of Kick-off Workshop Presentations

General

1. Total 13 papers have been presented by Teams from 3 utilities.
2. The gross efficiencies of power plants in Japan are:
   - About 41% for sub-critical fleet,
   - Above 42%for super critical fleet and
   - About 43% for Ultra supercritical fleet.
   - Most of the sub-critical fleet is old and majority of new capacities are either supercritical or ultra supercritical.
3. One of the features of Japanese experience has been the sustainability of operating efficiencies close to design.
4. The basis of efficiency management activities is same regardless of steam conditions and unit size. The basis can be applicable to sub-critical units in India also. Accordingly most of the presentations from their team covered experiences on sub-critical units. Some data was also presented collected by them from service providers for LMZ type turbines.
5. Activities for efficiency improvement included:
   - daily / monthly efficiency management,
   - Proper day to day O&M to analyse the gaps and root causes to keep efficiency at design level,
   - Pre- and Post-overhaul evaluation of performance
   - Shut down maintenance.
     - OH intervals defined by law for boiler (2 yrs) and Turbine (4Yrs).
     - For the equipment where 'law' permits discretion in shutdown interval / maintenance, since 2002 the strategy is moving towards 'condition based maintenance' from 'time based maintenance'.
   - Replacements particularly by applying new technologies with high efficiency equipments

Boiler Efficiency Management

6. Combustion management is given high priority:
   - Combustion tuning as an important activity during re-commissioning and change of input coal.

- Low flue gas O2 operation
- Case studies on parametric combustion optimization by varying dampers etc.
- On line measurement of unburnt carbon in fly ash
- Computer Simulation of boiler combustion is able to simulate combustion gas flow, trajectory of particulate, temperature distribution, oxygen concentration, etc.. It is useful for study of combustion optimization (decreasing of unburned carbon and NOx & SOx) and has been initiated in some plants to study problems and optimization.

7. Balancing of coal flow is given high priority:
   - Measurement of coal flow at feeders as accurately as possible
   - Real time measurement of pulverized coal flow through burner pipes using meControl coal system
   - Use of dynamic rotating classifiers in mills to optimize boiler performance
8. Intelligent soot blowing is the normal practice. 'Fuzzy logics' are applied in 'Control Logics', heat absorption is calculated from on-line parameters to operate soot blowers as required. Soot blower maintenance is equally given high priority.
9. High priority to air-heater performance such as:
   - Automatic Sensor Drive Systems (SDS) in air heaters to sustain reduce leakage levels
   - Use of high performance air heater baskets elements for better heat transfer
10. Retrofits of VFDs in important drives.

Turbine Cycle Efficiency Management

11. New types of seals (leaf seals) for turbine inter-stage
12. Application of high performance turbine blade and anti-erosive turbine nozzle
13. Turbine efficiency recovery by:
    - Turbine internals cleaning by honing
    - Scale removal from turbine nozzle
14. Assessment of area wise air quantity ingress into condenser using leak buster
15. Application of Yates meter for Pump performance assessment has been initiated.

Turbine / HP Heaters / Condensers: Some significant overhaul & re-commissioning practices:

16. Turbine oil flushing procedures after O/H
17. Turbine forced cooling procedure is followed for reduction of overhaul time duration.
18. HP Turbine casing bolt loosening before stopping of Turbine.
19. Inspection & repair of turbine coupling bolts.

20. Actual over speed test at 25% load (during hot condition) after turbine overhaul.
21. Procedure for fastener checking & replacement based on DPT.
22. Practice of High pressure cleaning of HP heaters.
23. HP heater tube eddy current test.
24. HP Heater vacuum test.
25. Condenser eddy current test for 100% tubes in ten days

RLA of Boiler & Turbine

26. The tests done and tools used for RLA of boiler & turbine presented.
27. Use of on site electrical discharge sampling device for Small Punch Creep test for tube RLA
28. RLA of transformers also covered. Generator RLA was not discussed though it may be one of the items of study.

Transformers

29. Life assessment of transformer by non-destructive method (insulation paper sampling eliminated):
    - Assessment of insulation paper degradation by $CO+CO_2$ and furfural measurements plotted against DP (degree of polymerization) based on the reference data prepared for 99 transformers.
    - Cumulative CO + CO2 data accounted after degassing for life estimation purposes.

Control and instrumentation (C&I)

30. Assessment of control systems: system for periodic assessment
31. System of 'Root cause analysis' of failures within 3-4 days.

Attachment 4

Priority List of Issues

1. Diagnosis of Boiler problems including surface reengineering to address issues like shortfall in steam temperatures, temperature imbalance at boiler outlet, high RH sprays, high exit gas temperatures at boiler outlet, Combustion tuning & optimization
2. HP / IP turbine performance & condition assessment (including associated piping and FW piping); Efficiency restoration & Up gradations
3. Assessment of Large Pumps (Boiler Feed Pumps, Condenser cooling water Pumps including assessment by Yates meter)
4. Assessment of Steam Turbine of TDBFPs
5. Predictive Diagnostic Technologies
6. Assessment of Control Systems
7. Assessment of Condenser air-in-leakage
8. Boiler Inspection & RLA (Tubes & Headers)
9. Inspection & study for Air Heater Performance improvement

8.1.2　第２回ステアリングコミッティ議事録

The Study
on
Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

Minutes of Meeting
of
Second Steering Committee: Review of Inception Report

JICA, JICA Study Team ,
Ministry of Power (MOP), NTPC

Mr. D.K.Agrawal	Mr. Noriyuki Shimizu 14/12/09
General Manager - I/C	Leader
NTPC Limited	JICA Study Team
India	Japan

DATE	:	**29th October, 2009**
VENUE	:	**Conference Room No. 108, 1st Floor, R &D BUILDING, NTPC CenPEEP, Noida**

Mr. D.K. Agrawal, GM I/C welcomed Mr. Fukuda, Counselor, Embassy of Japan, Mr. Chandan Roy, Director (Operations) & Chairman, Steering Committee, Mr. Miyake & Mr. Inada, Embassy of Japan, Mr. Katai, JICA India, Mr. Shimizu, team leader, all members of JICA ST and executives of CenPEEP for 2nd Steering Committee Meeting on 'The Study on Enhancing Efficiency of Operating Thermal Power in NTPC-India'.

He talked in brief about activities done by the Study group comprising members from JICA ST, CenPEEP and NTPC Stations. He mentioned that series of discussion have taken place with JICA-ST and JICA officials on various aspects of Study, finalization of the scope of study and selection of units as per mutually agreed criteria. He appreciated that the request for training was included under the project at Japanese facilities for knowledge and skill up gradation and understanding of Japanese practices. He thanked JICA for this.

He mentioned that feed back of training program on periodic inspection is very good and found to be useful. Some of the practices of Japanese Utilities may be adopted in NTPC such as safety-net at every two meter height, camera for surveillance on unsafe act, Audio visual training on safety for all the workers during overhaul, Robots for Economizer & super heater inspection, use of pneumatic tools for boiler tube cutting etc. CenPEEP will communicate the feedback on the training program shortly so that the future training program is more effective.

He also mentioned about expectation of NTPC for study of surface re-engineering to solve the problem of Vindhyachal unit -7. But study could not be organized by JICA-ST due to non availability of potential service providers during the defined work-window. However he informed that Combustion Simulation study of boiler is being done under this study program for U-7 of Vindhyachal.

He pointed out that change in OH schedule of the units leading to changes in the candidate units and in SOW at each stations and readjustment of activities to meet the tight work - window and time scale for study project of JICA ST. The planning and the preparatory works involved in the organization of field visit at plant, data organization, briefing to the plant people and coordination with JICA-ST was emphasized.

Referring to the progress of 3rd field visit, he mentioned that the performance tests have been completed at all the three plants. Helium leak buster test has been carried out at Singrauli. However, we need more information for replication of the technique in NTPC. In this context, we had already requested for additional information.

Pump efficiency test using Yates meter have been carried out at three stations. The report on the demonstration test is to be received. However, for confidence building on the technique and its replication, more information on the procedure and calculation will be needed. He expressed that these two techniques will be very useful as a diagnostic tool. Boiler RLA study is in progress at Singrauli & C&I assessment is in progress at Unchahar. Boiler RLA team will go to Unchahar on 3rd Nov for boiler inspection from Singrauli.

He also mentioned about the constraints on logistics due to large contingent of JICA-ST & CenPEEP member at the time of unit overhauling. Stations some how managed the requirements with cooperation of JICA ST team members. It might have caused some inconvenience to the JICA-ST and thanked them for cooperation in this regard.

He informed that a request for the extension of the project beyond Oct'2010 which has been communicated to JICA through MOP & MOF. This is needed to make sufficient time available for organizing the selected demonstration / execution at plants based on data/information, study which will be available not before January 2010.

He also mentioned about details of the Japanese practices in critical areas. JICA ST has provided some information and promised that remaining information would be provided in due course. We hope that the information would be provided shortly so that gainful discussion and learning can take place. He also requested JICA ST to provide as much information as possible on Japanese practices in critical areas in the spirit of sharing information for learning and mutual benefits.

Mr. Yukihiro, Fukuda counselor Embassy of Japan expressed pleasure in attending the 2nd Steering Committee meeting and mentioned that this project is important for all of Indian people. The Indian economy is continuously growing; power shortage is a big concern and the power requirement will further grow in the future. Environmental matter with regard to greenhouse gas emission is important issue for new Japanese government. He emphasized that data required for JICA ST should be made available and NTPC's response in this regard is appreciated. He hoped that the training programs will be useful for NTPC staff as they will be able to get technical skill and know-how of Japanese utilities practice.

Mr. Keiji Katai, JICA, New Delhi expressed sincere thanks to both JICA ST and NTPC for their cooperation for this project. JICA had many project in India not only for power sector but also for social sector. He mentioned that NTPC collaborations with US and high level of performance of NTPC units are great achievement.

JICA ST team is the joint venture of three companies and wants to have best possible analysis for usefulness of the project. He expressed that although the study is being done at 5 power stations and the recommendations will also be useful for other stations. Climate change is important issue and CDM task will also be conducted in this project.

Mr. K. C. Sharma, MOP, could not attend the meeting due to some pre occupation. His message was conveyed by Sh. Pankaj Bhartiya, GM, CenPEEP, In his message, Mr.Sharma expressed his best wishes and full support for the Study group.

Mr. Chandan Roy, Director (Operation), welcomed Counselor Mr. Fukuda, Mr. Miyake & Mr. Inada, from Embassy of Japan, Mr. Katai, Mr. Shimizu, all members of JICA_ST & NTPC team.

He appreciated Japanese culture of meticulous planning, courtesies, politeness and health consciousness. He expressed satisfaction over response of Japanese company working for NTPC and high respect for Japanese practice in India. NTPC has high expectations from this joint study. NTPC has learned a lot from US window, but expectation from this window is also high. He shared the current performance of the units with the average age of 18 years and various challenges & issues ahead for NTPC.

NTPC present capacity is more than 30000 MW and volume of fleet is expected to grow to 75000 MW by the end of 2017. No of units in operation is 117 and is likely to touch to 175 in the near future. It is difficult to maintain the same quality of the people. A robust system is required to control the activities.

He mentioned about difficulties in developing the vendors and also handling the vendor for overhauls as most of the units are planned during monsoon period. He expressed that there is a lot of opportunity for service provider in this country. We encourage the vendors to come, as the scope is very high. Many supercritical plants are going to be commissioned in near future and large opportunity is available for vendors for maintenance of supercritical plants.

Environment issues are getting stronger and technology is driven more by the environment. Customers are getting more aware and stake holders are more demanding. We have to continuously implement the best practices for plant performance improvement.

We are focusing a lot on efficiency and trying to run the unit close to the design efficiency. For the new unit, target HR deviation is 50 kcal/kWh more than design, where as for the old plants the target is 75 kcal/kWh. The system should be able to track the deficiency much ahead and avoid possible failure of the equipments. He emphasized the need of efficiency control with online system. NTPC is working on this model for long term sustainability. System should not be dependent on the individual. Capturing the expertise of the people and making it available for all units is an important objective of expert system. At the end, he expressed that NTPC will get lot of expert advice from this study.

Mr. Shimizu, Leader JICA Study Team (JI CA-ST), explained outline of the Progress Report to the participants

Brief of the Progress Report

- Study team visited 5 NTPC stations along with CenPEEP and analyzed the data & station problem. Originally 3 units were to be selected however finally 8 units were selected for the study to cover all the required scope of work. JICA ST discussed continuously with CenPEEP; planned various activities and collected necessary information / data for the study. JICA ST also followed the change of overhaul schedules.

All field works will be completed by on going 3rd field visits and proposal will be made for efficiency improvement by February 2010. Present condition and problems of selected units were summarized and reviewed.

- JICA ST informed that some of the work were subcontracted to the service providers
    - Control : M/S Yokogawa
    - CDM: contract process in progress
    - Pump : M/s Torishima
    - Helium Leak Buster: M/s FUJI
    - Boiler RLA: M/s Kyudensangyo
    - Turbine Assessment(RLA, Steam Path Audit and Piping): M/s Alstom Japan
- Boiler RLA includes two new techniques.
    - Scanning Electron Microscope
    - Transmission Electron Microscope
    - TOFD (Time of Flight Diffraction)

Issues & Discussion:

- JICA ST explained the combustion simulation study details of Vindhyachal #7. CenPEEP asked about detailed discussion with the service provider. D (O) suggested that NTPC officers should be deputed to Japan for discussion with service provider and participation in the analysis process so that NTPC have sufficient confidence on the result of the combustion simulation study. CenPEEP also requested JICA to send service provider to India for discussion at Vindhyachal station on combustion simulation.
- CenPEEP suggested that the Workshop/Seminar planned during the 4th field visit should be attended by the service provider for better dissemination on the findings of

the study. JICA ST told that the contract with service provider does not include this task. JICA ST will however discuss the matter with JICA.

- JICA ST informed that the test data received in the area of Generator & Generator transformer analysis will be done at Japan. CenPEEP expressed that there would be good learning from the study for NTPC electrical experts and they would be able to get trends and analyze the test data in a better manner.
- JICA ST informed that performance tests were carried out as per NTPC procedure in consultation with JICA ST. The observations by JICA ST were appreciated and shared. NTPC asked that any suggestions on the test procedure will be appreciated.
- JICA ST witnessed O&M operator patrol during 3rd field visit. JICA ST asked to share various O&M procedures for their review. CenPEEP agreed to provide 5 no. of procedures as asked by JICA ST.
- JICA ST visited central stores and simulators at Korba and highly appreciated both.
- NTPC requested to extend the project beyond October 2010 as the time available is very less for planning and arranging execution of some of the recommendations. Mr. Katai informed that extension of the project seems to be difficult.
- NTPC shared that high level of confidence is required on the recommendations before NTPC selects it for execution and replication. NTPC asked support of JICA ST and service providers during execution of the recommendation within study time frame. NTPC also asked that full information be shared as a part of technology transfer and further replication of the same in the other stations for the areas like yatesmeter, He leak buster, RLA techniques etc. However, JICA ST mentioned that those information which are of intellectual property nature, cannot be shared if service providers do not provide information. Mr. Katai said that they would workout the replication mechanism in this context.
- NTPC also conveyed the interest shown by MOP about the new technology being demonstrated by the JICA ST. NTPC enquired about the details of the demonstration planned during February 2010 – October 2010 time slot. NTPC urged them to provide the details and activities calendar so that NTPC can plan the demonstration activities. JICA ST explained that they will assess all activity after #3 field work and inform NTPC about the activities plan of February 2010 – October 2010 during 4th field work. NTPC shared that some of the recommendation may be carried out as demonstration by NTPC and urged JICA ST to provide the required support.
- JICA told that financial study will be done along with the technical proposal evaluation.
- NTPC requested JICA to explore about the future plan after completion of the current study project and also urged JICA and JICA ST to provide required support in some of the demonstration.
- NTPC suggested that the collaboration should not end with the current study and

should identify the potential areas for future collaboration.

Attachment

(1) Attachment-1: Agenda

(2) Attachment-2: List of Attendance

(3) Attachment-3: Progress Report

NTPC-JICA Project

Centre for Power Efficiency & Environmental Protection (CenPEEP)

The Study on Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

2nd Steering Committee Meeting

Chaired by Director (Operations), NTPC Ltd

October 29th 2009

Venue: Conference Room No. 108, 1st Floor, R &D BUILDING
NTPC CenPEEP, Noida

Agenda

10:30-10:35	Welcome address by Sh. D.K. Agrawal, GM I/C, CenPEEP, NTPC
10:35-10:40	Address by Mr. Yukihiro Fukuda, Counsellor, Embassy of Japan, New Delhi
10:40-10:45	Address by Mr. K.C. Sharma, Under Secretary, Ministry of Power, GOI
10:45-10:50	Address by Mr. Keiji Katai, JICA, New Delhi
10:50-11:00	Address by Sh. Chandan Roy, Director (Operations), NTPC
11:00-11:10	Brief Presentation by CenPEEP on JICA Study
11:10-11:35	Brief of the Project Progress by Mr. Noriyuki Shimizu JICA Study Team Leader o *Activities carried out* o *Future plan* o *Issues & observations*
11:35-11:50	Discussions and suggestions
11:50-11:55	Vote of Thanks

Meeting is to continue for rest of the day to discuss progress of the Study and plan future activities.

ATTENDED BY :

NTPC

(1) Mr. Chandan Roy	Director (Operation)
(2) Mr. D.K. Agrawal	GM I/C, CenPEEP
(3) Mr. Pankaj Bhartiya	GM
(4) Mr. S. Bandopadhyay	GM
(5) Mr. A.K.Mittal	AGM
(6) Mr. Alok Gupta	DGM
(7) Mr. A.K.Arora	DGM
(8) Mr. R.K.Khurana	DGM
(9) Mr. Surendra Prasad	
(10) Mr. Subodh Kumar	
(12) Mr. D.Banerjee	
(13) Mr. Manoj Jha	
(10) Mr. Anand Kr. Jha	
(11) Mr. Rajan Kumar	
(13) Mr. Y.K.Sharma	

Embassy of Japan

(1) Mr. Yukihiro Fukuda,	Counselor
(2) Mr. Yasujiro Miyake	First Secretary
(3) Mr. Goki Inada,	First Secretary

JICA

(1) Mr. Keiji Katai
(2) Ms. Shashi Khanna

JICA Study Team

(1) Mr. Noriyuki Shimizu
(2) Mr. Morikuni Miyagi
(3) Mr. Nobuchika Koizumi
(4) Mr. Tatsuya Morooka
(5) Mr. Takashi Fujimori

J Power

(1) Mr. Shigeru Kondo
(2) Mr. Shingo Takagi

8.1.3　第３回ステアリングコミッティ議事録

The Study
on
Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

Minutes of Meeting
of
Third Steering Committee
(02.03.2010)

JICA, JICA Study Team,
Ministry of Power (MOP), NTPC

18/6/10

Mr. D.K.Agrawal
General Manager - I/c, CenPEEP
NTPC Limited
India

18/06/2010

Mr. Noriyuki Shimizu
Leader
JICA Study Team
Japan

DATE	:	**2nd March, 2010**
VENUE	:	**NTPC MCM Room, SCOPE, New Delhi**

Mr. D.K. Agrawal, GM I/C, CenPEEP welcomed Mr. Chandan Roy, Director (Operations) & Chairman, Steering Committee, Mr. Toru Kobayakawa, JICA India, Mr. Shimizu, Team leader, all members of JICA ST and other participants for 3rd Steering Committee Meeting on 'The Study on Enhancing Efficiency of Operating Thermal Power in NTPC-India'.

He talked in brief about activities carried out under the Study. He informed that most of the field activities have been completed including Performance Assessment at candidate stations, Demonstration of Boiler RLA techniques & practices, Condition Assessment of Controls & Instrumentation, Life assessment techniques for Generator & Generator Transformers, Combustion Simulation Study for boiler and Financial analysis of proposals. He shared that new techniques like Pump assessment using 'Yatesmeter' and identification & quantification of condenser air-in-leak using 'Helium Leak Buster' have been demonstrated.

He also mentioned that the observations, findings & recommendations of JICA ST were discussed by NTPC engineers from all stations in a workshop and a seminar at PMI, Noida and appreciated the efforts put in by members of JICA ST.

Mr. Toru Kobayakawa, JICA India, expressed thanks to NTPC for inviting him to the 3rd Steering Committee Meeting. He mentioned that he had also participated in the workshop on 'Findings & Recommendations of the Study on 22nd Feb at PMI Noida and was impressed by the enthusiasm shown by the participants in the workshop. He further informed that the three partner utilities of JICA ST, J Power, Kyushu and Chugoku Electric had put in additional efforts in translating Japanese documents in English for sharing their expertise and experiences. He further said that there's a need for enhanced level of exchange between NTPC and JICA ST for implementation of recommendations as the Study comes to a close in Oct'10.

Mr. K. C. Sharma, MOP, welcomed all the participants and expressed pleasure in attending the 3rd Steering Committee meeting. He said that Ministry of Power had provided full support to the collaborative program with JICA and that further support to the Study shall continue. He expressed his best wishes for the program.

Mr. Chandan Roy, Director (Operation), welcomed Mr. Toru Kobayakawa, Mr. Shimizu, all members of JICA ST & NTPC team. He said that present capacity of NTPC is more than 31000 MW and volume of fleet is expected to grow to 75000 MW by the end of 2017. The average age of the NTPC units is about 19 years and robust systems need to be put in place to improve and sustain high performance levels.

He said that CenPEEP provides a window to NTPC to connect to utilities worldwide for continued learning. He mentioned that he had been personally involved in structuring the current program with JICA ST. He appreciated the work carried out by Study Team and the learning opportunities provided by the Study to NTPC engineers.

He said that on the whole it has been a very exciting experience for NTPC and that the learning process should continue beyond seminar or workshops. NTPC would implement the recommendations and put the learning back in the system. He expressed that there should be focus on gap areas for high performance.

At the end, he appreciated the efforts put in by JICA ST members and thanked them for coming to Steering Committee Meeting and all the support during study.

Mr. Subodh Kumar, CenPEEP made a brief presentation outlining various activities carried out at NTPC stations under the Study.

Mr. Shimizu, Leader JICA Study Team summarized the Study focusing on its historical steps, findings and recommendations for each assessment item, road map for Implementation, possible implementation plan and future schedule of the Study. The recommendations for improvement of efficiency of the target units were appreciated by all the participants.

Mr. Shimizu said that further deliberation is necessary in NTPC before decision making for implementation of each recommendation. He stressed that JICA ST is a Joint Venture formed by three Japanese Electric Utilities and they are not Equipment manufacturers and outlined the possible activities which JICA ST can execute.

Regarding the future schedule, he mentioned that the suggested items in FY2010 namely Turbine RLA and Training in Japan for Boiler RLA need JICA consent before finalization. For conducting Turbine RLA, he requested Chairman, Steering Committee, Sh. Chandan Roy for firm schedule of units between June and July 2010 as Turbine RLA could not be carried out in FY 2009 due to changes in shut down schedule of target units and constraints due to specific work window of JICA ST. He said that this action could result in timely acceptance by JICA.

Mr. Miyagi presented the salient findings of Combustion Simulation Study carried out for Vindhyachal boiler.

Mr. Hayakawa presented the salient observations of the demonstration of boiler Residual Life Assessment techniques carried out at Singrauli Unit 6 & Unchahar Unit 2.

Mr. Fujimori presented Japanese practices of Residual life Assessment of Generators & Generator Transformers.

Discussion Points:

- NTPC appreciated the 'Combustion Simulation Study' carried out for Vindhyachal Unit 7 boiler and requested JICA ST for additional simulation cases to find solution to the problem of shortfall and imbalance in steam temperatures. It was specifically requested to simulate three scenarios as follows to achieve rated steam temperatures.
    - Simulated Coal flow imbalance amongst the corners
    - Simulated variations from nominal value in wind box pressure (Same pressure in both left and right wind boxes)
    - Simulated variation in imbalance in left and right wind box pressure

  The intent in each of the above scenarios is to create abnormal fireside conditions to achieve design steam temperatures and minimal imbalance between left and right without boiler modifications.

  NTPC also requested for association of NTPC engineers during the Simulation exercise by the Japanese service provider.

  JICA ST informed that they would discuss with service provider and revert back; Also, that the contract with Service Provider has finished and further approvals from JICA would be required for additional simulation cases and participation in the simulation.

- NTPC requested JICA ST to conduct Turbine RLA as per Scope of Work before completion of the Study in Oct'10. NTPC will write separately to JICA with firm schedule (without any changes at later stage) of unit overhauls (maximum 2 units), wherein Turbine RLA can be carried out within the window of June/July 2010.

- JICA ST has recommended that a team of NTPC engineers (Six persons for eight training days) could be trained in Boiler Inspection & RLA techniques at Kyuden Sangyo, Japan to upgrade their skills and demonstrate new techniques. NTPC will write separately to JICA requesting for organizing the training in Japan.

- Sh. Chandan Roy, Chairman, Steering Committee, suggested that the collaboration should continue after completion of the current study and should identify the potential areas for future collaboration. A mechanism to continually share knowledge and experience should be established through a possible utility exchange program and regular trainings in Japan.

  Mr. Toru Kobayakawa, JICA India informed that the current study has a defined Scope of Work and any further collaboration can be done separately on a project basis. He also mentioned that there are other similar programs such as APP (Asia-Pacific Partnership on Clean Development and Climate) supported by Ministry of Economy, Trade & Industry (METI), Japan and the information exchange program with the Japanese electric utility that may be utilized by NTPC.

The meeting ended with a 'Vote of Thanks' by Sh. Pankaj Bhartiya, GM (CenPEEP)

Attachment

(1) Attachment-1: Agenda

(2) Attachment-2: List of Attendees

ATTENDED BY :

NTPC

(1) Mr. Chandan Roy
(2) Mr. D.K. Agrawal
(3) Mr. A.K. Mahendru
(4) Mr. H.K. Sandhir
(5) Mr. A.K. Sinha
(3) Mr. Pankaj Bhartiya
(4) Mr. S. Bandopadhyay
(5) Mr. A.K.Mittal
(6) Mr. Alok Gupta
(7) Mr. A.K.Arora
(8) Mr. R.K.Khurana
(9) Mr. Surendra Prasad
(10) Mr. Subodh Kumar
(12) Mr. D.Banerjee

JICA

(1) Mr. Toru Kobayakawa
(2) Ms. Shashi Khanna

JICA Study Team

(1) Mr. Noriyuki Shimizu
(2) Mr. Morikuni Miyagi
(3) Mr. Nobuchika Koizumi
(4) Mr. Hiroyuki Hayakawa
(5) Mr. Takashi Fujimori
(6) Mr. Kyoichi Nakanishi
(7) Mr. Katsumi Yoshida

J Power

(1) Mr. Shingo Takagi

8.1.4 第４回ステアリングコミッティ議事録

The Study

on

Enhancing Efficiency of Operating

Thermal Power Plants in NTPC-India

Minutes of Meeting

of

Fourth Steering Committee

(14.09.2010)

JICA, JICA Study Team,

Ministry of Power (MOP), NTPC

Venue: NTPC Noida

Pankaj Bhartiya

Mr. Pankaj Bhartiya
General Manager
NTPC Limited
India

N. Shimizu

Mr. Noriyuki Shimizu
Leader
JICA Study Team
Japan

Mr. Pankaj Bhartiya, GM, CenPEEP welcomed Mr. S.C. Pandey, Executive Director (Engg) NTPC, & Chairman, Steering Committee, Mr. Yukihiro Fukuda, Counsellor, Embassy of Japan, New Delhi, Mr. Goki Inada, First Secretary, Embassy of Japan, Mr. K.C. Sharma, Under Secretary, Ministry of Power, Govt. of India, Mr. Hiroshi Suzuki, Senior Representative, JICA India, Mr. Sharad Anand, Executive Director (NETRA), NTPC and N. Shimizu, Team leader JICA-ST, Mr. H.K. Sandhir, GM(OS), Mr. Thangapandian, GM-Vindhyachal, Mr. D. Bhattacharya, GM-NETRA and all members of JICA ST and other participants for attending 4th Steering Committee Meeting on 'The Study on Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India'.

He talked in brief about the journey of the project and study activities carried out under the Study. He informed that activities of the study project have been completed and JICA ST has submitted the draft final report. He also mentioned that the observations, findings & recommendations of JICA ST were discussed by NTPC engineers from all stations in a workshop and seminar at PMI, Noida and appreciated the efforts put in by members of JICA ST. Engineers from four state utilities and World bank also participated in seminar. He also mentioned that the dissemination process will continue through various workshops and seminars being organized by CenPEEP.

Mr. Yukihiro Fukuda, Counsellor, Embassy of Japan, New Delhi, in his opening remarks expressed happiness and honor for his participation in 4th and final Steering Committee Meeting. He shared that the dissemination of the study findings in the workshop and seminar organized at PMI has been quite successful. He thanked NTPC team and MOP officials who worked hard to make the study successful. He mentioned that the Guideline and Manual prepared during the Study and the recommendations of the Study would be very useful and contribute to the efficiency improvement of NTPC plants and Indian power sector.

Mr. Hiroshi Suzuki, Sr. Representative, JICA India, thanked JICA ST and NTPC for executing the study project successfully. He appreciated strong involvement of NTPC team in the study execution and shared that the recommendations are to be realized by NTPC independently. He shared that this is a successful study and would help in development of Indian Power Sector.

Mr. S.C. Pandey, Executive Director (Engg) NTPC, & Chairman, Steering Committee welcomed Mr. Yukihiro Fukuda, Counsellor, Embassy of Japan, Dr. Goki Inada, Embassy of Japan, Mr. Hiroshi Suzuki, Sr. Representative, JICA India, JICA ST and all the participants and appreciated the successful execution of the study through continuous interaction with Japanese Utilities and service providers. He stressed that the findings of the study should be disseminated in Indian Power sector. He assured that NTPC would try to translate the learnings into practice and replicate the same. He further shared that NTPC needs to bridge the gap between design and operating efficiencies and sought Japanese support for the same.

Mr. Pandey emphasized the need for

- A mechanism for further interaction of NTPC with Japanese experts
- Training of 3-4 NTPC teams in Japan every year
- Visits of NTPC senior officials to Japanese utilities.

He thanked Counsellor, Japanese embassy, JICA India and MOP for their support to the Study.

Mr. K. C. Sharma, MOP, welcomed all the participants and expressed pleasure in attending the 4th Steering Committee meeting. He said that CenPEEP had continuously briefed Ministry of Power about the progress of the Study. He expressed that NTPC has benefited from the interactions during the six training programs conducted in Japan. He said that the Study findings will benefit Indian Power Sector.

Mr. Sharad Anand, ED, NETRA welcomed the Japanese team and said that the current study on efficiency enhancement is very timely. He shared that a large no of NTPC units have crossed 100000 operating hours and demonstration & training on boiler and turbine RLA were very useful.

Mr. A.K.Arora, CenPEEP made a brief presentation outlining the Scope and methodology of various activities carried out at NTPC stations and the salient learnings from the Study and the visit of NTPC counterpart team to Japan.

Mr. Shimizu, Leader, JICA Study Team in his presentation summarized the study findings, recommendations for each assessment item, road map for Implementation and current status of various proposals. He further discussed the achievement of study vis-a-vis study objectives and shared his observations. He sought information on the current status of action plan for Vindhyachal U-7. The same was provided by Mr. Thangapandian.

Mr. Miyagi presented the salient findings of Combustion Simulation Study carried out for Vindhyachal U-7 boiler. He said that the additional simulations for variation in corner to corner coal flow and air flow, as requested by NTPC, have been completed. He shared that there is no impact of introducing corner to corner air and coal flow imbalance on temp imbalance and MS temperature. He also informed that training and discussion on combustion simulation in Japan, as requested by NTPC, has been completed.

Discussions:

- Mr. S. Bandyopadhyay, GM, CenPEEP, informed that Misumi plant in Japan uses multi point Oxygen probes for representative measurements - 4 measurement points in each probe and three probes in each gas duct. NTPC can also consider use of similar systems.
- Mr. Bandyopadhyay also pointed out that the techno economic analysis for air heater seals and turbine seals is based on the experience of improvement achieved in Japanese utilities and the proposals need to be customized for high ash Indian coals and operating conditions with the technical justification for improvement proposed.
  Mr. Shimizu responded that Japanese OEM can explore options to address high ash impacts.
- Mr. Thangapandian, informed that the simulation study recommendations are very useful. In line with the recommendation of the study and discussions with OEM, Cross connection after divisional panel, increase in LTSH area and upgradation of Reheater tube material are being planned. Its execution may take 2 to 3 years time. He also said that the use of ALCS in air heaters of older units would lead to improved ID fan margins and performance improvement.
- Mr. P. Bhartiya, GM, CenPEEP also informed the participants that all stakeholders like Project Engg, R&M Engg, NETRA, OS, CDM group etc (of NTPC) were associated during the course of study so that the recommendations can be critically analysed. He further reiterated the need of suitable mechanism for continued interaction between NTPC and Japanese Utilities and training of NTPC teams in Japan.
- Mr. Sharad Anand appreciated the collaborative study in the light of Indo-Japan friendship and reiterated the importance of efficiency improvement for reducing GHG emissions. He emphasized the need for making a detailed action plan for

efficiency improvement.

- Mr. S.C. Pandey, ED Engg, suggested to continue the information exchange and learnings of best practices through exchange visits of senior officials and explore areas of further cooperation.

The meeting ended with a 'Vote of Thanks' by Sh. S. Bandyopadhyay, GM (CenPEEP)

Attachment

(1) Attachment-1: Agenda

(2) Attachment-2: List of Attendees

ATTENDED BY :

NTPC

1. **Mr. S.C. Pandey**
2. **Mr. Sharad Anand**
3. **Mr. H.K. Sandhir**
4. **Mr. Pankaj Bhartiya**
5. **Mr. S. Bandyopadhyay**
6. **Mr. V. Thangapandian**
7. **Mr. D. Bhattacharjee**
8. **Mr. A.K.Mittal**
9. **Mr. J. Rajendran**
10. **Mr. Brajesh Singh**
11. **Mr. S. Sarkar**
12. **Mr. S.Hembram**
13. **Mr. R. Daga**
14. **Mr. A.K. Arora**
15. **Mr. R.K.Khurana**
16. **Mr. Surendra Prasad**
17. **Mr. Subodh Kumar**
18. **Mr. Partho Nag**
19. **Mr. S.P. Karna**
20. **Mr. A.K. Das**
21. **Dr. D. Banerjee**
22. **Mr. U.S. Verma**
23. **Mr. Anand K. Jha**

24. Mr. Manoj Kumar
25. Mr. Yogesh Kumar

<u>Japan Embassy</u>

1. Mr. Yukihiro Fukuda
2. Dr. Goki Inada

<u>JICA</u>

1. Mr. Hiroshi Suzuki

<u>JICA Study Team</u>

1. Mr. Noriyuki Shimizu
2. Mr. Morikuni Miyagi
3. Mr. Nobuchika Koizumi
4. Mr. Tatsuya Morooka
5. Dr. Hiroyuki Hayakawa
6. Mr. Takashi Fujimori
7. Mr. Kyoichi Nakanishi
8. Mr. Katsumi Yoshida
9. Mr. Makoto Yotsumoto

8.2 プレゼンテーションスライド

8.2.1　第１回ワークショップ

JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

Introduction for Workshop on Efficiency Management Activities in Japan

Noriyuki SHIMIZU

J-POWER

Japan International Cooperation Agency

Objectives of The Study

1. To improve the efficiency of coal-fired thermal power stations in India
2. To transfer to our counterpart the technology that is necessary to achieve the above objective

by applying the manners and technologies typically implemented by Electric Utilities in Japan

Study Team Formation

Joint Venture of:

	Installed Capacity (MW)
● Electric Power Development Co.,	16.4GW
● Kyusyu Electric Power Co.	19.7GW
and	
● Chugoku Electric Power Co.	11.8GW

Study Team Formation

Joint Venture of:

- Electric Power Development Co.,
- Kyusyu Electric Power Co.

  and
- Chugoku Electric Power Co.

Experiences+Strength:

⇒Many International Consulting Projects, 16 in India

⇒Cooperation Agreement with NTPC

⇒Training System and Experiences for oversees Trainees

Team Member

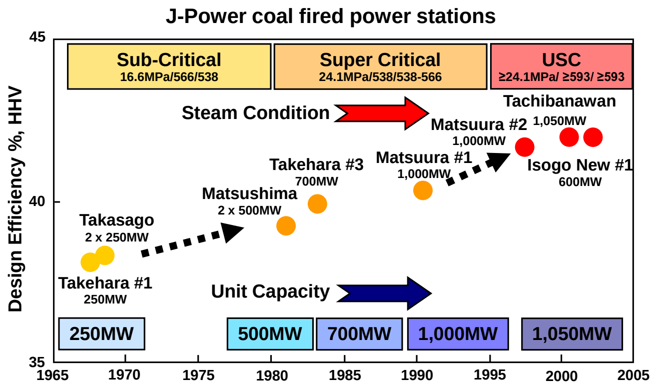
Shimizu	J-Power	Leader
Miyagi	J-Power	Sub -leader, Boiler
Koizumi	J-Power	Turbine, RLA-turbin
Fujimori	Chugoku EPCo	Electrical
Okame	Chugoku EPCo	C&I
Hayakawa	Kyushu EPCo	RLA-boiler
Morooka	J-Power	Efficiency Assesment
Yotsumoto	J-Power	CDM
Yamaguchi	Kyushu EPCo	Economic&Financial
Kuba	Kyushu EPCo	Coordinator
Tamura	Chugoku EPCo	Training Program

Trend of Efficiency Improvement

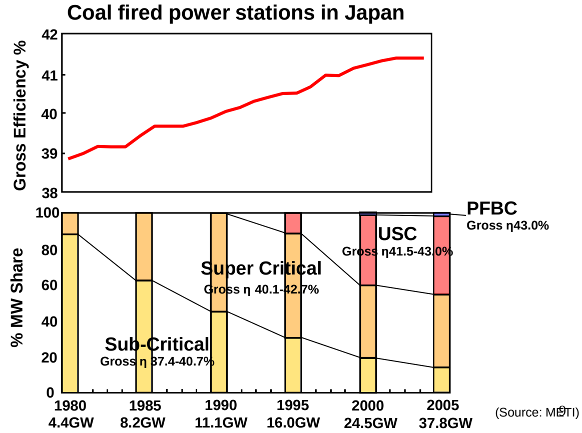
Coal fired thermal power stations in Japan

1. Upgrade of steam condition
   - sub critical < 22.1MPa
   - super critical ≥22.1MPa, ≤ 566ºC
   - ultra super critical ≥22.1MPa, >566ºC
2. Size up of Unit Capacity
   - ~200MW to 1,000MW+
3. R&D of new technologies
   - IGCC
   - IGFC

Efficiency Improvement

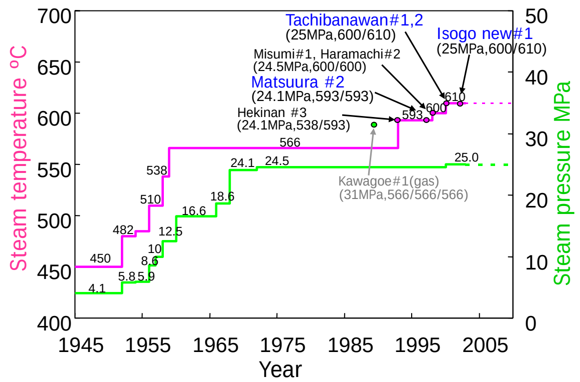


Historical Efficiency Improvement



(Source: METI)

Upgrade of Steam Condition



R&D of New Technology

PCF		IGCC	IGFC
		1500ºC class	
USC	A-USC 700ºC class		FC
Boiler ST	Boiler ST	Gasifier GT ST	Gasifier GT ST
Gross η: 43% Net η: 41% (HHV)	Gross η: 50% Net η: 48%	Gross η: 51-53% Net η: 46-48%	Gross η: ≥60% Net η: ≥55%

(Source: JCOAL)

USC Coal-fired Power Stations in Japan

Electric Power Co.	Power Station	MW	MPa/MST/RST	COD
Chubu	Hekinan #3	700	24.1/538/593	1993
Tohoku	Noshiro #2	600	24.1/566/593	1994
Hokuriku	Nanao Ota #1	500	24.1/566/593	1995
Tohoku	Haramachi #1	1,000	24.5/566/593	1997
J-Power	Matsuura #2	1,000	24.1/593/593	1997
Chugoku	Misumi #1	1,000	24.5/600/600	1998
Hokuriku	Nanao Ota #2	700	24.1/593/593	1998
Tohoku	Haramachi #2	1,000	24.5/600/600	1998
Shikoku	Tachibanawan	700	24.1/566/593	2000
J-Power	Tachibanawan #1	1,050	25.0/600/600	2000
Hokuriku	Turuga #2	700	24.1/593/593	2000
J-Power	Tachibanawan #2	1,050	25.0/600/600	2000
Chubu	Hekinan #4	1,000	24.1/566/593	2001
J-Power	Isogo New #1	600	25.0/600/610	2002
Hokkaido	Tomatoh Atsuma #4	700	25.0/600/600	2002
Chubu	Hekinan #5	1,000	24.1/566/593	2002
Kyushu	Reihoku #2	700	24.1/593/593	2003
Tokyo	Hitachinaka #1	1,000	24.5/600/600	2003
Tokyo	Hirono #5	600	24.5/600/600	2004
Kansai	Maizuru #1	900	24.5/595/595	2004

R&D of New Technology (cont'd)

IGCC Demo Plant	IGFC Pilot Plant EAGLE
▪ Output: 250MWe ▪ Test Period: 2007-2009 ▪ Developer: CCP R&D Co. (10 EPCos & CRIEPI) ▪ Air-blown gasifier	▪ Coal feed rate: 150t/d ▪ Test Period: 2001-2009 ▪ Developer: J-Power ▪ Oxygen-blown gasifier

Nakoso, Clean Coal Power R&D Co., Ltd.

Wakamatsu Research Institute, J-Power

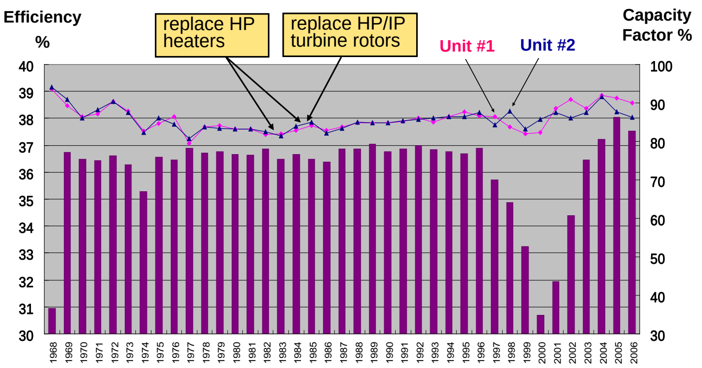
(Source: JCOAL)

Efficiency Management

1. Efficiency of coal fired power stations in Japan has been improved by upgrading of steam condition and size-up of unit capacity.
2. However, basis of efficiency management activities is same regardless of steam condition and unit size.
3. Such a basis can be applied to coal fired power stations in India, where sub-critical and 200-500MW class units are dominant.

Typical Efficiency Management Record

J-Power Takasago coal fired power station, 2x250MW



Activities in Takasago during 40years

1. Shut-down Maintenance
   Boiler: Biennially, Turbine: once every 4 years
2. Major Replacements of Facility
   - Boiler Tubes & SH/RH: 1985, 86, 89, 90, 91, 93, 94, 95, 96, 97 & 98
   - ESP Electrodes: 1987 & 88
   - Turbine Rotors: 1984 & 1985
   - FGD Absorbers: 1985 & 1986
   - Control System: 1985 & 1996
3. Daily Efficiency Management
4. CMMS (Computerized Maintenance Management System): 2002-
5. PdM (Predictive Maintenance by thermograph, vibration, oil analysis): 2002-

Typical Efficiency Management

1. Proper operation and maintenance to keep the efficiency at the level of the design efficiency
2. Active performance improvement by applying new technologies and/or replacing with high efficient equipment

Proper O&M

1. Monitor efficiency trend periodically
2. Analyze the deviation between current efficiency and the design efficiency to get the root cause
3. Devise countermeasures both during operation and /or periodical inspection shut-down

Typical O&M Activities

1. Operation
   - proper combustion management to reduce unburned carbon loss
   - proper soot blowing to prevent increase of flue gas temperature
   - proper management of feed water quality to prevent boiler tube corrosion and heat loss through boiler drum water blow
   - monitoring of air ingress into condenser

Typical O&M Activities (cont'd)

2. Maintenance
   - gap adjustment and replacement of turbine labyrinth seal
   - gap adjustment and replacement of AH seal
   - water washing and replacement of AH element
   - scale removal from turbine nozzle
   - boiler chemical washing
   - replacement of plugged condenser tubes

Active Performance Improvement

1. Gross heat rate improvement
   - application of AH SDS (Sensor Drive System) to reduce air leakage
   - application of high performance AH element for better heat exchange and corrosion proof
   - optimization of soot blowing
   - low flue gas O2 operation
   - application of high performance turbine blade and anti-erosive turbine nozzle

Active Performance Improvement

2. Net heat rate improvement
   (reduce in-house power consumption)
   - application of variable speed/pitch fans
   - partial in-service of aux. equipment

Workshop Agenda

1. Introduction
2. Efficiency management in Japan
3. Boiler performance improvement, RLA
4. Turbine/Aux. performance improvement, RLA
5. Electrical
6. C&I

We are happy to work with you to improve efficiency of coal fired power plants in NTPC/India as well as to proceed with technology transfer to our counterpart.

Thank You !

Japan International Cooperation Agency

JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

Efficiency management in Japan

Tatsuya MOROOKA

J-POWER

Table of Contents

1) Efficiency management concept in Japan

○Existing thermal power plants
Maintenance of design thermal efficiency
(proper Operation &Maintenance)

○New thermal power plants
Introduction of Best Available Technology
(GT combined cycle,USC)

2) Thermal Power Plants operation in Japan

○Thermal Power Plants
・Introduction of the latest performance technology
(for construction time)

○Independent Transmission System in island of Japan
・Operation from base load to peak load
(based on supply and demand)

2) Thermal Power Plants operation in Japan

To improve
the thermal efficiency of thermal power plants ･･･

【Ideal】
・Construct large capacity &
high efficiency thermal power plants
・Maintain design thermal efficiency
・Operate at maximum load ! but ･･･

2) Thermal Power Plants operation in Japan

【Reality】
・Life cycle of thermal power plant is about 40～50 years.
・We can’t construct large capacity thermal power plants because of stagnant electric demand in Japan.
・To accomplish electric power supply stability (social mission), we must operate from minimum to maximum loads.
・Utilization factor is decreasing due to increase of non fossil fuel’s electric power. (nuclear , solar etc.)

2) Thermal Power Plants operation in Japan

Number of units and total MW by COD decade
- coal fired power plants in Japan as of Y2005-

~1960's	8 units	1,448MW
1970's	3 units	550MW
1980's	21 units	7,699MW
1990's	23 units	14,067MW
2000's	25 units	13,341MW

※There are some old units alive.

2) Thermal Power Plants operation in Japan

○Approach for performance improvement

- **Replace**
- **Renovation**
- **Routine O&M**

2) Thermal Power Plants operation in Japan

○Replace

introduction of
Best Available Technology(BAT)

- **LNG combined cycle**
- **USC** **etc.**

2) Thermal Power Plants operation in Japan

○Renovation

remodeling according to aging deterioration

⇒Renovation by BAT

- **steam turbine blade (3D shaped)** **etc.**

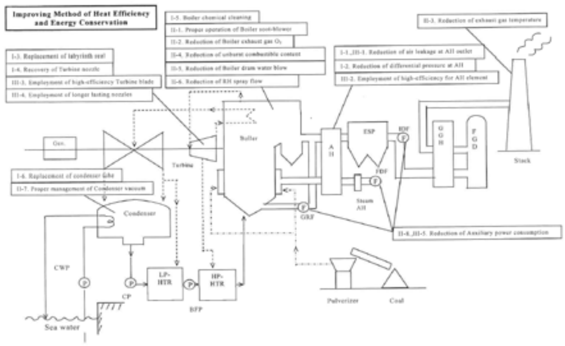
2) Thermal Power Plants operation in Japan

○Routine O&M

overhaul & daily mending

⇒just good timing
to maintain design thermal efficiency

2) Thermal Power Plants operation in Japan



2) Thermal Power Plants operation in Japan

○Efficiency management in Japan

Replace

Renovation

◎<u>Routine O&M</u>

※<u>Large investment</u> to construct new power plants

⇒We value <u>Routine O&M</u> to maintain design thermal efficiency.

2) Thermal Power Plants operation in Japan

Japan : maintain design thermal efficiency

India : ??? (coal fired power plants)

○POINT on this study

We pay attention to <u>the difference between the design and the actual thermal efficiency</u> .

⇒If there is a difference even a little, we might be able to improve the present efficiency without large investment.

To keep the design thermal efficiency is an simple & quiet activity. But it's a very important activity.

3) Management of thermal efficiency

○Management of thermal efficiency

- use of design coal
- management of <u>daily</u> actual efficiency
- management of <u>monthly</u> actual efficiency
- performance test（<u>before & after periodical inspection</u>）
- coal scale management (conveyer , coal feeder)
- maintenance management ⇒4) Maintenance scheme and program in Japan

<u>We want to evaluate the difference of above-mentioned items between Japan and India.</u>

3) Management of thermal efficiency

○Use of design coal

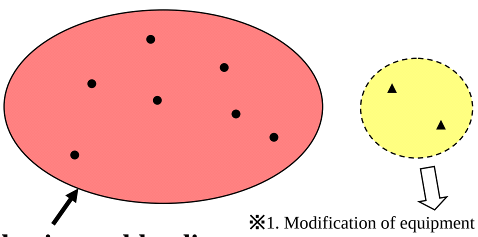
It's a very important factor to use design coal to maintain design thermal efficiency.

⇒If we don't use design coal, it causes the thermal efficiency decrease.

<u>We need to select or blend the coal to keep design thermal efficiency.</u>

3) Management of thermal efficiency

[design coal] [other than design coal]



<u>selection or blending</u>

※1. Modification of equipment to maintain emission regulation is indispensable.
2. As for the other influence, we study cost effectiveness of modification.

3) Management of thermal efficiency

○management of <u>daily</u> actual efficiency

- decision of items and values to be managed for thermal efficiency and in-house power requirement
- proper operation within allowable range decided above

※example of items to be managed for thermal efficiency

boiler : EcoO2, unburned carbon in ash

air heater : in and out gas temperature, differential pressure

steam turbine : main steam flow, 1st stage outlet pressure

condenser : vacuum

feed water heaters : inlet feed water pressure of high pressure heaters

3) Management of thermal efficiency

〇management of <u>monthly</u> actual efficiency

[In Japan]

- Each power station has responsibility to manage the actual efficiency. (not head office)
- The power plant can promptly discover the change in efficiency.
- The monitor and the analysis can be done at the same time in the power plant.
- The power plant can study improvement of efficiency most appropriately.

3) Management of thermal efficiency

〇management of <u>monthly</u> actual efficiency

[specific way of management]

- We record many data at rated output once every month.
- The purpose of record is to evaluate the difference between design values and actual values.
- example of evaluation items
  - boiler efficiency
  - steam turbine efficiency
  - gross thermal efficiency

3) Management of thermal efficiency

〇performance test

boiler：heat loss method

turbine：heat input and output method

thermal efficiency：heat input and output method

3) Management of thermal efficiency

〇coal scale management (conveyer , coal feeder)

- scale of conveyors for loading to and discharging from coal stock yard
  - zero point adjustment: every day
  - calibration : once every month
- coal feeder scale
  - calibration : periodical inspection
- coal property analysis
  - coal loading conveyer :each ship
  - discharging conveyer :moisture content (every day)
    calorific value (10 days average)
    ash composition (10 days average)

4) Maintenance scheme and program in Japan

〇Regulation system in Japan (Electric Utilities Industry Law)

Direct participation of the government
⇒Review of safety control about autonomous periodic safety inspection（Art.55）

Utility's voluntary preservation of security
⇒ Autonomous periodic safety inspection（Art.55）

- Overhaul interval
  - boiler : Biennially
    (steamdrum, header, tube, BFP, FDF,IDF etc.)
  - turbine : once every 4 years
    (steamturbine,condenser,MSV,GOV,RSV etc.)

4) Maintenance scheme and program in Japan

※Based on the Electric Utilities Industry Law・・・

a . Equipment for which overhaul is required

b . Equipment for which overhaul is not required
(we can decide the interval of overhaul)

⇒We schedule overhaul based on ・・・
- the Law (a)
- previous overhaul results (b)
- equipment conditions (b)

4) Maintenance scheme and program in Japan

Plant Maintenance Cycle

Plant Overhaul Maintenance Cycle

Year	1	2	3	4	5	6	7	8
Boiler Plant	M	BA	M	BA	M	BA	M	BA
Turbine Plant		TS		TA		TS		TA

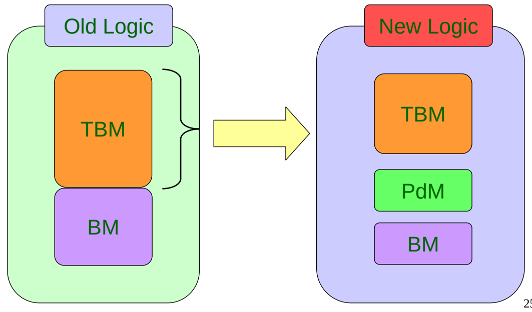
Typical Maintenance Outage Days

Class	BATA	BATS	M
300MW	45 days	43 days	15 days
500MW	63 days	55 days	15 days

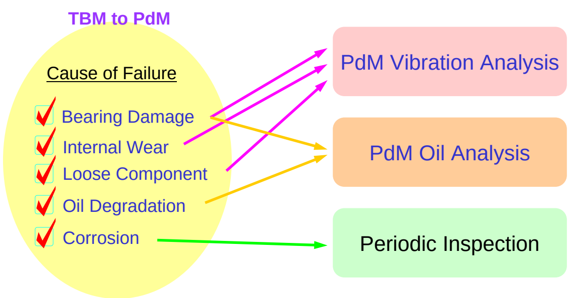
Note: BA(Boiler Major) TA(Turbine Major) TS (Turbine Minor)
M (Intermediate Inspection)

4) Maintenance scheme and program in Japan

・Introduction of PdM technologies



4) Maintenance scheme and program in Japan



Summary

1) Efficiency management concept in Japan
- ・Existing thermal power plants
  - ⇒maintain design thermal efficiency
- ・New thermal power plants
  - ⇒Best Available Technology

2) Thermal Power Plant operation in Japan
- ・Replace , Renovation , ◎Routine O&M
- ・POINT on this study
  - The thermal efficiency difference between the design and the actual.

Summary

3) Management of thermal efficiency
- ・We want to evaluate the difference between Japan and India.
  - use of design coal
  - management of daily actual efficiency ・・・ etc.

4) Maintenance scheme and program in Japan
- ・Regulation system in Japan
- ・Plant maintenance cycle
- ・PdM technology (TBM⇒PdM)

Thank You !

JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

Boiler Portion

Contents

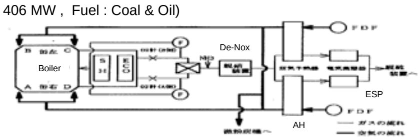
Boiler Performance improvement Introduction of cases in Japan
Eco Outlet gas O2 unbalance improvement

(Source: Energy conservation best practice national competition in 1994 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

1. Improvement Target:

To reduce unburned carbon by the modification of OFA damper control.

(Plant Rated Output: 406 MW , Fuel : Coal & Oil)



2. Phenomenon & Countermeasure

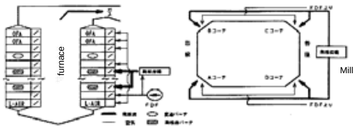
Boiler combustion air is controlled by FDF vane under the Boiler automatic control system which calculated total input fuel signal and Economizer (ECO) outlet O2 measurement value. However A and B side gas duct ECO O2 dose not controlled. (ECO outlet gas O2 A side: 4.2%, B side: 3.7%) They expected inhomogeneous combustion in the furnace.

Boiler Performance improvement Introduction of cases in Japan
Eco Outlet gas O2 unbalance improvement

(Source: Energy conservation best practice national competition in 1994 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

They focused on the OFA

and L-AIR damper control.



3. Improvement process

Study for OFA, L-AIR damper control system

Temporary Modification of OFA, L-AIR damper control system

Balance Test of ECO O2

Decision of Measurement from the test result

4. Result

Original=> ECO O2 A side: 4.2%, B side: 3.7%

Modification=> A side: 3.8%, B side: 3.8%

Boiler Performance improvement Introduction of cases in Japan
Boiler Gas Recirculation Fan (GRF) power consumption improvement by the speed control devices

(Source: Energy conservation best practice national competition in 1994 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

1. Improvement Target:

To reduce GRF power consumption without affecting fuel combustion in the Boiler.

(Plant Rated Output: 600 MW , Fuel : Oil)

2. Current Situation & Analysis (Plant Rated Output: 600 MW , Fuel : Oil)

a) 70% of Station power is consumed by GRF, FDF and CWP

b) Comparison study (actual and theoretical value) of the above three (3) major equipment power consumption

GRF (damper control): Theoretical value (Power assumed by the calculation) < Actual ➔ detail study is required

FDF (variable pitch control): Theoretical value> Actual ➔ no room for reduce power consumption

CWP (variable pitch control): Theoretical value = Actual ➔ no room for reduce power consumption

Boiler Performance improvement Introduction of cases in Japan
Boiler Gas Recirculation Fan (GRF) power consumption improvement by the speed control devices

(Source: Energy conservation best practice national competition in 1994 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

3. Improvement process

a) Study for large scale fan control system, cost and construction period.

b) Evaluation of those systems

c) Preparation of execution schedule (construction schedule)

4. Result

a) Unit 1 GRF applied VVVF system. Reduced Power consumption: 1190 kW (3560-2370)

Item	(a) Energy conservation	(b) Cost	(c) Reliability	(d) Operation	(e) Modification period	(f) Total points	(g) Result
variable wing	3	1	3	3	1	27	NA
Hydraulic coupling	3	2	3	3	3	162	A
VVVF	3	2	3	3	3	162	A
Pole change	2	3	3	1	1	53	NA
Evaluation Points 3	High (H)	H	H	H	Short	(axbxcxdxe)	
2	Medium (M)	M	M	M	-		
1	Low (L)	L	L	L	Long		

Boiler Performance improvement Introduction of cases in Japan
Improvement of Boiler efficiency by the Mill rotating classifier control program change

(Source: Energy conservation best practice national competition in 2002 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

1. Improvement Target:

To improve Boiler efficiency by the high fineness of pulverized coal.

(Plant Rated Output: 600 MW , Fuel : Coal & Oil)

2. Current Situation & Analysis

a) Boiler efficiency changed by the type of Coal.

Difference between Australia Coal A and D is 1 %.

b) Coal characteristic effected to dry gas heat loss, water heat of evaporation loss and unburned fuel loss.

It is necessary to take long period of operation test result in order to make effective operation procedure for reduction of dry gas heat loss and water heat of evaporation loss. Therefore ,they focused on the unburned fuel loss reduction.

Improvement of Boiler efficiency by the Mill rotating classifier control program change

(Source: Energy conservation best practice national competition in 2002 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

3. Improvement process:

a) Study of Mill rotating classifier control program ➔ Rotating speed change

b) Study of Mill outlet flow rate of coal and fineness of coal

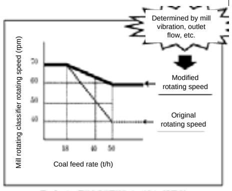
c) Study of Mill vibration and power consumption

4. Result

a) Boiler efficiency and Mill power consumption increased.

However total cost reduced.

	Australia Coal A		Australia Coal B	
	Before modification	After modification	Before modification	After modification
Unburned fuel loss	0.4 %	0.3%	0.25%	0.15%
Boiler efficiency	90.04%	90.13%	90.11%	90.21%
Mill Power Consumption	1,707 kW	1,971 kW	1,847kW	2,151 kW



Improvement of Power Consumption by the Low O2 Operation

(Source: Energy conservation best practice national competition in 2001 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

1. Improvement Target:

To reduce power consumption of draft fans by the low O2 operation under the adequate Boiler combustion air.

(Plant Rated Output: 175 MW , Fuel : Oil)

2. Current Situation & Analysis

a) Boiler outlet gas O2: 3.0% at 175MW , 3.5% at 145MW.

b) Boiler combustion air is controlled by main steam flow and gas O2 signal.

c) Unburned fuel is able to measure at ESP hopper.

d) Boiler outlet O2 is fluctuating plus minus 0.2%

e) It is necessary to utilize OAP (OFA) and secondary air resister for air supply

f) Boiler outlet gas analysis is required for review of combustion state.

Improvement of Power and/or Fuel consumption by the Low O2 Operation

(Source: Energy conservation best practice national competition in 2001 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

3. Confirmation test

a) Conditions

Boiler outlet O2 value change, 4 hours constant output (MW) and 4 hours and OAP (OFA) and secondary air resister adjustment

175 MW: 3.0% O2, 2.5% O2, 2.3% O2, 140MW: 3.5% O2, 3.0% O2, 2.8% O2

4. Result

a) Draft Fan power Consumption & Boiler Efficiency

MW	O2 set value(%)	Power Consumption (kW)	Reduction (kW)	Boiler Efficiency (%)	Deference (%)
175	3.0	2,033.19	74.67	86.36	0.25
	2.5	1,958.52		86.61	
140	3.5	1,712.85	61.74	87.15	0.07
	3.0	1,651.11		87.22	

Shortening of the duration for Annual Inspection work by the new method

(Source: Energy conservation best practice national competition in 2001 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

1. Improvement Target

To reduce 104 days duration of annual inspection on 600MW coal fired thermal power plant. (Plant Rated Output: 600 MW , Fuel : Coal & Oil)

2. Current situation & analysis

a) Unit 1 annual inspection duration on fiscal year 1998 required 104 days for all of the power plant equipment.

b) Lot of Dead time and waiting time for the works

c) Boiler furnace scaffolding assembling/disassembling and/or ash scrape out required time and manpower.

d) Limitation of crane utilization time due to the same schedule of dismantles for Generator and Steam Turbine.

e) It was take time repair the machine at the factory

f) Boiler combustion tuning was executed about 26 days

g) the manager could not instruct to staff timely due to the coordination meetings

Shortening of the duration for Annual Inspection work by the new method

(Source: Energy conservation best practice national competition in 2001 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

3. Result

(): shortening days

a) critical works applied two (2) shift working: (5days)

b) reviewing number of meeting and changing start of the works: (2days)

c) rationalizing boiler combustion tuning: (1day)

d) changing of Generator H2 leak test: (2days)

e) reviewing of control characteristic confirmation test items: (3days shortening)

f) holding of spare parts for the machine which repair at the factory : (5 - 11days)

h) modification of Boiler furnace scaffolding : (6days)

i) developing/operating acoustic wave ash scrap out system from the Boiler: (1day)

j) developing/operating ash removal equipment by water-jet: (1day)

k) re-scheduling Turbine inspection: (5days)

l) reviewing Boiler inspection items and applying two (2) shift working: (10days)

Shortening of the duration for Annual Inspection work by the new method

(Source: Energy conservation best practice national competition in 2001 fiscal year in Japan, which was organized by Ministry of Economy, Trade and Industry)

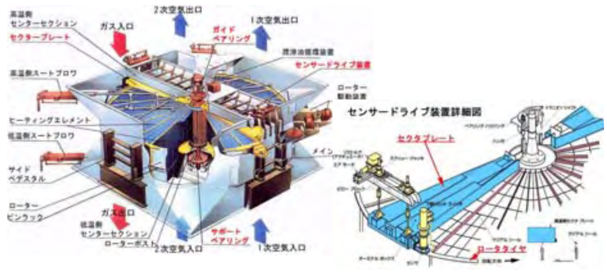
3. Result

	1997	1998	1999
(a) Annual Inspection Unit	Unit 1	Unit 2	Unit 1
(b) Type of Annual Inspection	Boiler: Full Turbine: Partial	Boiler: Partial Turbine: Simplified	Boiler: Partial Turbine: Simplified
(c) Duration	104 days	78 days	58 days
(d) Boiler preventive maintenance period	20 days	14 days	10 days

Boiler Performance improvement
Air Heater

Automatic Leakage Control

Tri-sector Air Heater



Boiler Performance improvement
Real time measurement of Coal in Coal fuel pipes

PROMECON

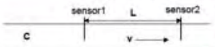
Summary

•PROMECON´s MECONTROL measurement provides both, mass per length (concentration) measurement as well as velocity measurement.
•For the customer it is most important that a measurement can be VERIFIED. The best way to do this is by BALANCING.
•MECONTROL allows such balancing due to the absolute and independent measurement of both: MASS FLOW and VELOCITY (Dirty Air Flow)
•MECONTROL provides the a proven track record of accurate mass flow installations in the power industry.
•MECONTROL provides a proven track record of accurate Air flow measurements on mill outlets.
•out of mass flow and air flow one can calculate the fuel air ratio

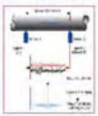
Boiler Performance improvement
Real time measurement of Coal in Coal fuel pipes

PROMECON

Mass flow measurement of pulverized fuel



Coal velocity is measured by cross correlation method.



Coal concentration C in the pipe is mass m per length unit L and is measured using microwave resonance:

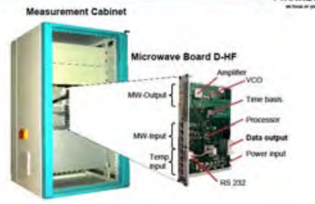
$$f = \frac{c}{\sqrt{(1+C\cdot\varepsilon_r)\mu_r}\cdot\lambda}$$

Measurement is:
absolute, indirect
Needs: No k-factors

Measurement is:
absolute, direct
Needs:No k-factors

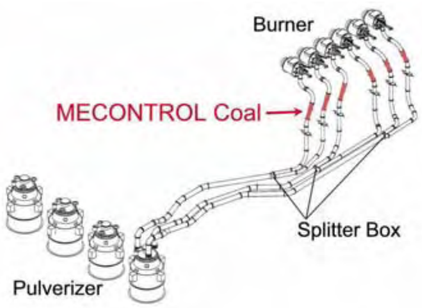
Boiler Performance improvement
Real time measurement of Coal in Coal fuel pipes

PROMECON



MECONTROL Coal Measurement Cabinet

Boiler Performance improvement
Real time measurement of Coal in Coal fuel pipes



Boiler Performance improvement
Online Measurement of the Unburned carbon in the Fly Ash

PROMECON

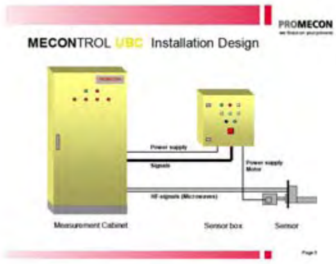
Combustion optimization

MECONTROL UBC

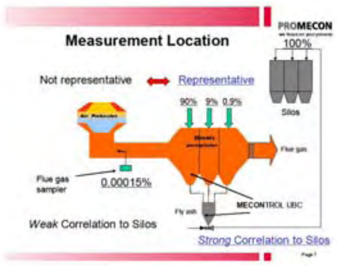
Online measurement of the unburned carbon in the fly ash

Boiler Performance improvement
Online Measurement of the Unburned carbon in the Fly Ash

Boiler Performance improvement
Online Measurement of the Unburned carbon in the Fly Ash



Boiler Performance improvement
Online Measurement of the Unburned carbon in the Fly Ash



Boiler Combustion Turning

Outline of Boiler Combustion Tuning Procedure

1. Condition
   - a) Boiler continuous operation at rated output
   - b) correction of measurement hardware
   - c) providing same type of coal
   - d) soot blower is not applied during the test
   - e) combustion Air box damper setting
2. Measurement items
   - (1) combustion characteristic
     - a) Visual inspection internal of the furnace (brightness, confirmation of combustion status at burner portion)
   - (2) ECO outlet O2
   - (3) Mill
     - a) pulverized coal particle size measurement
     - b) Mill outlet temperature and Amount of Mill pyrite
     - d) Vibration of Mill and Mill operation records (mill motor current, etc..)

Boiler Combustion Turning

Outline of Boiler Combustion Tuning Procedure

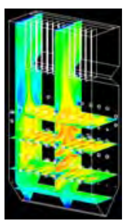
2. Measurement items
   - (4) NOx value
   - (5) Unburned fuel in ash (Sampling of fly ash at EP hopper and measurement of unburned fuel)
   - (6) Slugging and fouling characteristic
     - Confirmation of Bottom ash situation, number of times for soot blower, records of Boiler metal temperature
   - (7) Plant Control characteristic
     - a) Boiler static character
     - b) Boiler dynamic character

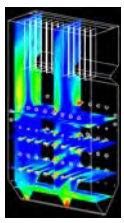
Boiler Combustion Turning

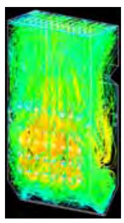
Outline of Computer Simulation

Computer Simulation of boiler combustion is able to simulate combustion gas flow, trajectory of particular, temperature distribution, oxygen concentration, etc..

It is useful for study of combustion optimization (decreasing of unburned carbon and NOx & SOx).


temperature distribution

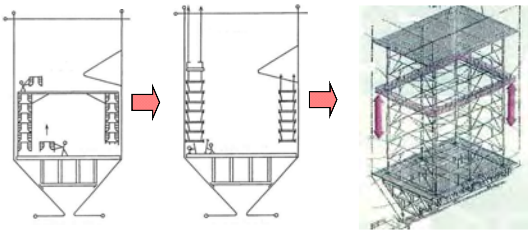

oxygen concentration


trajectory of coal particular

Boiler Annual Inspection Period improvement by Scaffolding

Scaffolding in the Boiler Furnace

Safety Stage System (Hoisting Scaffolding system)



250MW class boiler scaffolding assembling and disassembling period

(26 days) (16 days) (16 days or less ?)

Thank You !

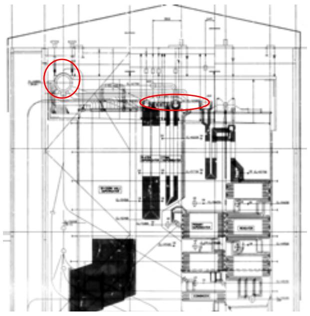
JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

Boiler Portion

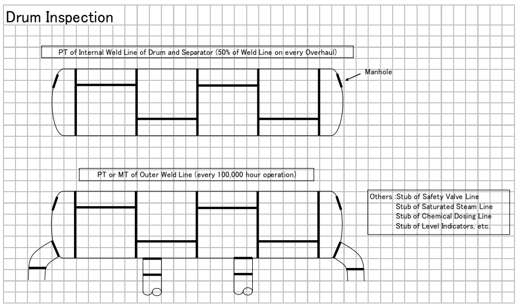
Area of Inspection

Area of Inspection

- **Disassembly and removal of Internal Components for VI**
  - Half Section at Each Inspection
- **Internal Sketch for Recording**
  - Location and Size of Defects
  (Crack, Corrosion, and Erosion)
- **P.T on Welding on Studs, Manhole and Waterline inside Shell**
- **Chemical Analysis on Sedimentation Materials**
- **External Welding Inspection on 100,000 hours**



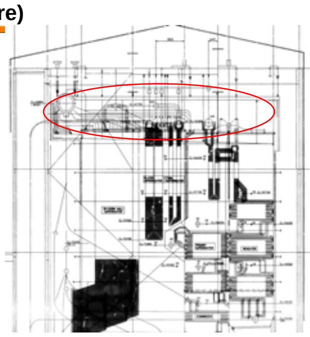
Steam Drum - Welding Inspection



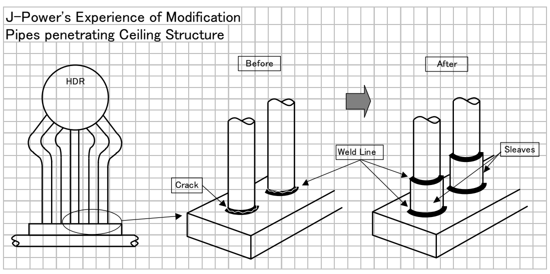
Area of Inspection - 2
(Upper Level Boiler Structure)

Penthouse Area

- Position of Air vent pipes, hangers and drain lines
  - Boiler Movement due to heat expansion
- PT on Welding Joint of Sampling lines
- P.T on Welding of stub pipes of header
- P.T on Weld line of the roof penetrating pipes for representative pipe



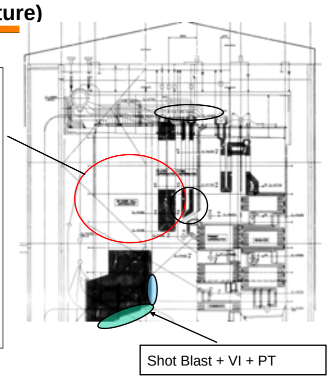
Roof Penetration Area



Area of Inspection - 3
(Upper Level Boiler Structure)

Div Wall, Platen, Final SH

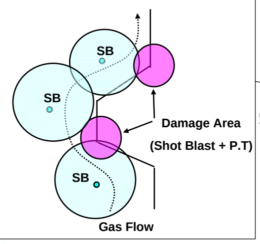
- Shot Blasting on Transition Welding and Attachment Welding (+/- 1m from Joints) for Visual Inspection
- P.T on Welding
- Check on Elephant Skin (Fire Crack)

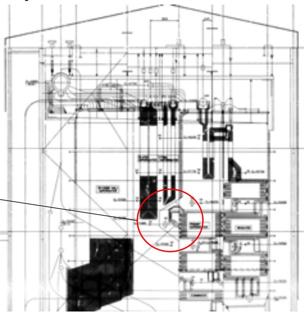


Area of Inspection - 4
(Upper Level Boiler Structure)

Nose Area

- **Erosion due to Sootblowing**
- **Erosion due to Gas Turbulence**





Area of Inspection -5
Middle Level of Boiler Structure

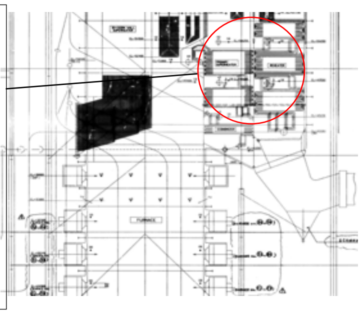
Heat Recovery Area

Major Problem

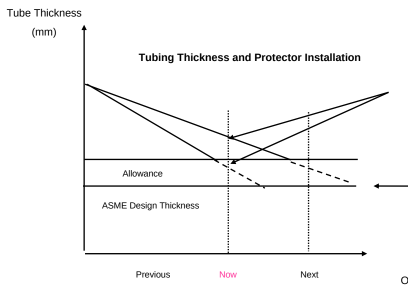
- Ash Erosion by Flue Gas
- Ash/drain cut by Sootblower

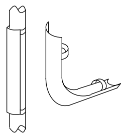
Inspection

- Air Blow Cleaning
- Visual and Touch Inspection (Especially Corner Area)
- Thickness Measurements

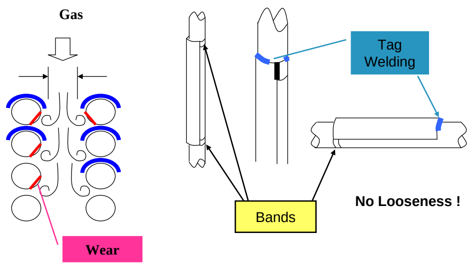


Thickness Measurement and Tube Protector





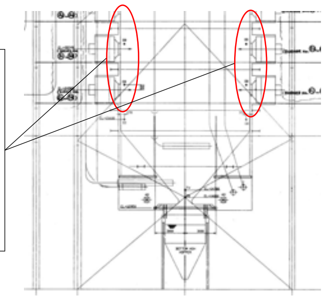
Tube Protectors



Area of Inspection 6 -Lower Level of Boiler Structure

Burner Area

- Damage of castable and bending of its studs
- Fire cracks (Elephant Skin)
- Tube sampling and scale analysis
- Careful inspection required especially after Condenser Sea Water Leak



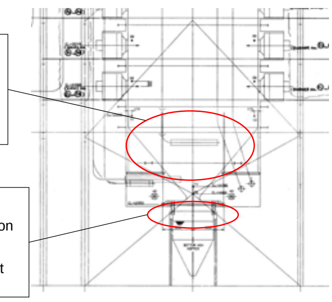
Area of Inspection 6 -Lower Level of Boiler Structure

Boiler Bottom Area

- Piping dent due to Clinker and repair welding
- Check Damages after removal of Scaffolding

Bottom Ash Hopper

- Damage of castable and corrosion of Seal Plates
- Scaling of Overflow Piping → Jet Cleaning



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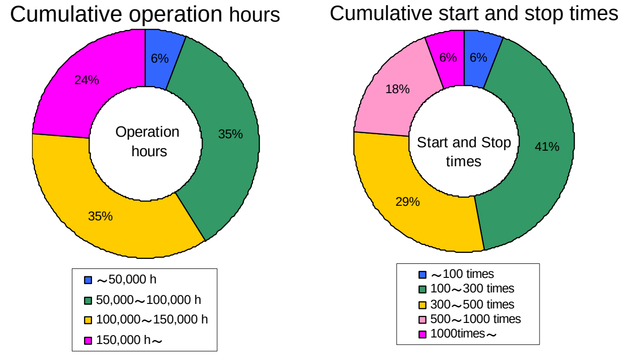
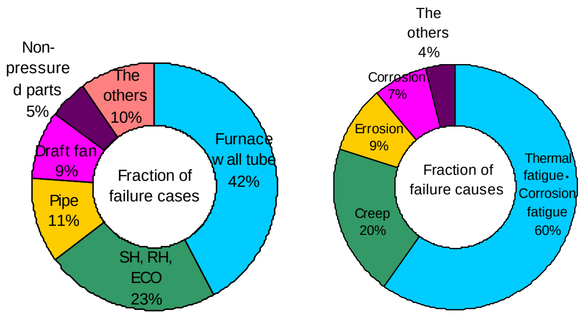
Life Assessment of Thermal Power Plant Boiler Components

Operation Condition of Thermal Power Plants



17 units in Kyusyu Electric Power Company

Statistics on Failure Cases and Causes of Boiler Equipment

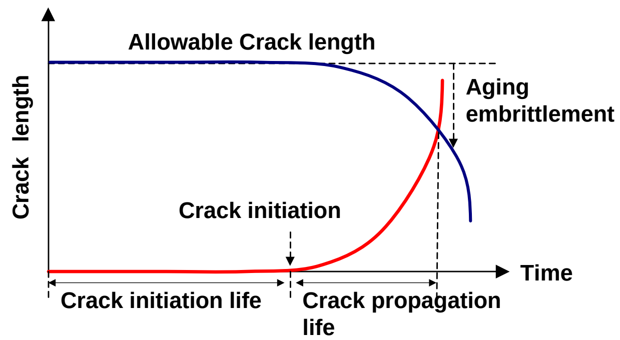


In pressured equipments

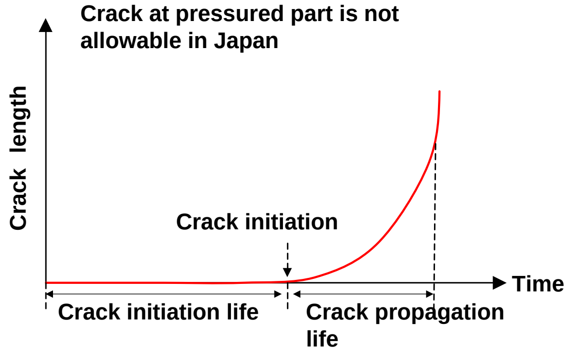
Failure Classification and Deterioration Factors of Boiler Equipments

Classification	Deterioration factors
Creep	Long-term creep
	Short-term creep
Fatigue	Thermal fatigue (Low cycle fatigue)
	High cycle fatigue
	Corrosion fatigue
Corrosion	High temperature corrosion
	Low temperature corrosion
	Pitting
	FAC (flow accelerated corrosion)
	Stress corrosion cracking
Errosion	Ash cut
	Steam cut

Crack Initiation Life and Crack Propagation Life(1)



Crack Initiation Life and Crack Propagation Life(2)



Non-Destructive Inspection Method for Main Deterioration

Classification	Phenomenon	Non-destructive Inspection method
Creep	Swelling at late life	Replica, etc.
Fatigue	Surface cracking	PT,MT
Corrosion	Decrease of thickness	Thickness measurement
Errosion		
Stress corrosion cracking	Surface cracking	PT,MT
Corrosion fatigue	Inner surface cracking	UT

Boiler Tube Overhaul Inspection

Water wall, SH, RH, Eco tubes

Inspection measure	Deterioration factors	Inspection inerval
VT	Errosion Corrosion Thermal deformation Cracking Burnout	Periodic inspection (every 2years)
PT	Dissimilar metal weld failures	
Thickness measurement	Errosion Corrosion	
Examination of sampling tube	Scale and deposition	Nesessary interval
PT for welding fin	Low cycle fatigue	In case of elongation of periodic inspection interval (max. 2years)
Measures for errosion	Errosion	
Measures for SUS scaling	SUS scaling	
PT for attached metal weld part of tube	Low cycle fatigue	After 80,000 hours operation
Remaining life assessment	Creep	Judge from operation and design condition

Steam Drum and Water Drum Overhaul Inspection

Steam drum, Water drum

Inspection measure	Inspection portion	Deterioration factors	Inspection inerval
VT	・Drum inside	Deposit Corrosion Errosion	Periodic inspection (every 2years)
Chemical analysis		Deposit	
PT	・Inner weld line ・Inner corner of stub ・Support and hanging lug	Low cycle fatigue	
MT	・External seam and girth weld line ・Inner weld line of stub	Low cycle fatigue	After 80,000 hours operation

Boiler Header Overhaul Inspection

Header

Inspection measure	Inspection portion	Deterioration factors	Inspection inerval
VT	General appearence	Errosion Corrosion Cracking Leak from weld part	Periodic inspection (every 2years)
PT (MT)	Stub weld with no flexible structure and no rounding of weld end toe	Low cycle fatigue	
VT Chemical analysis of deposit	Headder inside	Low cycle fatigue Errosion Deposition	Periodic inspection (every 4years)
PT (MT)	Header stub weld Support metal weld	Low cycle fatigue	After 80,000 hours operation
MT	Header girth weld and seam weld	Creep	
Remaining life assessment	Most damaged header and pipe beyond 450℃	Creep	To extend priodical inspection interval 2 year to 4year after 100,000 hours
	High temperature Header and pipe	Creep	Consideration in inspection plan

Aging Deterioration Problem

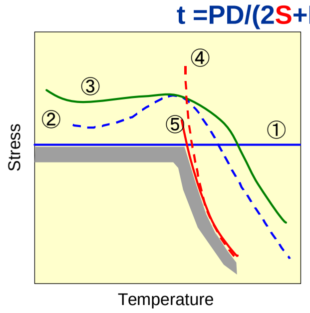
Thickness required is not always enough to creep rupture for aging boilers exceeded 100,000h operation.

t =PD/(2S+P)+0.005D

P: Internal pressure
D: Outer diameter
S: Allowable stress

What rules allowable stress S ?

t =PD/(2S+P)+0.005D



① 25% of Standardized tensile strength

② 25% of tensile strength at each temperature

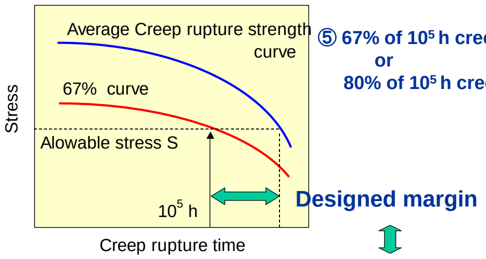
③ 67% of 0.2%proof stress at each temperature

④ 0.01% creep strain/ 10^3 h（Ave.)

⑤ 67% of 10^5 h creep strength（Ave.)
or
80% of 10^5 h creep strength（Min.)

Necessity of Remaining Life Assessment

$t = PD/(2S+P)+0.005D$

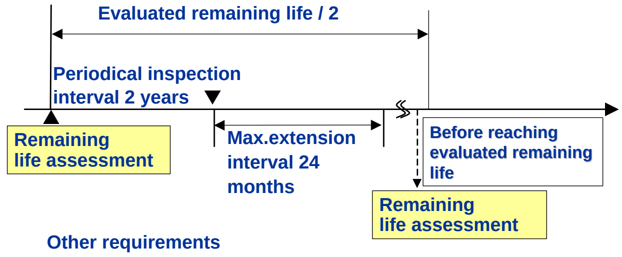


⑤ 67% of 10^5 h creep strength (Ave.)
or
80% of 10^5 h creep strength (Min.)

Designed margin

Actual remaining life ?

Extension of Boiler Inspection Interval by Remaining Life Assessment



Other requirements

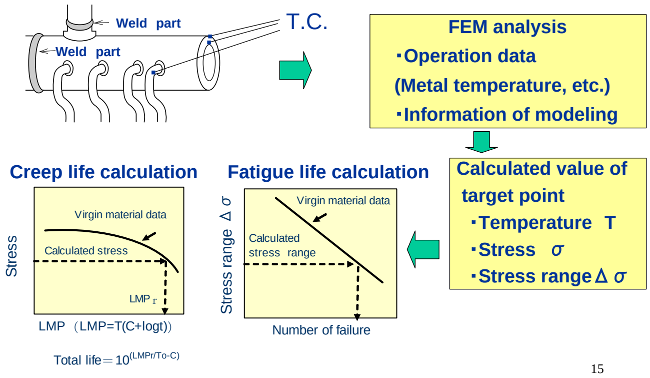
- Countermeasures for failures of own unit and other units
- Adequate operation and maintenance management
- Measures for low cycle fatigue dissimilar metal weld failures and SUS scale accumulation

etc..

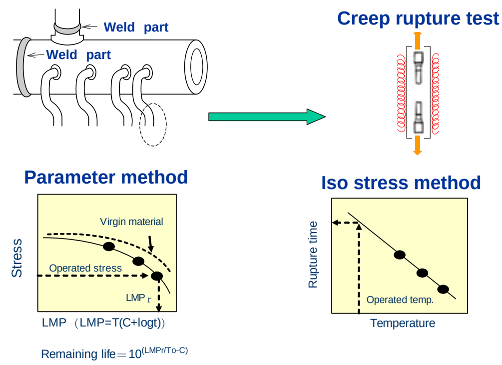
Remaining Life Assessment for High Temperature Components of Boiler

	Positive point	Negative point
Analytical examination	・Applicable to evaluate every necessary point ・Effective for selection of critical point ・Possible to evaluate with future operation mode ・Possible to do on-line monitoring	・Necessary for appropriate material strength data. ・Time and cost consuming with FEM analysis ・Calculation on paper without current damage condition
Destructive examination	・Precise evaluation	・Necessary for extraction of test samples and repairing ・Necessary for a few months to creep rupture ・Unable to monitor at identical point
Non-destructive examination	・Cost effective ・Possible to monitor at identical point	・Limitation of inspection from surface

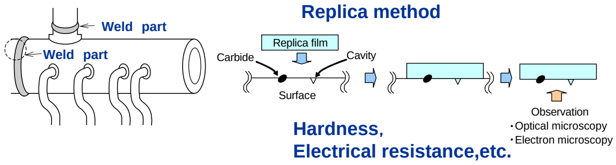
Analytical Examination

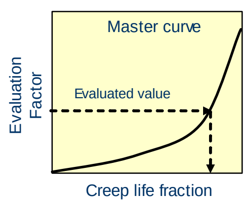


Destructive Examination



Non-Destructive Examination

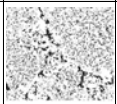
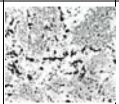
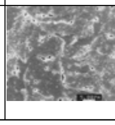
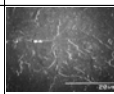
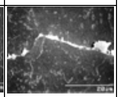




Non-Destructive Examination Technique of Remaining Life Assessment for Boiler

Method	Target to evaluate	Damate to evaluate	Parameter to evaluate
Hardness measuring	Base metal HAZ	Creep Low cycle fatigue	ΔHv, Hv/Hvo
Electrical resisitance	HAZ	Creep	ρ/?o
Chemical composition of carbide	Base metal HAZ	Creep	Mo/Cr
Creep cavity evaluation	HAZ	Creep	(A-parameter ,area fraction, number density,ets.)
Microstructural Comparison	Base metal HAZ	Creep	Creep cavity, Microstructure, Precipitates
Urtra sonic scattering noise	Base metal HAZ	Creep Low cycle fatigue	Ne/Neo
Interparticle spacing	Base metal	Creep	Interparticle spacing
Crystal grain deformation	Base metal	Creep	Grain aspect ratio
Micro-cracking length measurement	Base metal HAZ	Low cycle fatigue	Maximum micro-cracking length

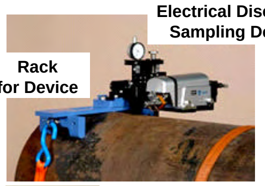
Example of Microstructural Comparison Method

		Observation Result		Standard Microstructure examples	
		Microstructure	Comment	Low damaged	High damaged
Base metal	Precipitates condition		・Not observed free-precipitates zone along grainboundary ・No remarkable degradation ・$\phi c = 1\sim12\%$	 No free-precipitates zone along grainboundary	 Free-precipitates zone along grainboundary
HAZ	Precipitates condition		・Fine precipitates remain ・No remarkable degradation	 Fine precipitates remain	 Fine precipitates disappear
HAZ	Creep cavity		・Not observed creep cavity ・No remarkable creep damage ・$\phi c = 0\sim20\%$	 A few creep cavities	 Linking cavities leads to macro crack (50μm)

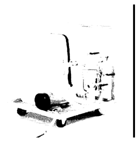
On-Site Electrical Discharge Sampling Device for Small Punch Creep Tests (1)

Electrical Discharge Sampling Device

Rack for Device



Controller



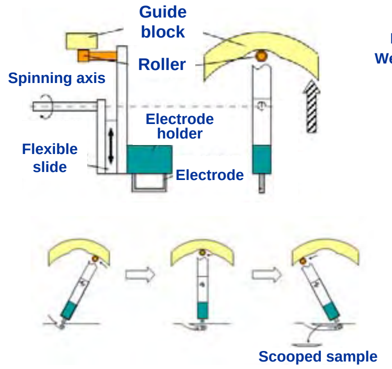
Circulation pump for working-fluid

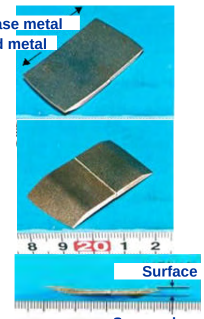
・Thinner and larger sampling with minimum mechanical and thermal damage (about 22mm×30mm×2mm)

・Flexible sampling with various shape of components

・3～4 hours / 1sampling

On-Site Electrical Discharge Sampling Device for Small Punch Creep Tests (2)





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JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

TURBINE EFFICIENCY IMPROVEMENT

Nobuchika KOIZUMI

J-POWER

Factors for Turbine Efficiency

Turbine efficiency improvement measures are described using examples.
Factors relating to "heat cycle condition" and "performance of main turbine" are shown below.

Heat Cycle Condition

Factors affecting the heat cycle

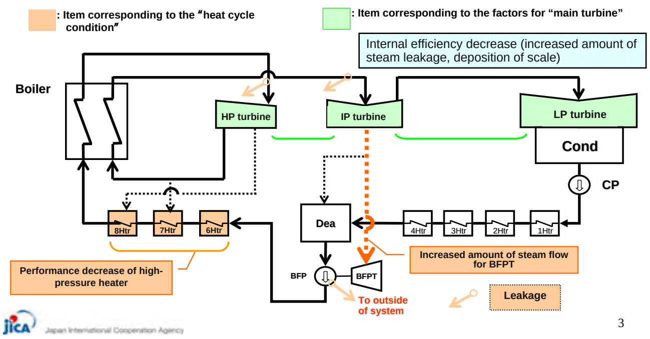
- Steam condition
- Condenser Vacuum
- Temperature of feed water and number of feedwater heaters
- Driving method for feedwater pump
- Other factors
  - Supplementary steam for boiler
  - Pressure loss in reheater
  - Boiler spraying
  - Leakage from piping & valve

Performance of main turbine

Factors affecting the turbine

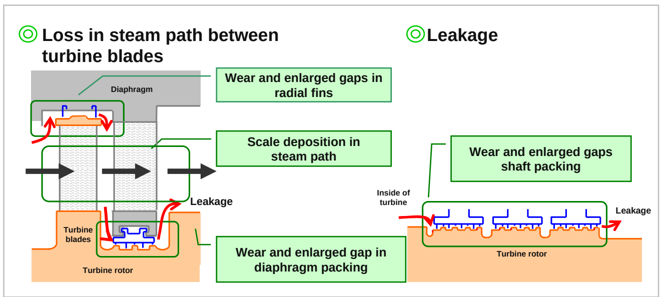
- Loss in passage between turbine blades
- Exhaust loss
- Leakage
- Mechanical loss

Survey Result of Turbine Efficiency Decrease Factors (before implementing measures)



Internal Efficiency Decrease Factors in Main Turbine

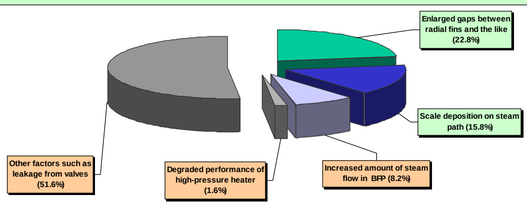
The figure below is to explain schematically efficiency decrease factors identified for the unit. A major factor among these was identified as wear over years in materials used to seal off steam flow inside the turbine.



Analysis of Turbine Efficiency Decrease Factors

The graph below shows distribution of efficiency decrease based on comparisons between the result of the survey and the efficiency as indicated in the initial data collected at the unit's start of operation.
To summarize the result, roughly 60% of total decrease could be attributed to the factors corresponding to the "heat cycle condition," and roughly the remaining 40%, to the "main part of the turbine."

Decrease attributable to the main part of turbine: 38.6% (roughly 40% of total)

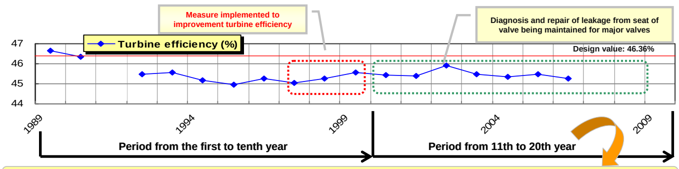


Decrease attributable to heat cycle condition: 61.4% (roughly 60% of total)

Result of Measures

Efficiency decrease factor			Description of measure	Evaluation of measure		Influencing degree	
Changed performance of main turbine	High-pressure	1. Enlargement of gaps between radial fins	Adjustment for proper gap(s) through parts replacement	+0.05%	0.42%	21.0%	100%
		2. Enlargement of gap in diaphragm		+0.10%			
		3. Enlargement of gap in shaft packing		+0.23%			
		4. Scale deposition on steam path	Removing scales	+0.04%			
	Medium-pressure	1. Enlargement of gaps between radial fins	Adjustment for proper gap(s) through parts replacement	+0.10%	0.21%	10.5%	
		2. Enlargement of gap in diaphragm		+0.06%			
		3. Enlargement of gap in shaft packing		+0.02%			
		4. Scale deposition on steam path	Removing scales	+0.03%			
	Low-pressure	1. Scale deposition on steam path	Removing scales	+0.03%	+0.03%	1.5%	
Changed performance of high-pressure heater		1. Increeased terminal temperature difference (TD)	Water jet washing of interior of tubes	+0.04%	0.04%	2.0%	
Increased amount of steam for driving BFP turbine		1. Raised feed water pressure	Chemical cleaning of boiler	-0.01%	0.13%	7.5%	
		2. Decreased feed water volume	Improvement of water chemistry	+0.14%			
Others		1. Internal leak in water-steam system	Investigation and repair of leaking valves	+1.15%	+1.15%	57.5%	

Measures for Turbine Efficiency



This pattern is maintained and carried out with periodic inspections (in two-year cycles) to maintain efficiency.

Pattern of diagnosing and repairing leakage from the seat of the valve

Diagnosis of leakage from the seat of the valve

Identification of valves to be repaired and repair plan for them

Repair of leakage from the seat of the valve

Collecting reference data after repair

One month before

Just after restart

Two to three months before

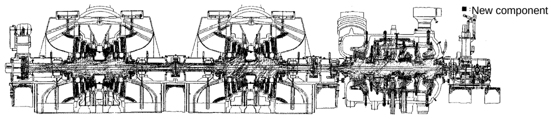
Turbine in operation

Outage

Turbine in operation

Japan International Cooperation Agency

Effect of renovation of turbine main component (Example)



Major new component

1) HP·IP rotor
2) HP·IP inner casing
3) LP rotor

Turbine	Item	Efficiency improvement (relative value)
HP·IP	Control stage	0.2 %
	New design blade	0.7 %
	New seal	0.2 %
	Recovery	0.7 %
LP	New design blade	1.2 %
	Recovery	0.5 %
Total		3.5 %

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Turbine Maintenance

Nobuchika KOIZUMI

J-POWER

Inspection Item at Periodical Maintenance

1. Main turbine

(1) Turbine rotor
- Cleaning by honing
- Detailed inspection and repair of the disk, the rotating blades and the rotor
- Measurement of run-out and centering of the shaft
- Inspection and repair of the coupling bolt

(2) Ejection Holes and Partitions
- Cleaning by honing
- Detail inspection and repair of the stationary blades and labyrinths

(3) Casing
- Measurement of the clearance of the inside and the outside of casing
- Detail inspection
- Measurement of the level of the horizontal flange
- Measurement of the alignment of the casing
- Maintenance of the bolts, hardness test

(4) Bearing
- Adjustment of the contact of the white metals
- Measurement of the bearing gaps

Inspection Item at Periodical Maintenance

2. Equipment attached to the turbine body

(1) Main Valves (MSV, CV, RSV, ICV)
- Maintenance and inspection of the inside and the outside of the valves, the valve rods, the valve seats, and the valve bodies
- Measurement of bend and the gaps of the valve rods
- Inspection of the bolts

(2) Speed Governor and Emergency Stopping Device
- Inspection of the speed governor mechanism and the piping for the control oil

(3) Turning Device
- Detailed and precision inspection of the gears and the bearings
- Inspection of the clutch mechanism

Inspection Item at Periodical Maintenance

3. Turbine lubricating oil device

(1) MOP, AOP, JOP and EOP
- Overhaul, repair and detailed and precision inspection

(2) Main Oil Tank and Oil Cooler
- Cleaning and oiliness test of the inside of the tank
- Cleaning of the oil cooler piping and the water chamber

(3) Oil filter, oil purifier
- Cleaning of the inside and replacement of the filter
- Overhaul and repair

Inspection Item of Condenser (1)

NO	ITEM	PURPOSE	METHOD
1	The inside of the cooling tubes	Clogging, corrosion, erosion	VI ET
2	The outer surface of the cooling tube	Erosion, damage	VI
3	The tube plate	To check marine creatures and dirty matter adhered To check the connecting part	VI
4	The inside of the water chamber	Swell, separation, damage, or a pin hole on the rubber lining Marine creatures and dirty matter adhered	VI PHT

VI: Visual Inspection
WT: Leak Test by Filling Water
DI: Dimensional Inspection
ET: Eddy Current Test
ST: Hardness Test
MT: Fluorescent Magnetic Test
PT: Liquid Penetrant Test
PHT: Pin Hole Test
DM : Thickness measurement

Inspection Item of Condenser (2)

NO	ITEM	PURPOSE	METHOD
5	The parts inside of the main body shell	Erosion, damage ,scale, dust	VI PT
6	Rubber expansion joint	Deterioration	VI ST
7	Nozzle for steam pipe	Crack	VI, PT

VI: Visual Inspection
Leak Test by Filling Water
DI: Dimensional Inspection
ET: Eddy Current Test
ST: Hardness Test
MT: Fluorescent Magnetic Test
PT: Liquid Penetrant Test WT:
PHT: Pin Hole Test
DM : Thickness measurement

Inspection Item of HP Feed Water Heater

NO	ITEM	PURPOSE	METHOD
1	Tube (steel)	Inlet attack	VI, DI
2	Tube (cu attribute)	Crack	ET
3	Water chamber	Crack	VI, PT, MT
4	Water chamber partition	Deformation	VI, DI
5	Shell	Erosion	VI, DM
6	Nozzle	Erosion	VI, DM

VI: Visual Inspection
Leak Test by Filling Water
DI: Dimensional Inspection
ET: Eddy Current Test
ST: Hardness Test
MT: Fluorescent Magnetic Test
PT: Liquid Penetrant Test WT:
PHT: Pin Hole Test
DM : Thickness measurement

Inspection Item of LP Feed Water Heater

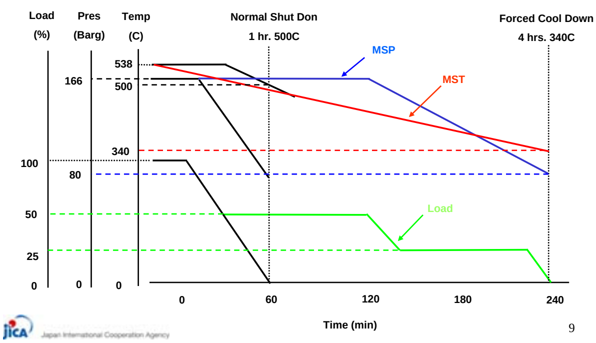
NO	ITEM	PURPOSE	METHOD
1	Tube (steel)	Erosion	UT, ET
2	Tube (cu attribute)	Crack, ammonia attack	ET
3	Water chamber partition	Deformation	VI, DI
4	Shell	Erosion	VI, DM

VI: Visual Inspection
Leak Test by Filling Water
DI: Dimensional Inspection
ET: Eddy Current Test
ST: Hardness Test
MT: Fluorescent Magnetic Test
PT: Liquid Penetrant Test WT:
PHT: Pin Hole Test
DM : Thickness measurement

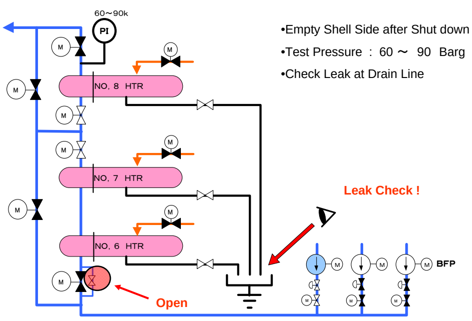
Turbine Shut Down and Preparation Works

1. **Turbine Forced Cooling**
2. **Heater Leak Check**
3. **Operation and Maintenance Coordination**

Turbine Forced Cool Down

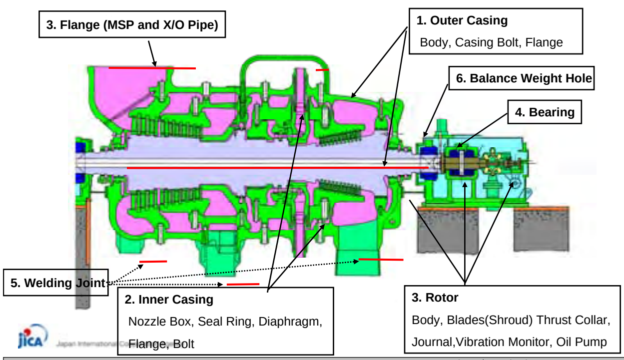


Heater Leak Check



•Empty Shell Side after Shut down
•Test Pressure : 60 ～ 90 Barg
•Check Leak at Drain Line

HP Turbine Inspection Points



HP Turbine Major Inspection - (1)

HP Turbine 1st Blade Erosion - Boiler Scale

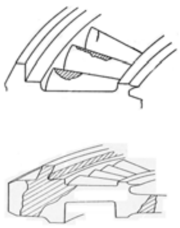
Example (Wear due to Scale)

HP Turbine Major Inspection - (2)

Example (Wear due to Scale) Unit 2 (Foreign Material)

HP Turbine Major Inspection - (2)

Typical Erosion

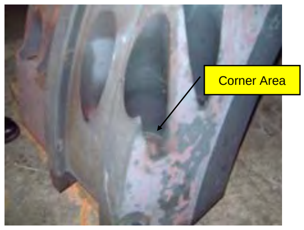


MSV Strainer

HP Turbine Major Inspection (3)

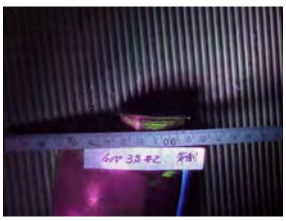
Example - Outer Casing (Stress Concentration)

Unit 2 HP Inner Casing



HP Turbine Major Inspection - (4)

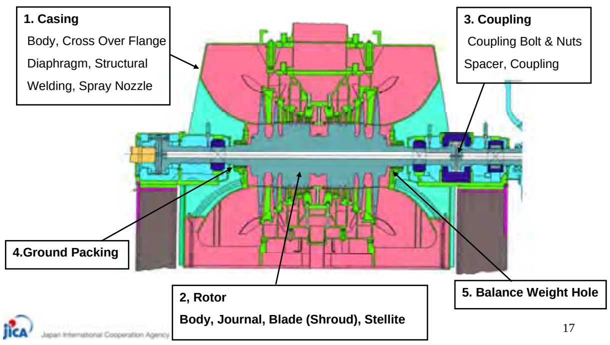
Creep - Shrouds and Roots



Damage Example - Shrouds

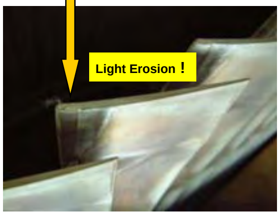
Typical Creep Damage Area

LP Turbine Inspection Points



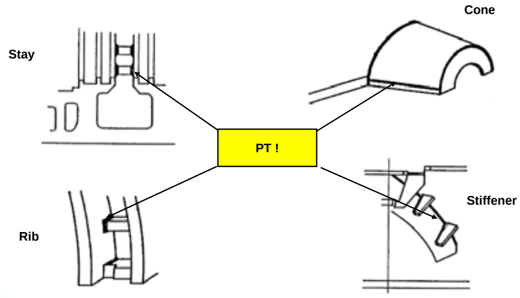
LP Turbine Major Inspection (1)

Unit 4 LP Last Blade - Stellite



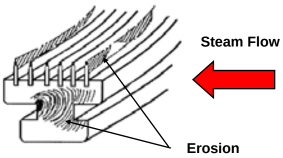
LP Turbine Major Inspection (2)

Casing Structure Welding



Turbine Major Inspection - Other Area (1)

Diaphragm Seal Ring Erosion
(Efficiency Loss)



Turbine Major Inspection - Other Area (2)

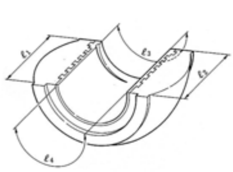
Balance Weight Flange

Turbine Major Inspection - Other Area (3)

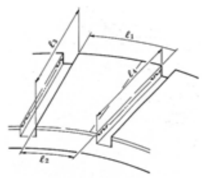
Cleaning
↓
Thread Inspection
↓
PT

Turbine Major Inspection - Other Area (4)

White Metal Bonding Condition

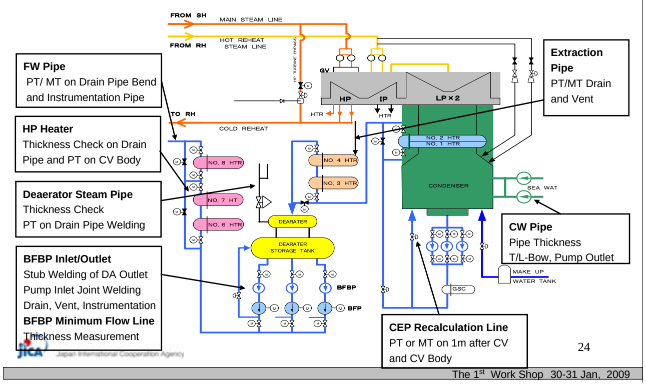


Radial Bearing

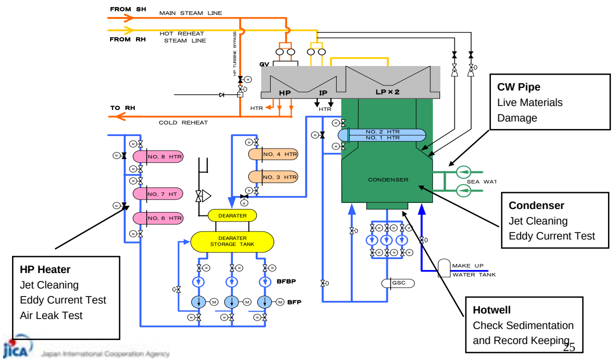


Thrust Bearing

Turbine Piping Inspection



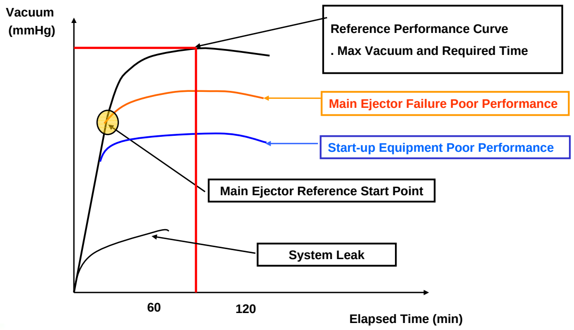
Turbine Auxiliary Inspection Point



Turbine Commissioning

1. Heater Leak Test
2. Condenser Tube Leak Test
3. Condenser Vacuum Test
4. Turbine Steam Admission & AOP/EOP Test
5. Turbine Overspeed Test
6. Unit Interlock Test (MFT, Unit Trip)

Turbine Commissioning - Vacuum Test



Turbine Overhaul Improvement - Acceleration Work

1. Overhaul Period (300MW Class)
   - J-Power P/S 45 days
2. Area of Consideration
   - Work Schedule Improvement
   - Equipment Improvement
   - Oil Flushing Improvement

Work Schedule Improvement

1. Turbine Cool Down Acceleration
2. Work Sequence Improvement

Disassembly Improvement

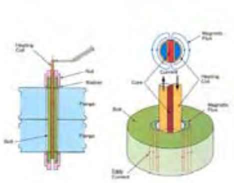
1. HP Turbine Casing Bolt
   Loose Before Turning Gear
2. Turbine Forced Cool Down
   Disassemble Flow Guide
   earlier and lift LP Casing
3. Lay down Area

Overhaul Schedule Optimization

Turbine Overhaul Improvement - Induction Heater (1)

Heating with Burner

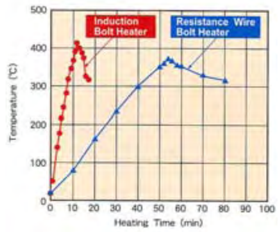
New Type - Induction Heater



Turbine Overhaul Improvement - Induction Heater (2)

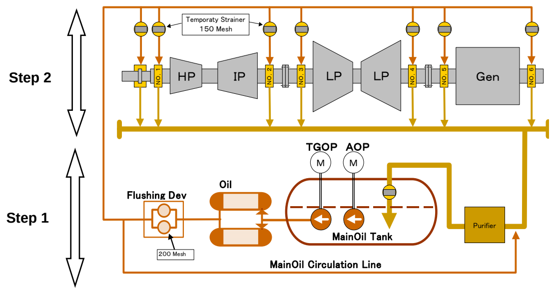
Resistance Wire

Saving Time
= 30min X 34 times = 1020 min (17 hrs)



Turbine Overhaul Improvement - Turbine Oil Flushing

Step 2 Oil Flushing after Bearing Assembly



Step 1 Oil Flushing before Bearing Assembly

Thank You !

JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

TURBINE RLA ASSESMENT

Nobuchika KOIZUMI

J-POWER

EXAMPLE OF ASSESMENT

Test Matrix for 200 MW LMZ Turbine — PRELIMINARY

Sr No.	Tests/ Components	VO	LP/DPT	MPI	UT	Replica	Hardness	Special Tests
1.0	HP+ IP Turbine Rotor							
1.1	Rotor	100%	Journal region	100% accessible regions by coil/yoke	through bore + externally accessible regions	8 locations	replicated locations	Bore UT, Videoscopy Stress analysis of Rotor Shaft
1.2	Blades	100%	NO	100% accessible regions by coil /yoke	NO	NO	NO	Deposit analysis Eddy Current test of moving blades
1.3	Shrouds	100%	NO	100% accessible regions by coil /yoke	NO	NO	NO	
1.4	Sealing Grooves(castellations)	100%	NO	100% accessible regions by coil /yoke	NO	NO	NO	
1.5	Coupling Bolts	100%	100%	NO	NO	NO	NO	
2.0	HP and IP Casing							
2.1	Casing Halves	100%	keys & keyways	only critical areas	NO	4 locations	replicated locations	Deposit analysis, Stress Analysis
2.2	Parting plane studs and Fasteners	100%		100% by yoke	NO	NO	high temperature studs	Destructive tests on one stud each from HP and IP regions
3.0	HP and IP Diaphragm and Liners							
3.1	Nozzle, Diaphragms, and Diaphragm carriers	100%	keys & keyways	100% by yoke	NO	8 locations	replicated locations	Deposit analysis
3.2	Parting plane Fasteners	100%	NO	10% by yoke	NO	NO	high temperature studs	

Legends:
VO=Visual Observations, LP/DPT=Dye Penetrant Test, MPI: Fluorescent Magnetic Inspection, UT: Ultrasonic Test, Replica In-situ Metallography, Hardness: Portable rebound hardness

EXAMPLE OF ASSESMENT

Test Matrix for 200 MW LMZ Turbine — PRELIMINARY

Sr No.	Tests/ Components	VO	LP/DPT	MPI	UT	Replica	Hardness	Special Tests
4.0	Babbitted Bearings							
4.1	Babbit bonding and surface	100%	babbit s/c 100%	NO	babbit s/c 100%	NO	NO	
4.2	Bearing housing, pedestal	100%	NO	On parting plane	NO	NO	NO	
5.0	LP Turbine Rotor and Casing							
5.1	Rotor	100%	Journal region	100% accessible regions by coil /yoke	through bore + externally accessible regions	2 locations	2 locations	Bore UT, Videoscopy
5.2	Blades	100%	shields, damping wires	100% accessible regions by coil /yoke	NO	NO	NO	Eddy Current test of moving blades
5.3	Shrouds	100%	NO	100% accessible regions by coil /yoke	NO	NO	NO	
5.4	Sealing Grooves(castellations)	100%	NO	100% accessible regions by coil /yoke	NO	NO	NO	
5.5	Casing Halves	100%	NO	only critical areas	NO	NO	NO	
5.6	Coupling Bolts	100%	100%	NO	NO	NO	NO	

Legends:
VO=Visual Observations, LP/DPT=Dye Penetrant Test, MPI: Fluorescent Magnetic Inspection, UT: Ultrasonic Test, Replica In-situ Metallography, Hardness: Portable rebound hardness

EXAMPLE OF ASSESMENT

Test Matrix for 200 MW LMZ Turbine — PRELIMINARY

Sr No.	Tests/ Components	VO	LP/DPT	MPI	UT	Replica	Hardness	Special Tests
6.0	Integral Steam Piping & Valves							
6.1	Integral Steam pipes - HP Casing	100%	NO	Critical Butt welds	Critical Butt welds	4 locations	replicated locations	Thickness Measurement at bends
6.2	Integral Steam pipes - IP Casing	100%	NO	Critical Butt welds	Critical Butt welds	4 locations	replicated locations	Thickness Measurement at bends
6.3	Main steam Piping critical weld and bend (Turbine main steam stop valve to HPT control valves)	100%	NO	Critical Butt welds	Critical Butt welds	6 locations	replicated locations	Thickness Measurement at bends, Stress Analysis
6.4	Hot Re-heat Piping critical weld and bend (IPT stop valve to IPT control valves)	100%	NO	Critical Butt welds	Critical Butt welds	6 locations	replicated locations	Thickness Measurement at bends, Stress Analysis
6.5	Cross over pipe	100%	NO	Weld joints	NO	NO	NO	
6.6	ESVs	100%	seat,cones, Chamber	spindle, strainers, Fastners	NO	4 locations	replicated locations	
6.7	IV	100%	seat,cones, Chamber	spindle, strainers Fastners	NO	4 locations	replicated locations	
6.8	HP Control Valves	100%	seat,cones, Chamber	spindle, strainers Fastners	NO	4 locations	replicated locations	
6.9	IP Control Valves	100%	seat,cones Chamber	spindle, strainers, Fastners	NO	4 locations	replicated locations	
6.10	HP/LP Bypass Main valves	100%	seat,cones, Chamber	spindle, strainers, Fastners	NO	2 locations	replicated locations	

Legends:
VO=Visual Observations, LP/DPT=Dye Penetrant Test, MPI: Fluorescent Magnetic Inspection, UT: Ultrasonic Test, Replica In-situ Metallography, Hardness: Portable rebound hardness

Thank You !

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ASSESMENT OF PUMP

BOILER FEED WATER PUMP

CIRCULATING WATER PUMP

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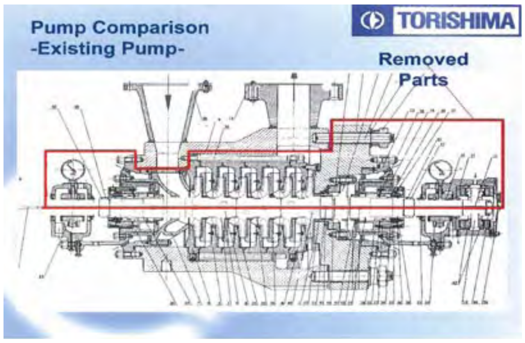
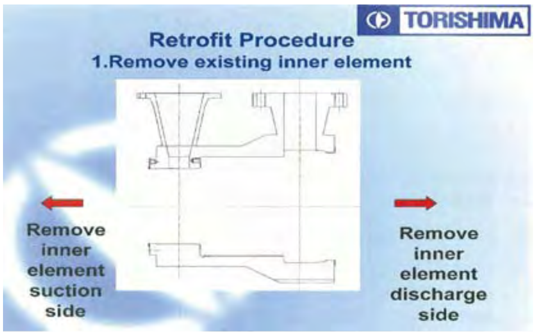
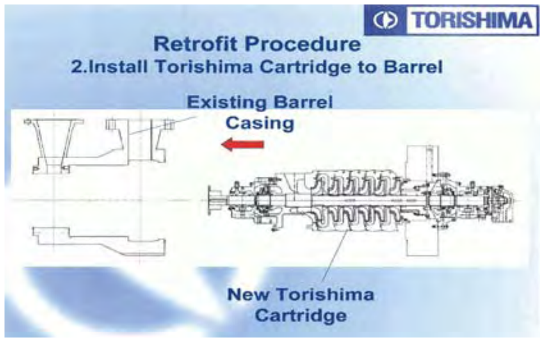
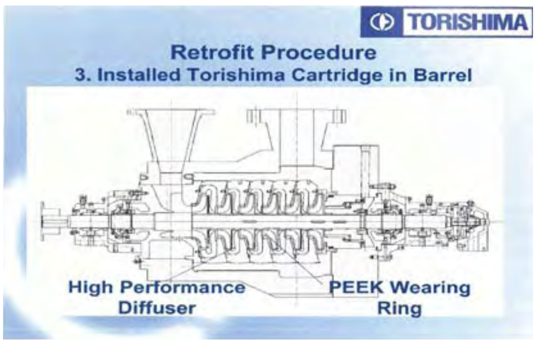
RETROFIT OF 200 KHI BOILER FEED WATER PUMP

Japan International Cooperation Agency









TORISHIMA

5. Comparison of Performance: New/Existing

TORISHIMA

6. Expected Improvement & Effects

Energy saving

1) Efficiency : before and after improvement
Existing Sigma Pump E(ex)= 72%
Newly replaced by Torishima E(n) = 83%
* Improved EFF = 11%

2) Shaft power : before and after improvement
Existing Sigma Pump SP(ex)= 2500KW
* Expected Reducing SP = 2500KWx0.11= 275KW/hr

3) Yearly energy saving : after improvement
* Expected Yearly saving energy= 275KW/hrx8000hrs
= 2,200,000KW/year

Thank You !

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LEAK BUSTER

(Detection technology of air leak into condenser)

LEAK BUSTER

Detection technology of air leak into condenser

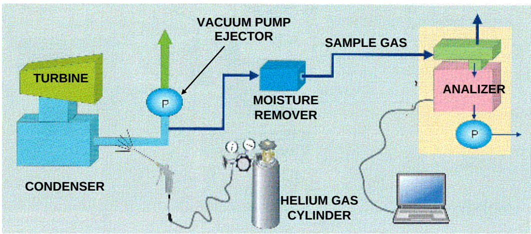
Features

1. Air leak points of the vacuum portion can be accurately detected during operation
2. **The applox. air leak volume can be measured.**
3. The measurement can be made without dismantling the heat insulation.
4. Measuring work is completed in a few days.
5. No major set up of equipment is required.

LEAK BUSTER

Detection technology of air leak into condenser

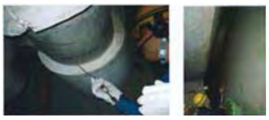
System configuration



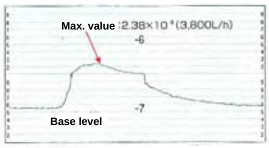
LEAK BUSTER

Detection technology of air leak into condenser

How to asses air leak volume?



Helium spraying



Air leak volume:
Equivalent to 5.0kg/h

LEAK BUSTER

Detection technology of air leak into condenser

LEAK BUSTER

Results	Result 1	Result 2	Result 3	Result 4	Result 5
Turbine maker	A Certain Company	A Certain Company	Fuji Electric Systems Co., Ltd.	A Certain Company	Fuji Electric Systems Co., Ltd.
Output (MW)	1000	1000	600	600	27
State before implementation	Operation of two vacuum pumps including the standby	Operation of two vacuum pumps including the standby	Operation of two vacuum pumps including the standby	Operation of two vacuum pumps including the standby	
	Vacuum deterioration 3.33kPa	No vacuum deterioration	No vacuum deterioration	No vacuum deterioration	Vacuum deterioration 1.33kPa
Design air amount	20kg/h	10kg/h	20kg/h	20kg/h	12kg/h
Air amount measurement	120kg/h or more (over range)	55kg/h	48kg/h	50kg/h	33kg/h
Increased air amount	100kg/h or more	40kg/h	28kg/h	30kg/h	21kg/h
Detecting air leak amount	131kg/h	39kg/h	28kg/h	29kg/h	19kg/h
Leak point	• LP turbine steam inlet pipe: 124kg/h • Condenser expansion joint: 4kg/h • Vacuum pump: 2kg/h • LP turbine gland 1kg/h	• Drain piping around turbine bearing: 35kg/h • LP turbine: 4kg/h	• LP turbine: 13kg/h • Around condenser: 13kg/h • Around BFPT: 1.5kg/h • Vacuum pump: 0.8kg/h	• LP turbine: [illegible] • Around condenser: 13kg/h • Around BFPT: 4kg/h • Vacuum pump: 3kg/h	• LP turbine: 4kg/h • Around condenser: 13kg/h • Around BFPT: 1kg/h • Vacuum pump: 1kg/h
Repair content	LP turbine inlet temporary repair	Piping replaced	LP turbine inlet temporary repair	BFPT, vacuum pump temporary repair	Condenser flange portion temporary repair
Air amount after temporary repair	Result: 60kg/h Prediction: unknown because outside the range		Result: 36kg/h Prediction: 33kg/h (=46−13)	Result: 40kg/h Prediction: 39kg/h (=50−11)	Result: checking when starting next time Prediction: 20kg/h (=33−13)
Air amount after permanent measures		15kg/h (Same level as at operation start)			
Main leak portions or repair situation	• LP turbine inlet steam bellows portion	• Drain piping through condenser (drain piping around turbine bearing)	• LP turbine gland portion taping done	• BFPT flange portion	• Condenser connecting flange portion

Thank You !

JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plants in NTPC-India

-Diagnosis of Transformer-

Jan. 2009

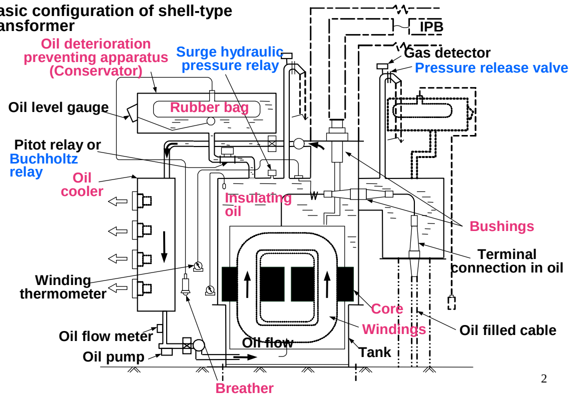
Japan International Cooperation Agency

Contents

1. Main components of transformer
2. The sorts of transformer diagnosis
3. Condition check diagnosis (Dissolved Gas Analysis)
4. Deterioration diagnosis & Remaining life diagnosis

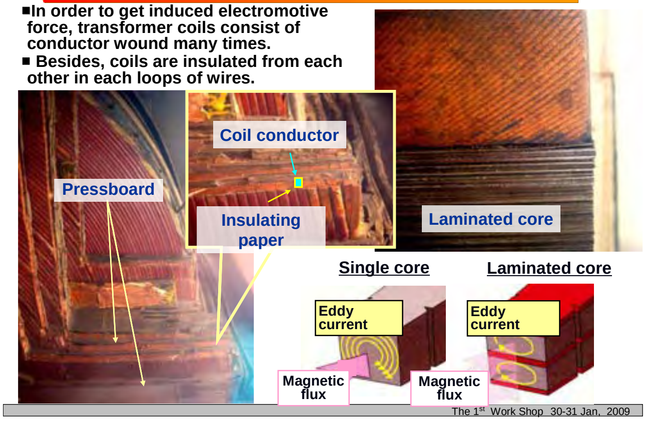
Main Components of Transformer

Basic configuration of shell-type transformer



Internal Structure of Transformer

- In order to get induced electromotive force, transformer coils consist of conductor wound many times.
- Besides, coils are insulated from each other in each loops of wires.



Inspection & Diagnosis of Transformer (in Japan)

Transformer inspection

Inspection	Frequency	Inspection contents
Patrol inspection	Once/day	Oil temp., oil level, Oil leak, abnormal sound, smell, rust, etc
Dissolved gas analysis (DGA)	Once/year	Dissolved Gas Analysis
PI (simple inspection)	Once/2 years	Megger testing, Visual inspection, etc.
PI (detail inspection)	Once/6 years	Protection relay performance test, etc.
PI (special inspection)	Depending on the results of DGA	

PI: Periodical inspection

Transformer diagnosis

Diagnosis	Methods
Condition check diagnosis	Dissolved Gas Analysis
Deterioration diagnosis (Life-remaining diagnosis)	Furfural analysis(★) Carbon dioxide (CO_2 + CO) analysis

★ : adaptable for insulating paper made from kraft pulp

Dissolved Gas Analysis (DGA) (1)

- Various gases are generated by heat decomposition of insulating paper and insulating oil, when abnormal condition such as electric discharge and over heating occurs in a transformer.
- Abnormal condition is estimated and analyzed from the gas components, the gas volume and the ratio of generated gas.

Abnormal condition	Main generated gas
Over heating insulating oil	H_2, CH_4, C_2H_6, C_2H_4, C_2H_2
Over heating at solid insulator	H_2, CH_4, C_2H_6, C_2H_4, C_2H_2, CO, CO_2
Electric discharge in insulating oil	H_2, CH_4, C_2H_4, C_2H_2
Electric discharge at solid insulator	H_2, CH_4, C_2H_4, C_2H_2, CO, CO_2

Dissolved Gas Analysis (DGA) (2)

Criteria of DGA (in Japan)

Unit : ppm

Gas	Caution I level	Caution Ⅱ level	Abnormal level
CO	≧ 300	(1) C_2H_2 : ≧ 0.5 or (2) Both C_2H_4 : ≧ 10 and TCG : ≧ 500	(1) C_2H_2 : ≧ 5 or (2) Both C_2H_4 ≧100 & TCG at least 700 or (3) Both C_2H_4 ≧ 100 & TCG increase ≧ 70 ppm/month
H_2	≧ 400		
CH_4	≧ 100		
C_2H_6	≧ 150		
C_2H_4	≧ 10		
C_2H_2	-		
TCG*	≧ 500		

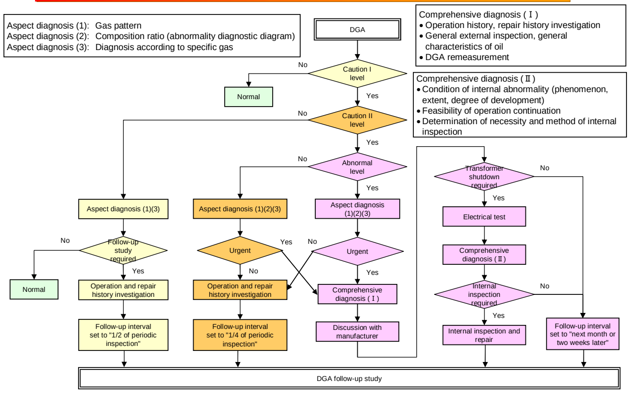
*TCG: Total Combustible Gas, the sum of CO to C2H2

Caution I level : The level that transformer is out of normal condition although it is not judged to be abnormal and dangerous condition

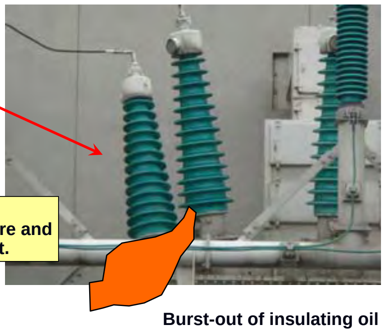
Caution II level : The level that transformer becomes abnormal condition gradually

Abnormal level : The level that transformer is clearly abnormal condition. (aggravating further from Caution Ⅱ level)

Diagnosis Flowchart with DGA



One Case of Transformer Troubles



After disassembling transformer, the iron core and windings were burnt out.

Burst-out of insulating oil

Analysis of the Transformer Trouble

Decline of insulating paper mechanical strength due to deterioration

↓

Damage to insulating paper due to damage factor

↓

Layer short

↓

Overheating/internal pressure up of insulating oil

↓

Burst-out of insulating oil

If any measures had been taken to comprehend internal condition of transformer, this trouble might have been avoided.

Important
Comprehending the condition
Implementing preventive maintenance

Long term plant outage & Large amount of repair cost is required

- **Operation loss because high efficiency plant has to stop.**
- **Energy loss because low efficiency plant has to operate.**
- **Insufficient power supply because of plant outrage**

Deteriorating Phenomenon of Transformer

- **In transformers, deterioration of insulating materials are rather remarkable than that of metals**
- **In insulating materials, deterioration of mechanical function is proceeding faster than that of electrical.**

Material type	Deteriorating phenomenon
Metal materials • Conductor, silicon steel plate, etc.	• There are almost no mechanical/electrical deteriorating tendencies.
Insulating materials • Insulating paper, Pressboard, etc. • Insulating oil	• Deterioration of mechanical strength (tensile/ compressive) • Decrease in breakdown voltage • Generation of combustion gases, etc.

Insulating materials deteriorate faster than metal materials

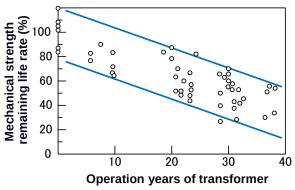
Life of Transformer

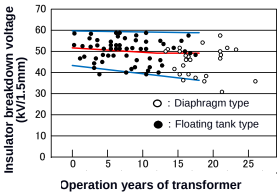
- **Among insulating materials, deteriorating severity of insulating oil is milder than others. Additionally, its function can be refreshed by degassing filtration treatment or exchanging to new one.**
- **Pressboard reaches its service limit slowly than insulating paper, because its temperature elevation is generally lower than insulating paper and its necessary function is compressive strength.**
- **When the insulating paper mechanical strength is decreased, there is an increased risk of breaking paused by electromagnetic force arising from surge current at the time of external short circuit fault and other accidents.**

End of insulating paper life

- **Basically, it is impossible to re-wind the insulating paper and to replace the transformer coils. Thus the insulating paper life means the transformer life.**

Mechanical & Electrical Strength of Insulating Paper

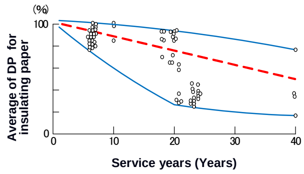


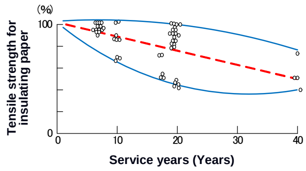


Insulating strength:
Mechanical strength deteriorates faster than electrical strength

Insulation Paper Strength and Degree of Polymerization

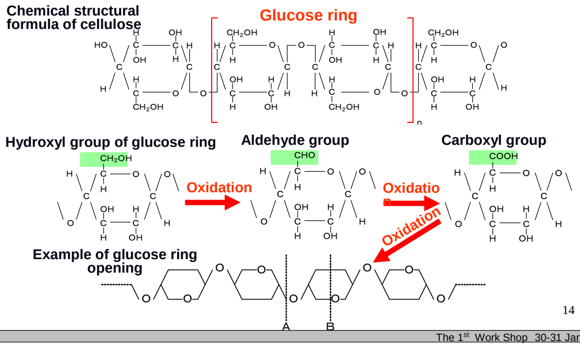
- Measuring the strength of insulating paper in a fully inspection costs a lot and is difficult to do accurate because of the insulation paper core set.
- The degree of polymerization (DP) is the fiber density of insulating paper and is closely related with the mechanical strength of insulating paper.





Weakening process of insulation paper strength (Generation of organic constituents)

- The decrease of insulating paper mechanical strength is caused by chemical changes (glucose bond breaking and ring opening) of the cellulose.



Organic constituents extracted from insulating paper aging

- Various organic constituents are produced by chemical changes of the cellulose.

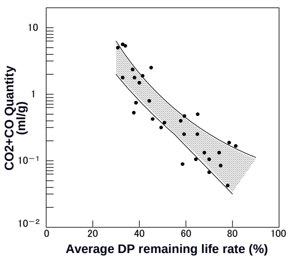
Inorganic	H_2O, CO, CO_2
Hydrocarbon	CH_4Methane, ethane, propane, propylene
Alcohol	Ethyl alcohol, furfuryl alcohol
Aldehyde/ Ketone	Acetaldehyde, furfural, 5-methylfurfural, 5-hydroxymethyl-2-furfural, acetone, methyl ethyl ketone
Acid	Formic acid, 2-furan carboxylic acid, acidum tartaricum, butyric acid
Others	Furan methyl carboxylic acid, acetic ether ($CH_3COOC_2H_5$), furan (C_4H_4O), 2-acetyl furan

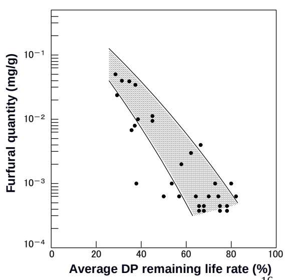
The quantity of organic constituents marked by this symbol has close relevance with mechanical strength of insulating paper.

CO,CO2 and Furfural are closely related with insulating paper strength
Remaining life diagnosis is conducted with the relation.

Average DP survival rate and deterioration indicator substances

- The qty. of (CO+CO2) and the qty. of furfural are closely related with the average DP remaining life rate of insulating paper. They can be therefore treated as deterioration indicators (the components which deterioration level can be measured).
- One of the main reasons for the data spread is difference in the load factor of transformers.



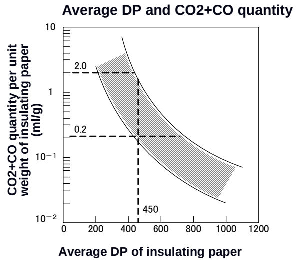


Judgment Criteria for Remaining Life Diagnosis (Deterioration Diagnosis) (Japanese case)

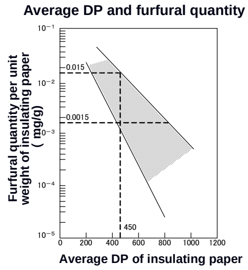
- Reference values for the remaining life of insulating paper is set to 【Average DP 450】
- Based on this, the judgment criteria of deterioration indicators is developed.

	Level of caution	Level of danger
CO2+CO qt.	0.2 (ml/g)	2.0 (ml/g)
Furfural qt.	0.0015 (mg/g)	0.015 (mg/g)

Average DP and CO2+CO quantity



Average DP and furfural quantity



Applicability of Gas Analysis

Applicability of CO and CO2

- This method cannot be applied to open type transformers, because CO and CO2 in the transformer is released to the atmosphere.

Applicability of furfural method

- Furfural is a liquid of 161℃ in boiling point and dissolves to insulating oil.
  Therefore, it can be detected even in an open type transformer.
- When adsorbing materials exist in a transformer, this method cannot be applied to because furfural is adsorbed to it.

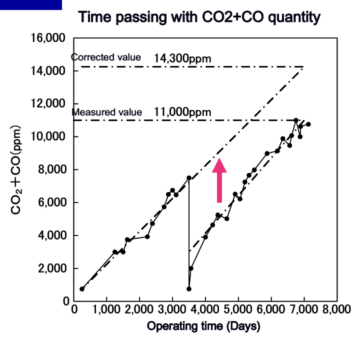
Degassing correction method

Why need degassing correction?

- Gas quantity is decreasing at the time of insulating oil exchange, degasification, etc. Therefore, degassing correction is needed.

How to correct?

- Make clear the quantitative changes of deterioration indicator substances along with time in the event of insulating oil exchange, degasification, etc. Then, make corrections by linking balanced properties after degasification to those before degasification.



Remaining Life Diagnosis of Transformer

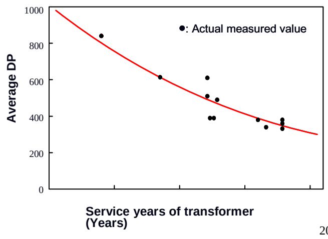
Remaining life diagnosis method by average DP

- The average DP is estimated by sampling approach, CO/CO2 method or furfural method, and the remaining life of transformer is calculated by Acker's regression formula.
- Remaining life diagnosis of transformer enable trouble prevention, reflection to replacement planning and so on.

Acker's regression formula

$$LR = L0 (1 - r)^{n}$$

L_R : DP
L_0 : Initial DP
r : coefficient estimated the results of diagnoses
n : Operating years



Flowchart of Transformer Preventive Maintenance

Oil-immersed transformer

During stop	Diagnosis by sampling insulators	Measure DP
During operation	Diagnosis by analyzing (CO+CO2) gases	Estimate DP from gas quantity
During operation	Diagnosis by analyzing furfural	Estimate DP from furfural quantity

Old-style diagnosis

Considering the load factor of transformer

Transformer deterioration diagnosis
↓
Transformer remaining life diagnosis
↓
Trouble prevention, Reflection to the replacement planning

Thank You !

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Japan International Cooperation Agency

JICA Study Team for Enhancing Efficiency of Operating Thermal Power Plant in NTPC-India

Instrumentation and Control Systems

Japan International Cooperation Agency

Contents

Instruments used in Japanese Power Stations

Main Instruments used in Japanese Power Stations

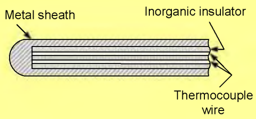
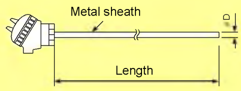
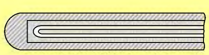
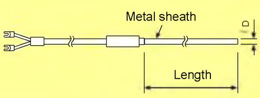
Item	Outline
• **Thermometer**	**Thermocouple measurement features and applicable areas** **Resistance temperature detector measurement features and applicable areas**
• **Flow meter**	**Various flow meter measurement methods, features and applicable areas**
• **Waste gas analyzer**	**Various gas analyzer measurement methods and applicable areas**

Methods and features of temperature measurement at power station

	Measurement methods	Temp. range	Applications at power plant	Features
1	Thermocouple	-200 ~ 1700°C	Feedwater temp. Steam temp. Different metal temp. * For general use	Different types according to different materials. Large thermo electromotive force and small variation in properties. Excellent in resisting heat and corrosion. Limitations on types due to measurement atmosphere. Reference junction temperature compensation required.
2	Resistance temperature detector	-200 ~ 650°C	Condense Water intake temperature * For precise measurement	Higher accuracy and stability than thermocouple. Slower responsiveness than thermocouple. Sensitive to mechanical shock and vibration.
	• Two-wire			Susceptible to the influence of change in outside air temperature.
	• Three-wire			Not susceptible to the influence of change in outside air temperature.
	• Four-wire			Not affected to the influence of change in outside air temperature.

Types of thermoelectric pyrometer

• Sheath thermocouple

Structure of measuring junction	Configuration of sheath thermocouple
Grounding system 	With terminal plate 
Non-grounding system 	Without terminal plate 

Methods and features of flow measurement at power station

	Measurement methods	Target fluids: Liquid	Gas	Steam	Application at power plant	Features
1	Differential pressure	○	○	○	Main steam flow rate Main feedwater flow rate	Wide measuring range, low cost, and big error in low flow rate region.
2	Area	○	○	○	Auxiliary equipment cooling water flow rate	Simple structure & low cost. Subject to error in gas measurement
3	Positive Displacement	○	○	×	Incoming fuel flow rate Makeup water flow rate	High accuracy & for high viscosity but weak against dirt. In the bearing, there is longevity.
5	Electromagnetic	○	×	×	Desulfurization slurry Waste water treatment	Superb in resisting corrosion and wear. Electric conductivity required.
6	Vortex	○	○	○	Gas turbine fuel flow rate	Wide measuring range, high accuracy, but unsuitable for small flow.
7	Ultrasonic	○	○	△	Desulfurization slurry Waste water treatment	Superb in resisting corrosion and wear. Susceptible to influence of air bubbles.

Methods, Types and Areas of Waste Gas Analysis in Power Stations

	Measurement Item	Measurement Method	Area of Use
1	NOx, SO2	Infrared method	Denitrification inlet, denitrification outlet, desulfurization inlet, desulfurization outlet, stack inlet
		Chemi-luminescent method	
2	O2	Zirconia method	ECO outlet (For optimum combustion control)
		Magnetic wind method	Denitrification inlet, denitrification outlet
		Magnetic pressure method	
3	Dust concentration	Transmission method	EP outlet
		Scattered light method	

Control technology for multi coal fired boiler

1. Coal-fired boiler constraints
2. Necessity of control technology for multi coal fired boiler
3. Basic concept of control technology for multi coal fired boiler
4. Division of multi coal fired boiler operational logic and boiler control logic
5. Adjustment of boiler control logic parameters

Reference: Optimum combustion control

Control technology for multi coal fired boiler

1. Coal-fired boiler constraints

Boiler heat capacity

With variable-pressure boiler, pressure (saturation temperature) changes with load.

Consider:
Heat quantity corresponding to evaporation when load changes
+
Heat quantity corresponding to change in heat capacity of retained water and steel of boiler tube header, etc.

Change in characteristics with coal brand

- **Change in fuel consumption due to difference in heating value**
- **Change in heat absorption characteristics due to difference in combustibility**
- **Change in mill capacity and coal supply characteristics due to difference in grindability**

Change in boiler characteristics over time

Boilers tend to get dirty and their characteristics change greatly over time.

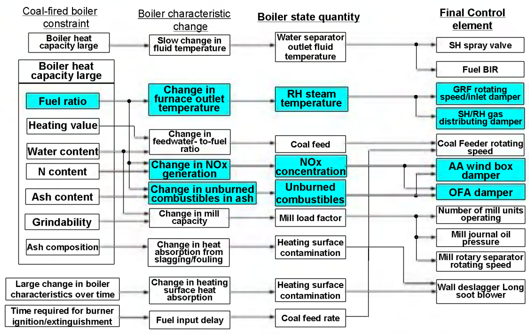
Burner ignition/extinguishment time

- **Since coal burner ignition takes time, the control designing should take into account the ignition/extinguishment time.**
- **A mill motor is a large auxiliary machine; thus, it is unsuitable for repeated starts and stops. Therefore, it is difficult in practice to change loads with continuously changing the number of mills in operation.**

Control technology for multi coal fired boiler

2.Necessity of control technology multi coal fired boiler

Table 1 Relationship between control operating element and change in boiler characteristics with respect to coal-fired boiler constraints



Control technology for multi coal fired boiler

2.Necessity of control technology for multi coal fired boiler

Coal-fired boiler constraints

⇩

Boiler heat characteristics, exhaust gas property characteristics, and mill characteristics undergo large changes statically/dynamically according to the type of coal.

⇩

Necessity of control function that supplements boiler control corresponding to this change

- Control that adjusts boiler characteristic changes
- Control that adjusts mill capacity changes
- Control of soot blower

Control technology for multi coal fired boiler

2.Necessity of control technology for multi coal fired boiler

Key points of control

1. Proper grasp of heat transfer characteristics from combustion state of boiler, regardless of coal type data
2. Grasp of coal property changes in mill from mill's operating state

⇨ Optimum correction of related parameters

To be more precise

1. **Grasp of distribution of furnace/superheater/reheater's heat absorption from estimation of heating surface's heat absorption state**
2. **Grasp of coal heating value from estimation of boiler's total heating value**
3. **Grasp of change in coal properties in mill from mill heat balance, mill current value, and other operating state quantities**

Proper control parameter correction ⇨ Achievement of optimum boiler operation regardless of change in coal properties and contamination over time

Control technology for multi coal fired boiler

3. Basic concept of control technology for multi coal fired boiler

Influencing factors and quantities involved in control of technology for multi coal fired boiler

Factor that Affects Control	Effect	Quantification of Influencing Factor	Correcting Control Item
Fuel ratio	Deviation in furnace heat absorption Deviation in degree of superheat	Heat absorption index	BIR for fuel, feedwater, air, etc. Steam temperature control Gas distributing damper control, other
Contamination	Deviation in furnace heat absorption Deviation in degree of superheat		
Heating value	Deviation in fuel feed rate Deviation in BIR	Total heating value	Heating value correction
Ash content	Deviation in feed rate		
Water content	Delay in coal exhaustion	Change in mill state quantity	Mill outlet temperature control Mill pressurization equipment hydraulic control Mill rotary classifier control Mill primary air flow control
Grindability	Change in mill's actual capacity Delay in coal exhaustion		

Control technology for multi coal fired boiler

3. Basic concept of Control technology for multi coal fired boiler

Quantified influencing factors

①Heat absorption index (HAI):
Value that shows distribution of heat absorption of furnace and superheater/reheater. Represents change in combustion due to change in burner position, contamination distribution, flammability (equivalent to fuel ratio) associated with coal properties, etc.

②Total heating value:
Represents change in fuel input due to change in water content, caloric value of fuel, etc.

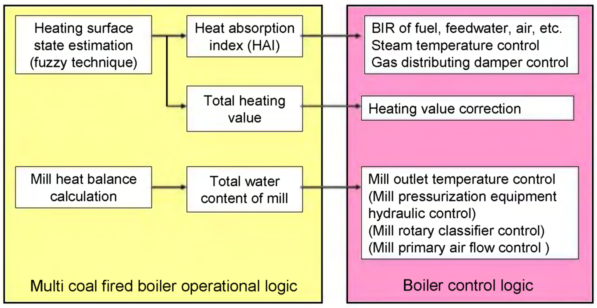
③Change in mill state quantity:
Utilizes changes in state quantities of mill roll lift, mill current value, and water content ratio estimated from the mill heat balance to represent the change in mill coal exhaustion capability caused by a change in coal properties.

Correction

Adjusted control parameters based on standard coal ⇨ **Enables optimum control that suppresses changes in characteristics of multi-coal-type coal-fired boiler.**

Control technology for multi coal fired boiler

4. Division of multi coal fired boiler operational logic and boiler control logic



Control technology for multi coal fired boiler

5.Adjustment of boiler control logic parameters

Basic concept

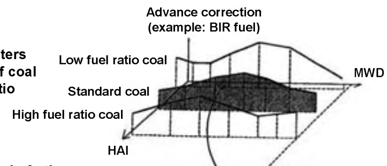
Adjustment of parameters based on combustion of standard coal

⇩

Adjustment of parameters based on combustion of coal with different fuel ratio

⇩

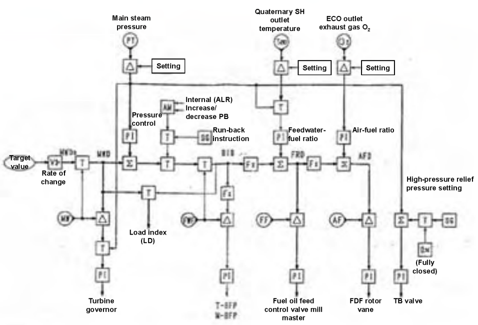
Automatic setting and control of other fuel ratio property parameters by three-point proportional division



Adjustment of three coal types enables automatic correction of others through proportional division

Reference: Optimum combustion control

To improve the controllability of the ECO outlet gas O_2 deviation, multi point analyzers with zirconia type are used because of their fast response. As a result, optimum combustion is achieved.



Assessment of control system

1. Objectives
2. Investigation Items
3. Investigation Method
4. Assessment Contents (Summary)

Assessment of control system

1. Objectives

The objectives is to confirm the state of key facilities at a power station and to investigate the feasibility of improving the reliability, operating performance and functionality of the power station through renovating or modifying its instrumentation and control systems.

2. Investigation Items
   - Control performance of control systems
   - Installed condition of control systems and field measuring instruments
   - Weak regions of control systems

3. Investigation Method
   - Acquired data analysis
   - Observation of operating conditions
   - Visual inspection of field equipment
   - Interviews with personnel involved

Assessment of control system

4. Assessment contents (Summary)

a. Grasp of control performance (operating data, observation, interviews)
   (1) Records of operating trends
   (2) Confirmation of the control mode
   (3) Conditions and causes of manual intervention by operators

b. Appropriateness of the installed state of equipment (control systems, field measuring instruments) (visual check)
   (1) Installed environment and state
   (2) Equipment maintenance conditions
   (3) Detection pipes

c. Gauging of control system weak regions (maintenance records)
   (1) Records of unit trip caused by the control system
   (2) Adjustment accuracy and inspection frequency of measuring instruments
   (3) Soot blower system operating history and conditions

Site investigation period
Around 3 days/1 unit

d. Identification of parts of instrumentation and control systems that can be improved

Thank You !

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