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Ministry of Power

NTPC LTD

THE STUDY ON ENHANCING EFFICIENCY OF OPERATING THERMAL POWER PLANTS IN NTPC-INDIA

Final Report

Volume II

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TABLE OF CONTENTS

Vol. I

Vol. I

Vol. I

Vol. I

Vol. II

Vol. III

Vol. IV

Vol. V

8.4.1 Boiler RLA

Scope of work and diagnosis procedure for Boiler RLA

< Objectives of power plants >

(1) Singrauli Unit 6
(2) Unchahar Unit 2
(3) Rihand Unit 2

< Objectives of boiler components>

(1) Water wall
(2) Super heater
(3) Reheater
(4) Super heater header
(5) De super heater pipe
(6) Reheater header
(7) Main steam pipe

< Procedure>

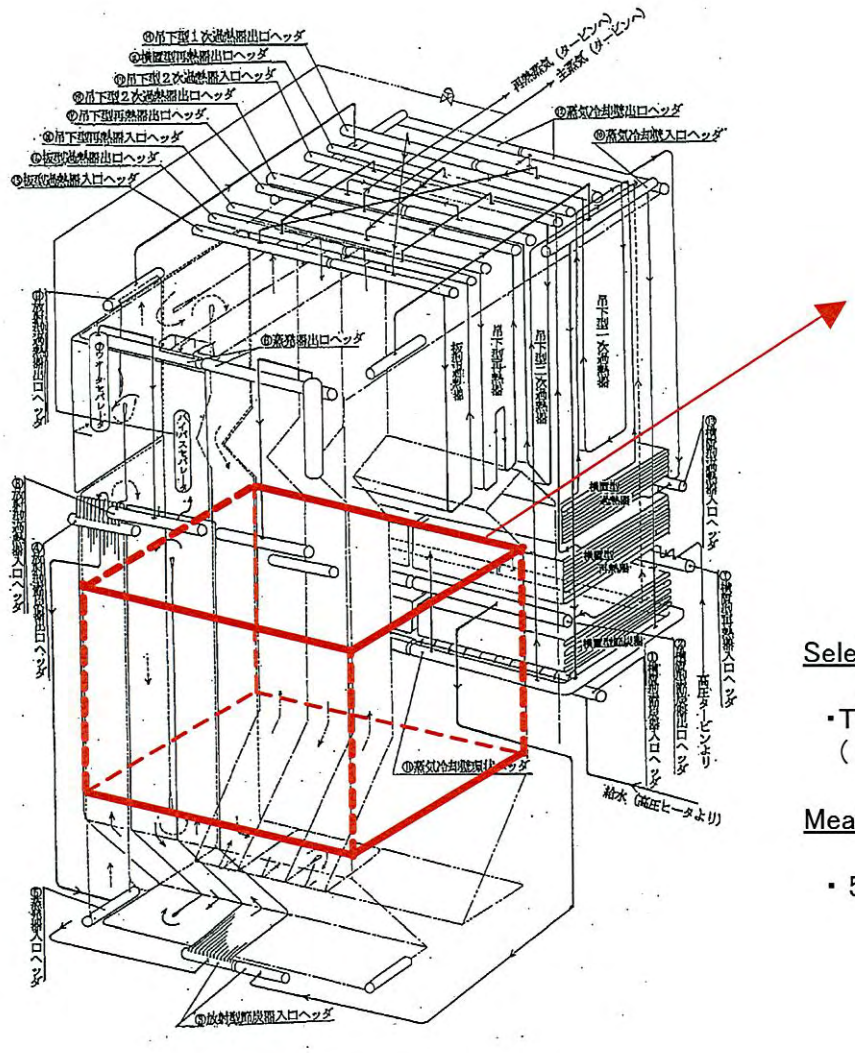
Boiler remaining life assessment will carried out based on the following procedure.

NO.	Parts	INSPECTION	Singrauli 6	Rihand 2	Unchahar 2	Reference
1	WATER WALL	VT	・Mainly at burner level ・Erosion part		*	
2		THICKNESS	・20 points(5points each from 4corners)		*	8 -4 - 1 - 1
3	SUPER HEATER	VT	・Mainly Platen super heater		*	
4		THICKNESS MEASUREMENT	・50 points around soot blower		*	8 -4 - 1 - 2
5		SAMPLE TUBE INSPECTION	・ 1 tube with 1m length for Platen SH including weld joint portion		*	8 -4 - 1 - 3
6		CREEP RUPTURE TEST (inspected in Japan)	・3 specimens from base metal, 3 specimens from weld joint from the tube identical to above.		*	8 -4 - 1 - 4
7		SUS SCALE DEPOSITION INSPECTION	・50 points of bottom bend portion of austenitic steel tubes		*	8 -4 - 1 - 5
8	REHEATER	VT	・Mainly around soot blower		*	
9		THICKNESS MEASUREMENT	—		*	
10		SAMPLE TUBE INSPECTION (inspected in Japan).	・2 tubes with 1m length for Final RH (one each from furnace inside and penthouse) including weld joint portion		*	8 -4 - 1 - 3
11		CREEP RUPTURE TEST (inspected in Japan) for 1 tube with 1m length.	・3 specimens from base metal, 3 specimens from weld joint from the tube identical to the one of the above sample tubes		*	8 -4 - 1 - 4
12		SUS SCALE DEPOSITION INSPECTION	・50 points of bottom bend portion of austenitic steel tubes		*	8 -4 - 1 - 5
13	SUPER HEATER HEADER	VT	・Visual inspection in penthouse ・If the fiber scope is shipped in time, fiber scope inspection is carried out for outlet header		*	
14		PT(DPT)	・4 portions at stub weld of Inlet header		*	8 -4 - 1 - 6
15		UT	・1ring of circumferential weld of outlet header with UT and TOFD identical to the replica portion		*	8 -4 - 1 - 7
16		REPLICA INSPECTION	・1 point on 1ring of circumferential weld of left outlet header ・1 point on base metal of left outlet header	・2 point on 1ring of circumferential weld of outlet header	*	8 -4 - 1 - 8 8 -4 - 1 - 9 8 -4 - 1 - 10
17	DE SUPER HEATER PIPE	REPLICA INSPECTION	・2 points (one each from 2rings of circumferential weld)		*	8 -4 - 1 - 8 8 -4 - 1 - 9 8 -4 - 1 - 10
18	REHEATER HEADER	VT	・Visual inspection in penthouse		*	
19		REPLICA INSPECTION	・2 points (one each from circumferential weld of left and right of out let header	・2 point on 1ring of circumferential weld for outlet header	*	8 -4 - 1 - 8 8 -4 - 1 - 9 8 -4 - 1 - 10
20	MAIN STEAM PIPE (near the stop valve weld joint)	REPLICA INSPECTION	・2 points on circumferential weld of left main steam pipe	・2 points (one each from left and right side)	*	8 -4 - 1 - 8 8 -4 - 1 - 9 8 -4- 1 - 10

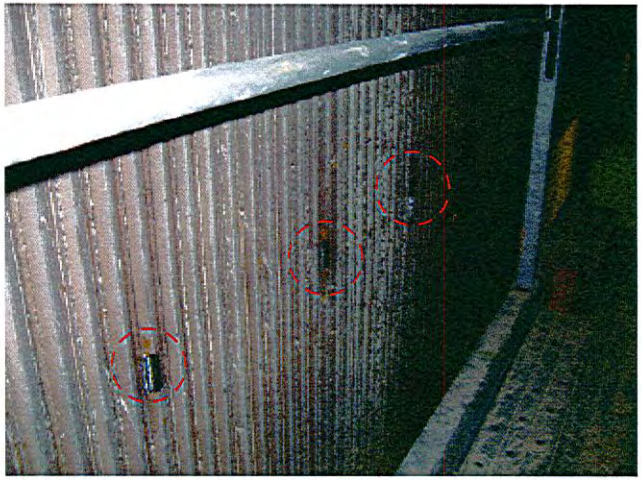
*:Decided after site meeting, basically followed by items of the other two units.

・BUILDING OF SCAFFOLDS, REMOVAL OF THERMAL INSULATION ,
AND REMOVAL OF DUST IN BOILER FURNACE SHALL BE COMPLETED IN ADVANCE.

Thickness Measurement （Water wall tube）



Bird's eye view of boiler



Example of measurement points

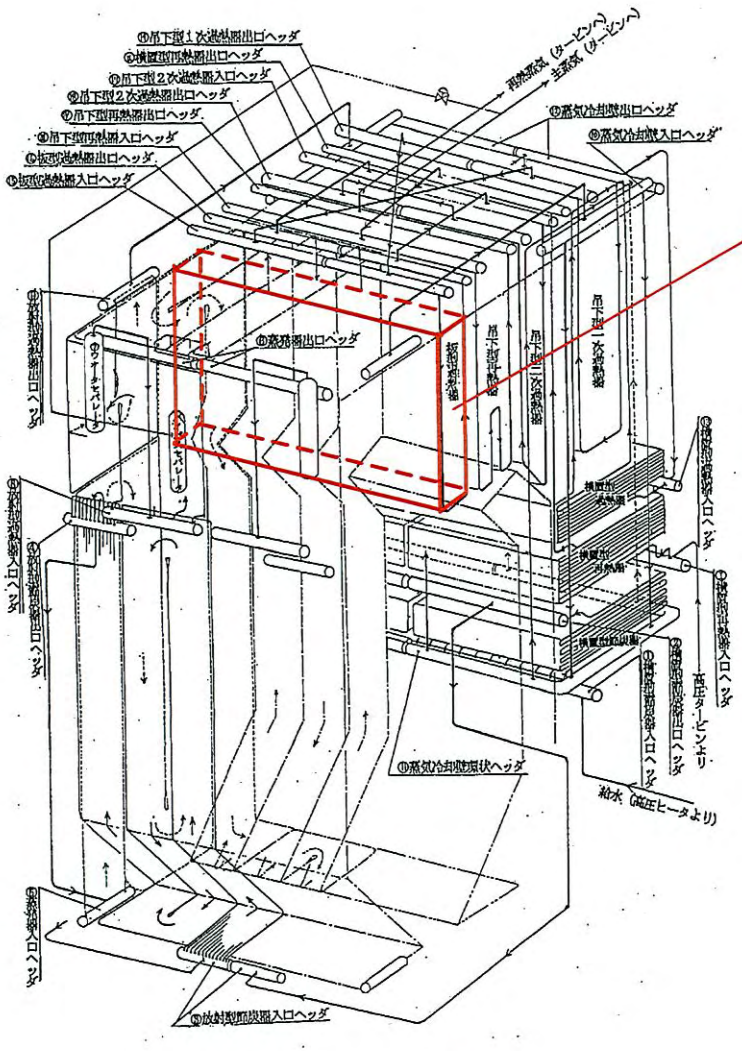
Selection criteria

- The most severe heat load potion like the upper part of the burner level .
  (Available metal temperature data would help the selection)

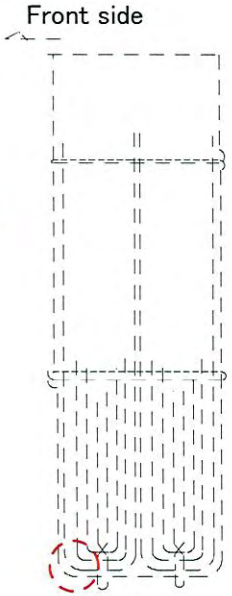
Measurement points and quantity

- 5 points of each corner.

Thickness Measurement （Super heater tube)



Bird's eye view of boiler



Inspection portion

Example of measurement points

Selection criteria

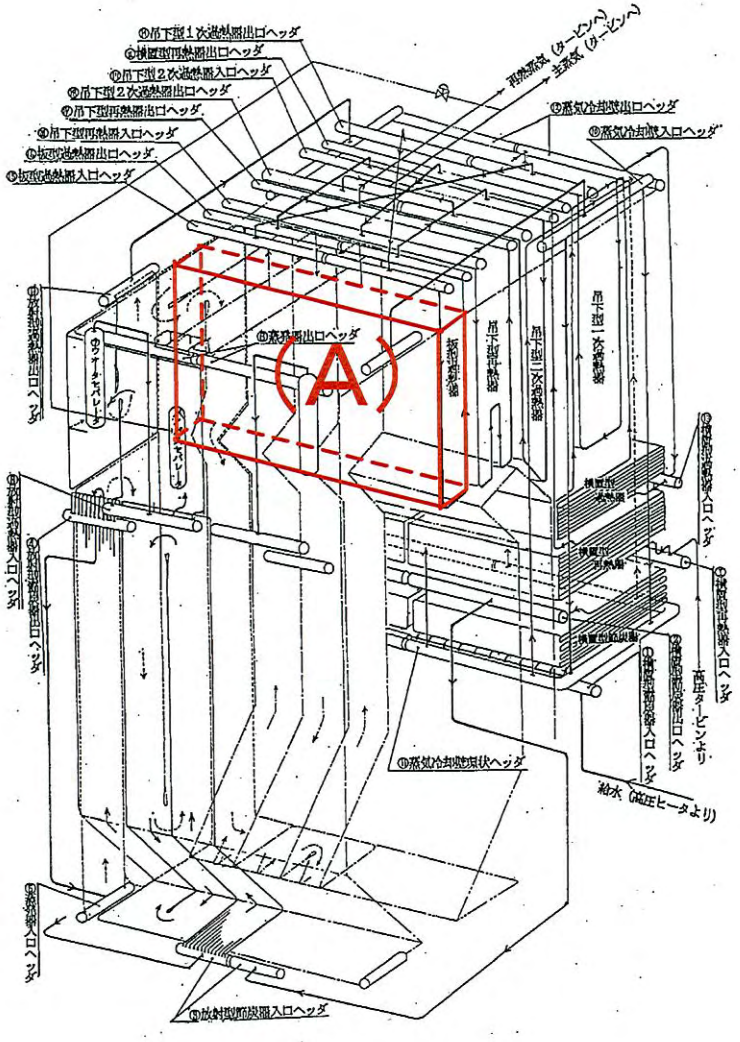
- The highest temperature portion of super heater tubes (or reheater tubes) .
- The portion directly exposed to combustion gases from the furnace with the risk of thickness loss by oxidation from outside.

Measurement points and quantity

- Total 50 points of the straight portion of outer tube (1–3rd) around soot blower for selected final superheater panel.

8－4－1－3

Sample Tube Inspection (Super heater tube, Reheater tube)



Bird's eye view of boiler

Example of sampling point for SH

Examination item
1.Appearance inspection
2. Inner and outer suface inspection
3. Inner scale examination (adhesion thickness, composition(water wall tube))
4.Hardness test
5. Tube dimensions measurement
6. Microstructure examination

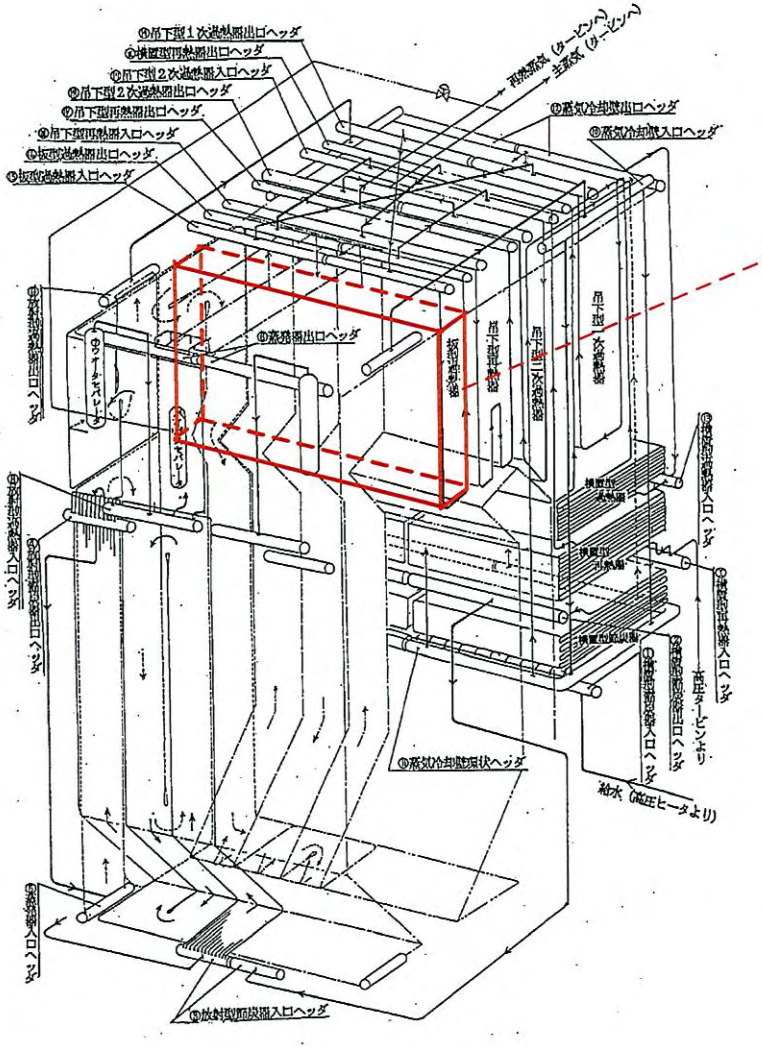
Selection criteria

〔Super heater tube〕
・The highest temperature portion of super heater tubes (or reheater tubes) .

Measurement points and quantity

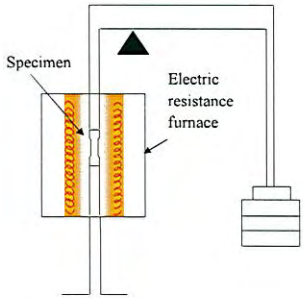
〔Super heater tube〕 1 tube with 1m length including weld joint portion.
〔Reheater tube〕 2 tubes with 1m length for Final RH
(one each from furnace inside and penthouse)
including weld joint portion.

Creep Rupture Test （Super heater tube, Reheater tube）

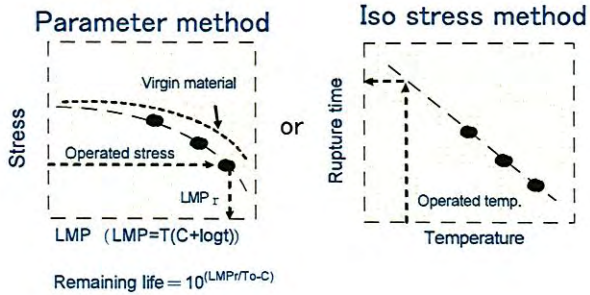


Bird's eye view of boiler

Example of sampling point for SH



Schematic view of creep tupture test



RLA by creep rupture test

Selection criteria

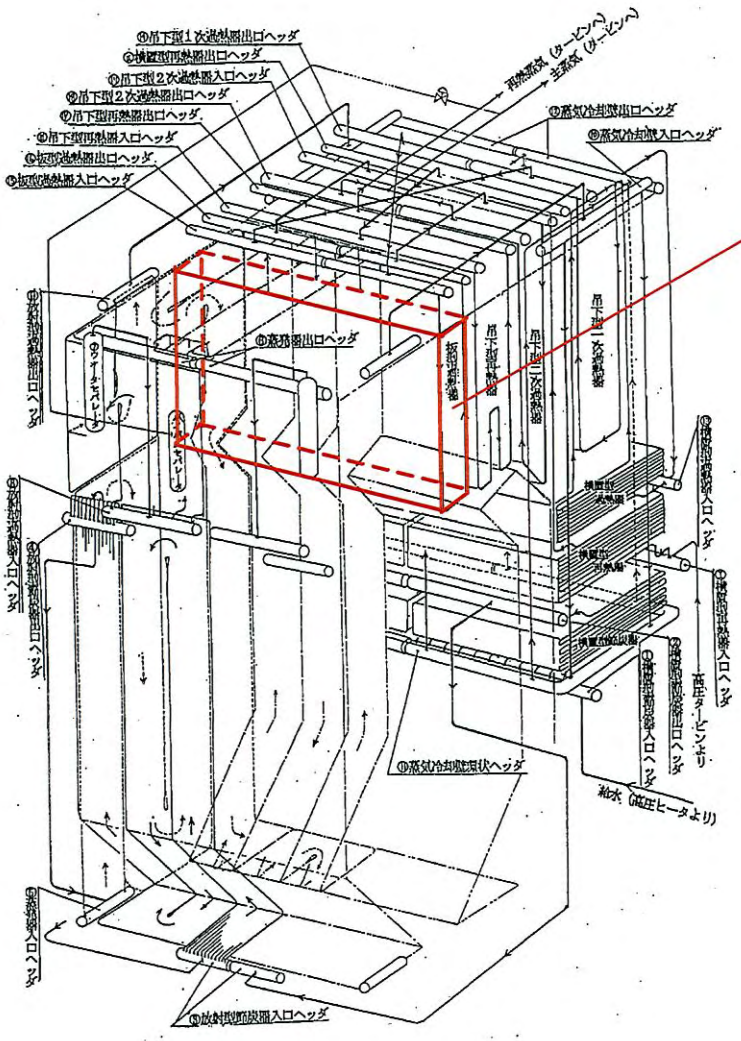
- The highest temperature portion of super heater tubes and reheater tubes （Including circumferential weld portion ）

Measurement points and quantity

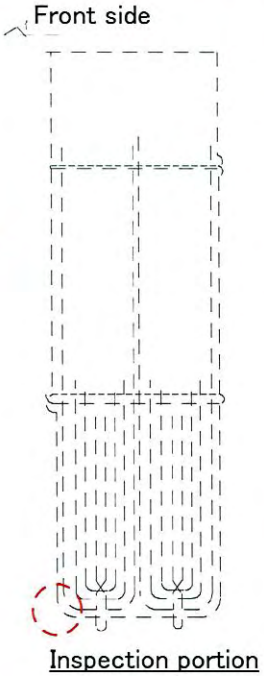
- 1 tube with 1m length including circumferential weld portion of super heater (Base metal and weld potion evaluated separately (test peices total 6))
- 1 tube with 1m length including circumferential weld portion of reheater (Base metal and weld potion evaluated separately (test peices total 6))

SUS Scale Deposition Inspection (Super heater tube, Reheater tube)

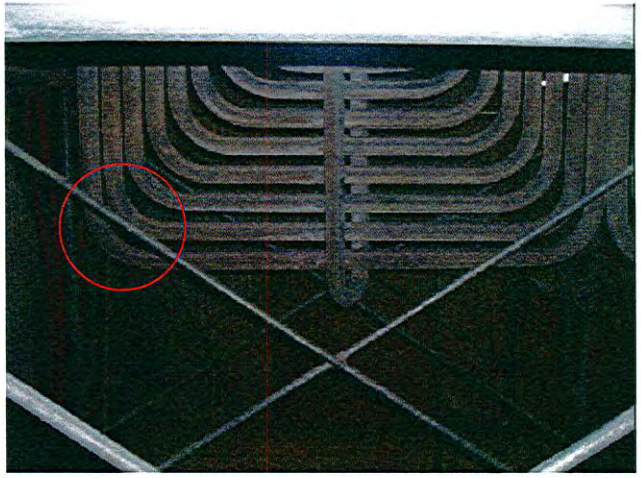
8 - 4 - 1 - 5



Bird's eye view of boiler



Inspection portion



Example of inspection points

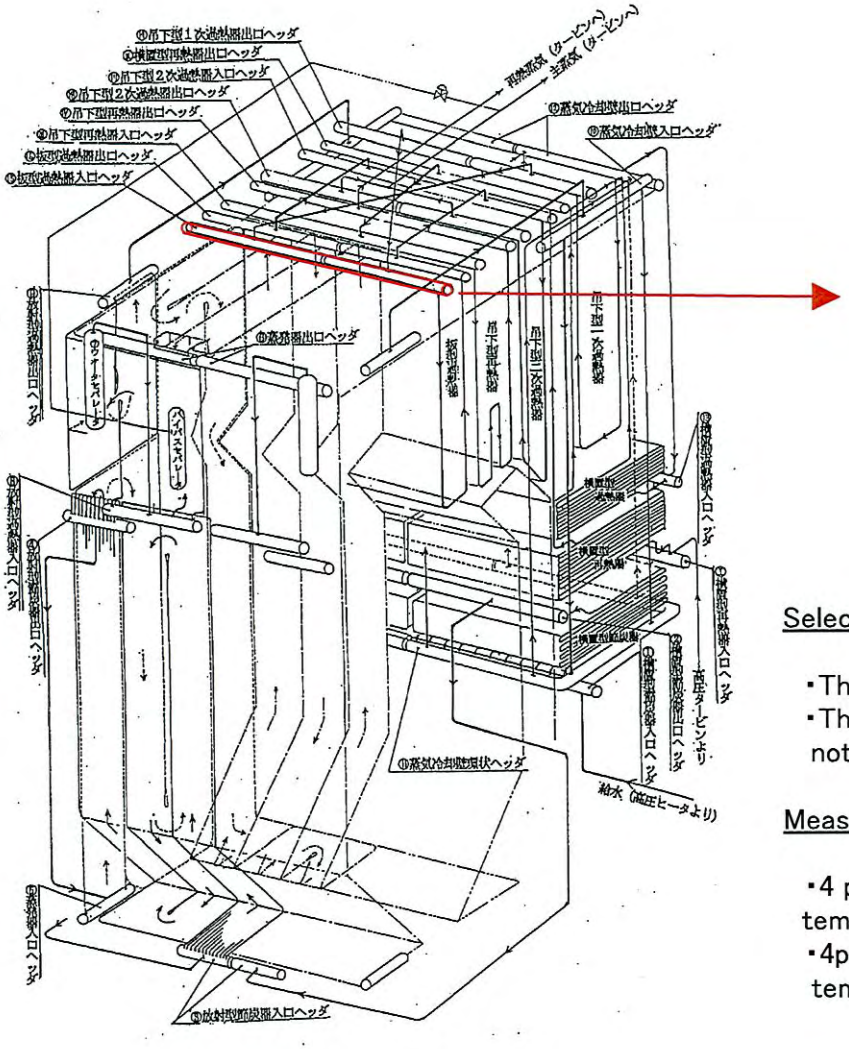
Selection criteria

- Portion of super heater tubes and reheater tubes where austenitic stainless steel is used.
- Bottom bend portion where exfoliated steam oxidation scale from inner surface of tube by thermal expansion and contraction during start-stop is expected to fall and pile up.

Measurement points and quantity

- 50 points of bend portion of austenitic stainless steel for selected final superheater panel.
- 50 points of bend portion of austenitic stainless steel for selected rerheater panel.

Penetrant Testing (Stub portion of final super heater header)



Bird's eye view of boiler

Example of inspection points

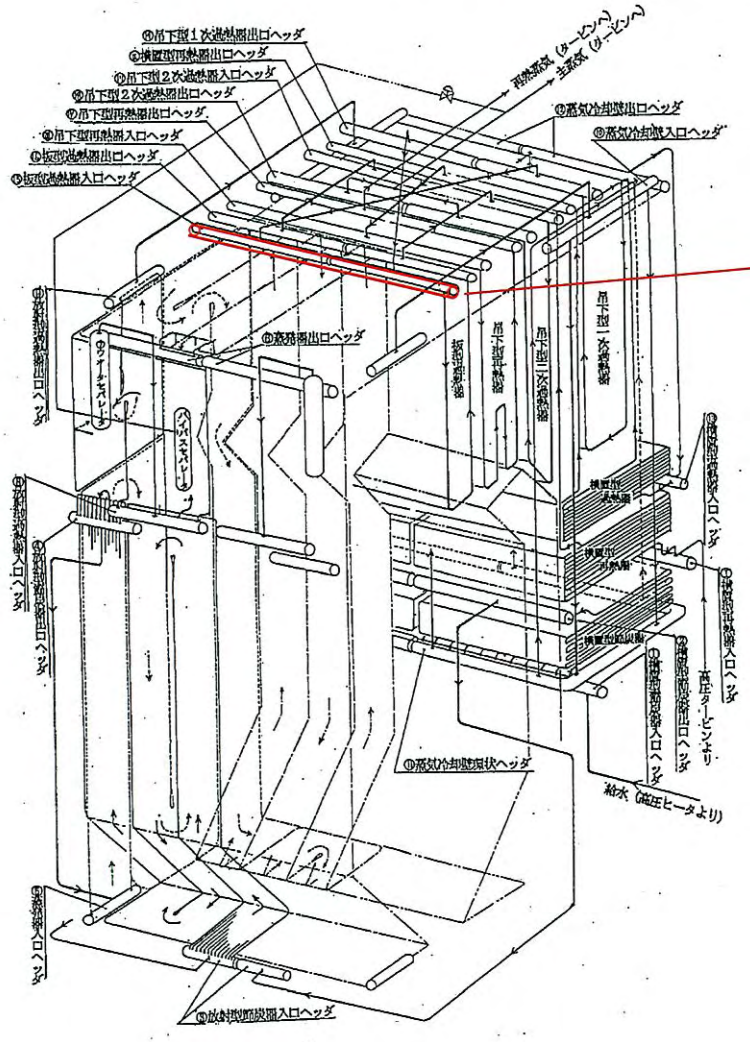
Selection criteria

- The highest temperature stub, if metal temperature data is available.
- The high stressed stub by structural constraint, if metal temperature data is not available.

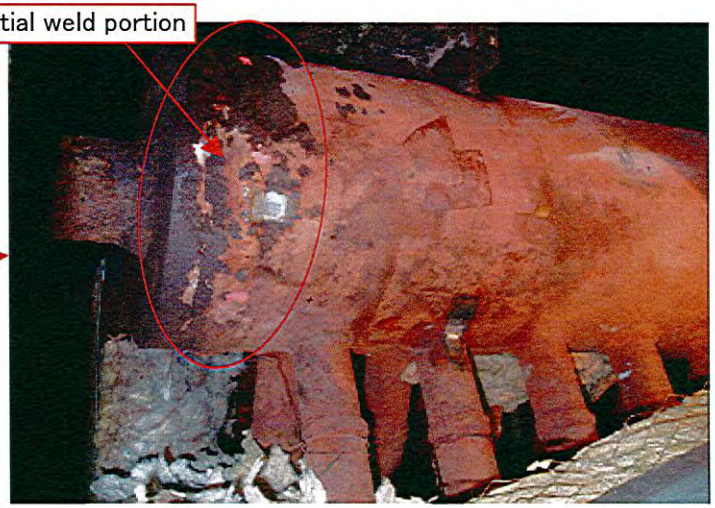
Measurement points and quantity

- 4 points with high temperature portion among axial direction, if metal temperature data is available.
- 4points of stubs with high stressed portion by structural constraint, if metal temperature data is not available.

UT Inspection、TOFD Inspection(Final super heater header circumferential weld portion)



Bird's eye view of boiler



Example of inspection points

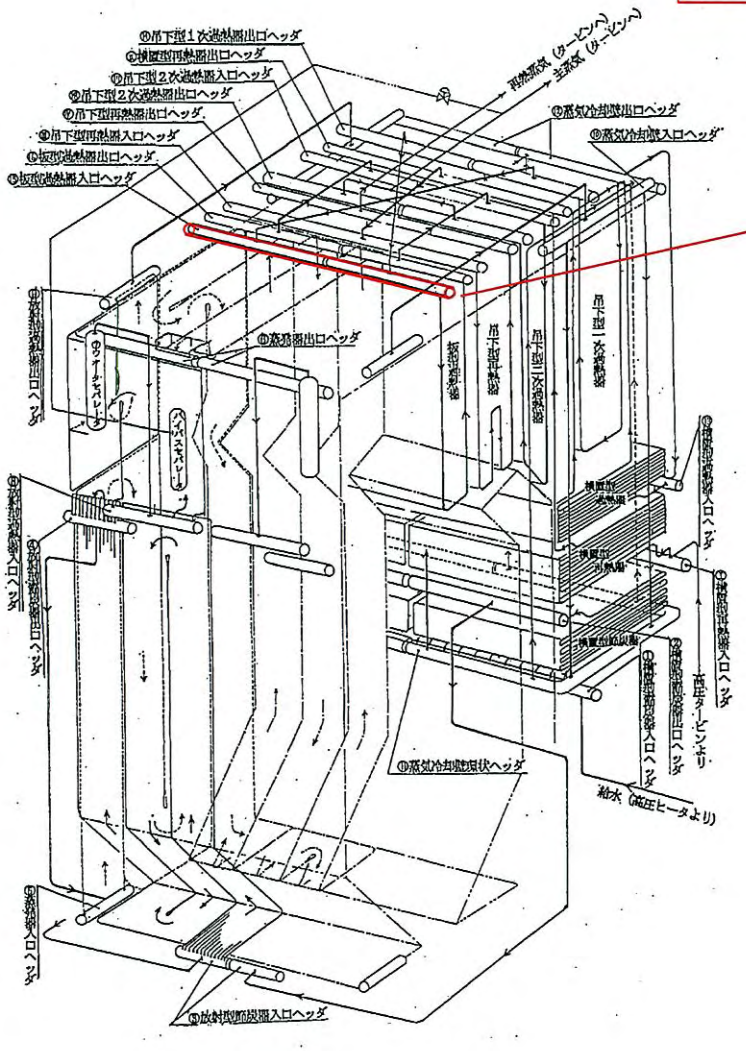
Selection criteria

- Circumferential weld portion with the highest temperature , if metal temperature data is available.
- The high stressed circumferential weld portion by structural constraint, if metal temperature data is not available.

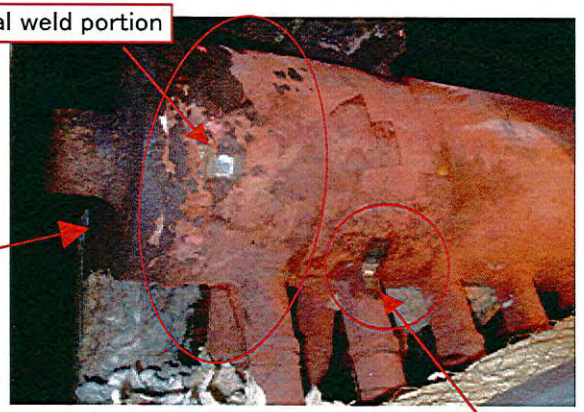
Measurement points and quantity

- All around one circumferential weld (1Ring), except interference portion with stubs.

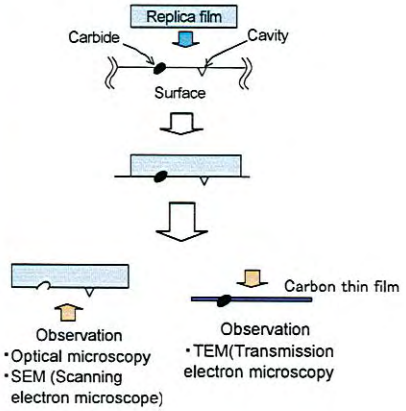
Replica Inspection (Final super heater header, Desuper header, Reheater header and Main steam pipe)



Bird's eye view of boiler



Example of inspection points



Selection criteria

〔Circumferential weld and stub weld portion〕

- The highest temperature portion , if metal temperature data is available.
- The high stressed weld portion by structural constraint, if metal temperature data is not available.

Measurement points and quantity

〔Circumferential weld potion〕

- 2 points on 1ring of circumferential weld in final super heater header
- 2 points (one each from 2rings of circumferential weld) in desuper heater pipe.
- 2 points on circumferential weld in reheater header.
- 2 points on circumferential weld in main steam pipe.

Examination Technique of Remaining Life Assessment for Boiler High Temperature part

Japanese RLA guidline

(1) Degradation factor to be evaluated
- Creep rupture remaining life
  (Designed temperature beyond 450℃)

(2) Components to be evaluated and the method to assess the remaining life

【Components】
- Furnace evaporation header
- Super heater header or Main steam pipe
- Reheater header or High temperature reheat pipe
  Representative points among high heat loaded and high stressed portion in these components

【Method to assess the remaining life】
More than one method shown in table

(3) Effective (countable) remaining life
- 1/ 2 of remaining life evaluated by above methodes

Method	Guideline		This study	
	Base metal	Weld (HAZ)	Base metal	Weld (HAZ)
Hardness measuring	—	○		
Electrical resisitance	—	○		
Chemical composition of carbide	○	○		
Creep cavity evaluation	—	○		
Microstructural comparison	○	○	○	○
Urtra sonic scattering noise	—	○		
Interparticle spacing	○	—		
Crystal grain deformation	○	—		
Destructive test	○	○		
Analytical method	○	○		

○ : applicable, − : not applicable

(Microstructural comparison method outline)
Remaining life synthetically evaluated by three types of damage as shown below.

【Base metal】
- Evaluation of average diameter
- Comparison with the referernce picture of microstructure related to creep the damage ratio
- Comparison with the referernce picture of carbide precipitationrelated to the creep damage ratio

【Weld metal】
- Comparison with the referernce picture of creep void and micro crack related to creep the damage ratio
- Comparison with the referernce picture of microstructure related to creep the damage ratio
- Comparison with the referernce picture of carbide precipitationrelated to the creep damage ratio

Microstructural comparison method in this study