

Microstructural Comparison Method (Weld portion)

Reference picture of carbide precipitation

Feather like precipitation	No precipitates free zone along grain boundary
Feather like precipitates start to disappear	Precipitates free zone start to appear
Feather like precipitates disappeared	Broadening of precipitates free zone

Reference picture of microstructure

No precipitates on grain boundary	
Precipitates start to appear on grain boundary	
Precipitates coarsen on grain boundary	

Reference picture of creep void and micro crack

Grade	X 1400	No void
1		Isolated void
2		A number of voids on grain boundary
3		Chained voids to micro crack
4		Macro crack beyond 50 μm
5		

↑ stress

Quantitative evaluation

Quantitative evaluation of grain boundary precipitates

Volume fraction = n/total grids
(n: grids on the precipitates)

Quantitative evaluation of precipitates free zone

Relationship of evaluated value and LMP (time-temperature parameter)

Upper limit
LMP
Lower limit
Volume fraction

Procedure for microstructural change to creep damage

A microstructural change point LMP₁ obtained by aging test

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Service hours t_s of evaluation component

Calculation of equivalent temperature T_{E1} from LMP₁ and service hours t_s

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Creep rupture LMP_{r1} from NIMS creep data at applied stress σ of evaluation part.

Calculation of rupture hours t_{r1} with PLM_{r1} and T_{E1}

Creep life consumption ratio t_s / t_{r1} for a microstructure change point LMP₁

LMP=(273+T)(C+logt), T:temperature, t: time

Example of synthetic evaluation

Coarse grain HAZ

Evaluated factor		Creep damage ratio	
Stress 35MPa		0 10 20 30 40 50 60 70 80 90 100	
Micro structure	Bainite lath structure	0%	Disappearance bainite lath
	Grain boundary	18% (572°C)	
Precipitate	Fine precipitates in grain	7% (555°C)	54% (589°C)
Creep void and micro crack	No void		
	Isolated void		
	A number of voids on grain boundary		
	Chain voids		
Synthetic evaluation		20% (573°C)	50% (588°C)

Schedule of work for Boiler RLA

Item - Contents		In charge	Day						~2010 Feb.	
			1week before	1	2	3	4	5		6
Boiler Cooling & Scaffolding Assembly		P.S.								
Cleaning of boiler inside		P.S.								
Removal of heat insulation stuff		P.S.								
Checking of work site		JST,JSC		All members						
Meeting before work		JST,JSC	All members							
Water wall tube	Visual check	JST,JSC			A,D					
	Thickness measurement of tubes	JST,JSC			B,D					
	Grinding									
	Measurement					B,D				
							Demo			
SH tube	Visual check	JST,JSC			B,C,E,F,G,H					
	Thickness measurement of tubes	JST,JSC			B,D					
	Grinding									
	Measurement					B,D				
	SUS scale deposition inspection	JST,JSC			E,F					
	Grinding									
	Measurement						E,F			
								Demo		
	Tube sampling	Cutting	P.S.							
		Restoration								
Preparation for shipping of tube										
Examination of tube		JSC								
	Creep rupture test of tube									
RH tube	Visual check	JST,JSC			B,C,E,F,G,H					
	SUS scale deposition inspection	Grinding	JST,JSC			E,F				
		Measurement					E,F			
	Tube sampling	Cutting	P.S.							
		Restoration								
	Preparation for shipping of tube									
	Examination of tube	JSC								
Creep rupture test of tube										
SH header	Visual check	JST,JSC				A,C,G,H				
	PT (stub)	Grinding	JST,JSC				G,H			
		Inspection						G,H		
	UT (Circumferential weld)	Grinding							G,H	
		UT(TOFD) detection								E,F,G,H
									Demo	
Replica inspection	Replica sampling	JST,JSC				A,C			Demo	
	Examination of replica Remaining life assessment	JSC								
Dasuperheater	Visual check	JST,JSC				A,C,G,H				
	Replica inspection	Replica sampling	JST,JSC					A,C		
		Examination of replica Remaining life assessment	JSC							Demo
RH header	Visual check	JST,JSC					B,D			
	Replica inspection	Replica sampling	JST,JSC						B,D	
		Examination of replica Remaining life assessment	JSC							
Main steam pipe	Visual check	JST,JSC					B,D			
	Replica inspection	Replica sampling	JST,JSC						B,D	
		Examination of replica Remaining life assessment	JSC							
Preparation for shipping of inspection instruments		JSC								

- JST Hayakawa
- JSC member A
- JSC member B
- JSC member C
- JSC member D
- JSC member E
- JSC member F
- JSC member G
- JSC member H

Boiler RLA demo in Singrauli #6unit & Unchahar #2

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

Boiler RLA
&
Kyudensangyo Co.,Inc

27.October 2009 -11.November 2009

Schedule for Boiler RLA demo

Schedule for Boiler RLA

	Month	October									November											~ January
	Day	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11		
	Day of the week	Sa	Su	Mo	Tue	We	Th	Fr	Sa	Su	Mo	Tue	We	Th	Fr	Sa	Su	Mo	Tue	We		
Singrauli UNIT6	Boiler Inspection																					
Unchahar UNIT2	Meeting																					
	Boiler Inspection																					
	◇ Examination in Japan																					

Scope of work (1)

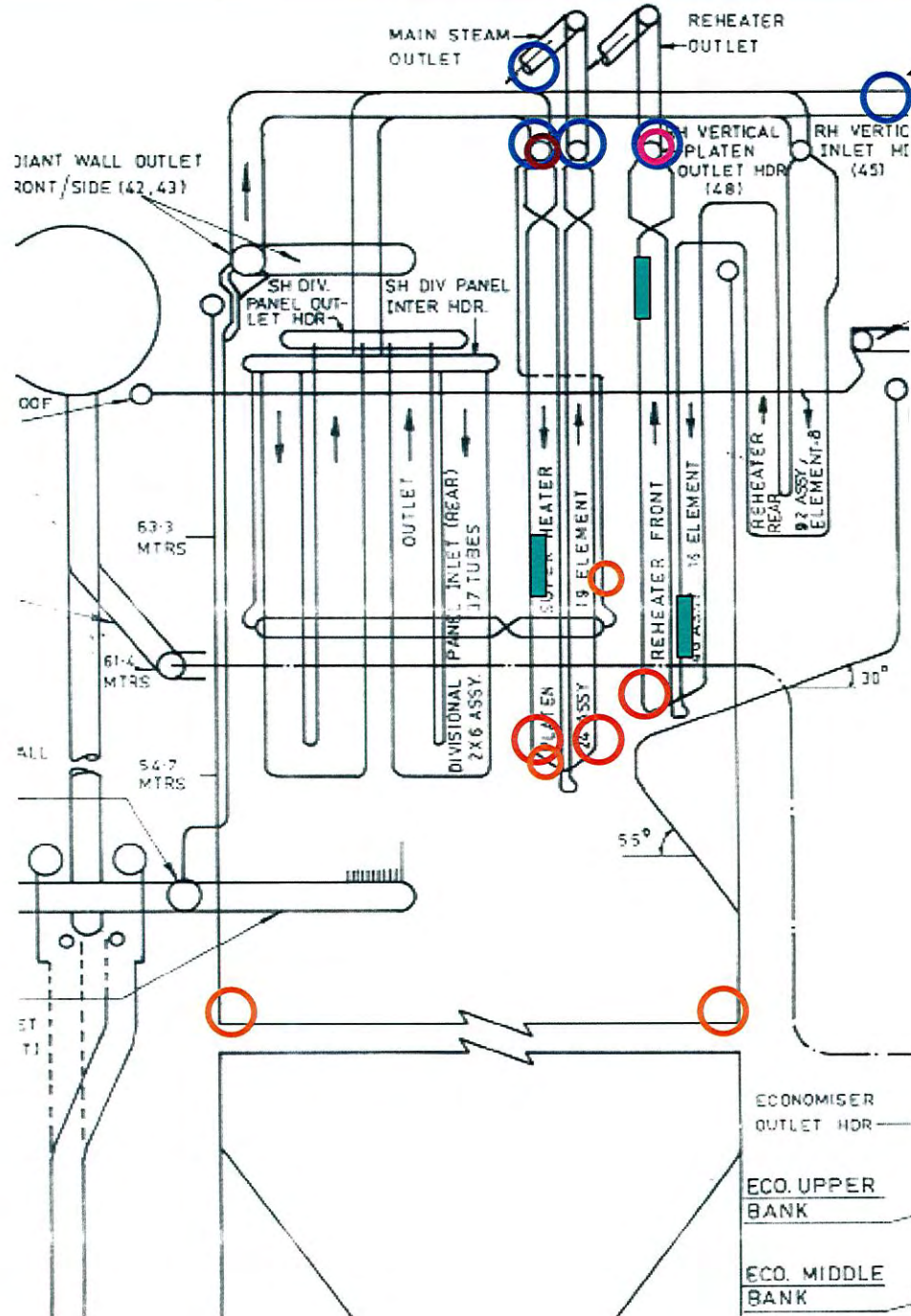
NO.	Parts	INSPECTION	Singrauli #6	Unchahar #2
1	WATER WALL	VT	<ul style="list-style-type: none"> Mainly at burner level Errosion part 	
2		THICKNESS MEASUREMENT	<ul style="list-style-type: none"> 20 points(5points each from 4corners) 	
3	SUPER HEATER	VT	<ul style="list-style-type: none"> Mainly Platen super heater 	
4		THICKNESS MEASUREMENT	<ul style="list-style-type: none"> 50 points around soot blower 	
5		SAMPLE TUBE INSPECTION *	1 tube with 1m length for Platen SH including weld joint portion	2 tubes with 1m length from Final SH, 1 tubes with 1m length from Platen SH including weld joint portion that is selected by steam oxide scale measurement result.
6		CREEP RUPTURE TEST*	<ul style="list-style-type: none"> 3 specimens from base metal, 3 specimens from weld joint from the tube identical to above. 	<ul style="list-style-type: none"> 3 specimens from base metal, 3 specimens from weld joint from the tube identical to above.
7		SUS SCALE DEPOSITION INSPECTION	<ul style="list-style-type: none"> 50 points of bottom bend portion of austenitic steel tubes 	<ul style="list-style-type: none"> 29 ×3 points of bottom bend portion of austenitic steel tubes
8	REHEATER	VT	<ul style="list-style-type: none"> Mainly around soot blower. 	
9		SAMPLE TUBE INSPECTION *	2 tubes with 1m length for Final RH (one each from furnace inside and penthouse) including weld joint portion.	
10		CREEP RUPTURE TEST*	<ul style="list-style-type: none"> 3 specimens from base metal, 3 specimens from weld joint from the tube identical to the one of the above sample tubes. 	
11		SUS SCALE DEPOSITION INSPECTION	<ul style="list-style-type: none"> 50 points of bottom bend portion of austenitic steel tubes 	

*: Examined in Japan

Scope of work (2)

NO.	Parts	INSPECTION	Singrauli #6	Unchahar #2
12	SUPER HEATER HEADER	VT	• Visual inspection in penthouse	
13		PT(DPT)	• 4 portions at stub weld of Inlet header .	• 4 portions at stub weld of Platten inlet header right side.
14		UT		• 1 ring of circumferential weld of Final outlet header right side with UT and TOFD identical to the replica portion
15		REPLICA INSPECTION	• 1 point on 1 ring of circumferential weld of left outlet header. • 1 point on base metal of left outlet header.	• 1 point of circumferential weld portion of right side of Final outlet header.
16		DE SUPER HEATER PIPE	REPLICA INSPECTION	• 2 points (one each from 1 ring of circumferential weld right and left).
17	REHEATER HEADER	VT	• Visual inspection in penthouse	
18		UT	• 1 ring of circumferential weld of outlet header with UT and TOFD identical to the replica portion	
19		REPLICA INSPECTION	• 2 points (one each from circumferential weld of left and right of out let header.	• 3 points of circumferential weld portion of right and left side outlet header.
20	MAIN STEAM PIPE (near the stop valve weld joint)	REPLICA INSPECTION	• 2 points on a circumferential weld of left main steam pipe	• 2 points on two circumferential welds of right main steam pipe
21	HOT RHEAT PIPE	REPLICA INSPECTION		• 1 point on a circumferential weld of right High temperature reheat pipe.

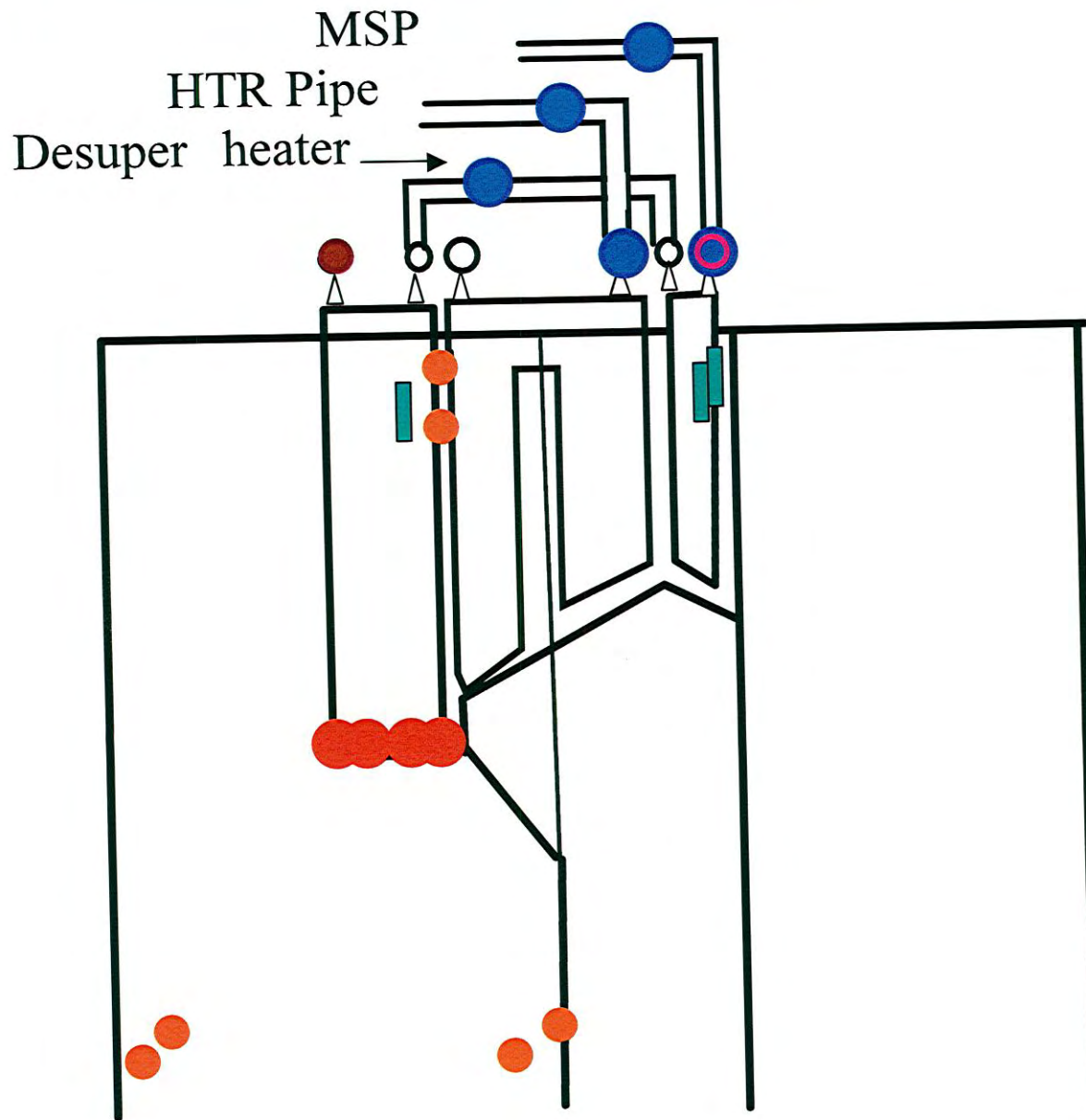
Inspection points



Desuper heater

- : Replica
- : SUS scale
- : Thickness measurement
- ▭ : Tube sampling for inspection and creep rupture test
- : UT, TOFD
- : DPT

Inspection points (Unchahar #2)



- : Replica
- : SUS scale
- : Thickness measurement
- : Tube sampling for inspection and creep rupture test
- : UT, TOFD
- : DPT

Findings (1) (Singrauli #6)

Components	Inspection method	Findings
Water wall tube	Visual check	<ul style="list-style-type: none"> •Erosion of a number of tubes around short soot blower were found. •No erosion at any other portions. •No erosion and decrease in thickness around burners.
	Thickness measurement of tubes	Thickness was measured at erosion regions around soot blowers near each 4 corner. Min. thickness was 3.7mm(2nd blower in front wall first from right. $\phi 51 \times 5.6\text{mm}$, SA210 Gr.C
Platten SH	Visual check	<ul style="list-style-type: none"> •Attrition of binding tube #4 and #5 was found. (Min.2.8mm) •Attrition of cooling spacer tube with front tube of #14 panel (Min.5.0mm) •Disorder of arrangement at lower part of panel with distortion to adjacent panel. •A number of disjointed slide spac
	Thickness measurement of tubes	<ul style="list-style-type: none"> •1: Outer tube of rear side portion at sootblower level [24points] \Rightarrow Min.6.3mm $\phi 63.5 \times 6.3\text{mm}$ SA213 TP347H •2: Outer bottom tube [24points] \Rightarrow Min.9.8mm $\phi 54.0 \times 9.5\text{mm}$ SA213 TP347H •3: Attrition of cooling
	SUS scale deposition inspection	Nos. exceeding 10% fullness : 7 /50 (magnetized effect of material)
	Tube sampling for sample tube inspection (inspected in Japan).	#3-1 (from left side in penthouse)
	Creep rupture test (inspected in Japan)	

Findings (2) (Singrauli #6)

Components	Inspection method	Findings
Reheater	Visual check	• Disorder of arrangement at lower part of panel with distortion to adjacent panel.
	SUS scale deposition inspection	No exceeding 10% fullness
	Tube sampling for sample tube inspection (inspected in Japan).	#3-1 (from leftside in penthouse) 1m including weld f 54*5.6, SA213 T22 #14-5 (from rear side in furnace) (SA213T22 f 54*4.5-SA213T11 f 54*4.0)
	Creep rupture test (inspected in Japan) for 1 tube with 1m length.	
Super heater header	Visual check	• No appearance abnormality in stubs and other weld portion.
	DPT	#2(1,4,7,12) Indication was found in #2-12 stub at tube side. Indication disappeared after grinding off the tube in 1mm depth .
	Replica inspection	• No crack in Base metal, HAZ(Heat Affected Zone) and weldmetal. • More detail microstructural observation is required in labo.
De superheater pipe	Replica inspection	• No crack in Base metal, HAZ(Heat Affected Zone) and weldmetal. • More detail microstructural observation is required in labo.
Reheater header	Visual check	• No appearance abnormality in stubs and other weld portion.
	Replica inspection	• No crack in Base metal, HAZ(Heat Affected Zone) and weldmetal. • More detail microstructural observation is required in labo.
	UT	• No detection of flaw beyond H-detection line. • 4 detected flaw under H-detection line.
	TOFD	• A number of flaw considered as satle blow holes and slag inclusions were detected. • No considerable crack detected.
Main steam pipe (near the stop valve weld joint)	Replica inspection	• No crack in Base metal, HAZ(Heat Affected Zone) and weldmetal. • More detail microstructural observation is required in labo.