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RADIOGRAPHIC EXAMINATION OF PRESSURED PARTS FOR HEAT RECOVERY STEAM GENERATOR

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ABSTRACT

RADIOGRAPHIC EXAMINATION OF PRESSURED PARTS FOR HEAT RECOVERY STEAM GENERATOR. A larger Nuclear Power Generation and Non Nuclear Power Generation are shipped to the job sites in various stages of fabrication and subassembly. Welding and welding related processes are central to Power Generation component fabrication and assembly in the site. This papers presents some results of the investigation that was carried out to examine the welding results of the site construction of Heat Recovery Steam Generator Piping of Tanjung Priok Gas Fired Power Plant Extension Project (740 MW) using the Radiography Test Method based on the ASME Standard. From this investigation it could be concluded that there was no crack founded in the selected specimens of the piping. The rejectable Incomplete Penetration was found in the Hot Reheat Steam Piping HRSG1. Some Porosities and Slag Inclusion are rejected because their size and length are longer than acceptable value limits, therefore should be repaired. However some of the results are accepted and no need to be repaired. The rejected Worm Holes is found on IP Super Heater Inlet Piping of HRSG1 whereas the undercut occurred on HP Steam Drum of HRSG.

Keywords: Welding, radiographic examination, steam piping, HRSG

ABSTRAK

PENGKAJIAN RADIOGRAFI BAGIAN-BAGIAN BERTEKANAN DARI HEAT RECOVERY STEAM GENERATOR. *Pembangkit Listrik Tenaga Nuklir dan Pembangkit Listrik Non Tenaga Nuklir yang berkapasitas besar dikirim ke lokasi pekerjaan dalam berbagai tahap fabrikasi dan sub perakitan. Pengelasan dan proses pengelasan yang berhubungan dengan komponen pembangkit merupakan inti dari fabrikasi dan perakitan di lokasi pembangkit. Tulisan ini menampilkan beberapa hasil pengkajian yang dilakukan untuk mengevaluasi hasil pengelasan pipa HRSG yang dikonstruksi dilokasi dari "Tanjung Priok Gas Fired Power Plant Extension Project (740 MW)" dengan menggunakan Metoda pengetesan Radiografi yang didasarkan pada Standar ASME. Dari investigasi ini dapat disimpulkan bahwa tidak ditemukan adanya "crack" pada benda-benda uji yang terpilih. Ditemukan Incompele Penetration yang ditolak pada Hot Reheat Steam Piping HRSG1. Beberapa Porositi dan Slag Inclusion ditolak karena besar dan panjangnya lebih panjang dari batasan-batasan nilai yang diijinkan oleh karena itu harus diperbaiki. Akan tetapi beberapa hasil pengkajian diterima dan tidak perlu diperbaiki. Pada IP Super Heater Inlet Piping dari*

HRSG1ditemukan beberapa Worm Hole yang tidak memenuhi kriteia sedangkan Undercut yang ditolak terjadi pada HP Steam Drum dari HRSG.

***Kata Kunci** : Las, pengkajian, radiografi, pipa uap , HRSG*

INTRODUCTION

Radiographic examination performed to determine the discontinuities in the material results in a foundry products, fabrication and welding results. Iridium 192 is one source of radiation used in radiography technique. Radiography applications are widely used for pipe inspection of nuclear power generation and non-nuclear.

Boilers, Headers, Steam Lines, Turbines, Feed Water Heaters and Condensers are the main components of Nuclear Power Generation, Steam Power Generation, and Combined Cycle Generation must be fabricated, assembled and erected in good technical condition based on ASME or and ASTM standards. The Heat Recovery Steam Generator (HRSG) is the primary component of the Combined Cycle Power Plant. The function of the HRSG is to produce the superheated steam and then the steam expand through the steam turbine in which the thermal energy converted to rotating mechanical energy, and then the mechanical energy is converted to electrical energy in generator.

The HRSG is arranged with the total pressure parts comprising steam drums, super heater, evaporation, economizer, headers. Down corners and integral pipe works in the form of a self contained unit supported by its own steel structure. A few HRSG types are small enough to permit shipment completely assembled. A larger HRSG are shipped to the job sites in various stages of fabrication and subassembly. The HRSG of Tanjung Priok Gas Fired Power Plant Extension Project is shipped to the jobsite in the form of shop-fabricated components. Welding and welding related processes are central to HRSG fabrication and assembly in the site. There are many welding processes from which to select. The choice is primarily based on the best method of generating and conveying the energy needed to create the weld. Electric arc welding is by far the most common group of processes used in fabricating HRSG equipments ,although other processes also apply.

The welds that are made in the HRSG site assembly can be divided into two categories, those for joining of pressure parts and attachments to pressure parts and those for joining non pressure parts. Welds that are made of pressure parts must conform to requirements of applicable codes and technical requirement. Non Destructive Test (NDT) provides the mechanism for quality control of base metals and weldments. There are four predominant methods of NDT that pertain to the pressure vessel industry. They are : radiography test (RT), ultrasonic test (UT), magnetic particle inspection (MT) and dye penetrant inspection (PT).

This paper discuss some result of the radiography test that were carried out to examine the welding results of the site construction of Heat Recovery Steam Generator Piping of Tanjung Priok Gas Fired Power Plant Extension Project

OBJECTIVE

The objective of this study is to examine the welding results of the site construction of Heat Recovery Steam Generator Piping of Tanjung Priok Gas Fired Power Plant Extension Project (740 MW) using the

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Radiography Test Method based on the ASME Standard.

DISCRIPTION OF HRSG SYSTEM

Figure 1 shows the Heat Recovery Steam Generator (HRSG) of Tanjung Priok Gas Fired Power Plant Extension Project (TPGFPPEP).The HRSG is of vertical gas flow, natural circulation, triple pressure, reheat type. Gas turbine exhaust gas will be routed to the HRSG, where it will pass over the tubes of the superheater, evaporator, economizer and condensate preheater before exhausting to the atmosphere through stack. In the HRSG, the energy of the gas turbine exhaust gass will be converted as HP, IP and LP steam

Figure1. Heat recovery steam generator (HRSG) of Tanjung priok gas fired power plant extension project under construction.

EQUIPMENT, MATERIAL AND METHODOLOGY

Radiographic testing (RT) usually is suitable for testing welded joints that can be accessed from both sides, with the exception of double-wall signal image techniques used on some pipe. RT makes use of X-rays or gamma rays. X-rays are produced by an X-ray tube, and gamma rays are produced by a radioactive isotope. The basic principle of radiographic weld inspection is the same as that of medical radiography. Penetrating radiation is passed through a solid object (in this case, a weld rather than part of the human body) onto photographic film, creating an image of the object's internal structure on the film. The summary of radiography test material and equipment is given in Table 1.

A double wall exposure technique was used in this examination. For weld in components with a nominal outside diameter greater than 3,5 inches (89 mm), the ***Single Wall Viewing*** is a technique may be used in which the radiation passes through two walls and only the weld on the film side wall is viewed for acceptance on the radiograph. When complete coverage is required for circumferential welds, minimum three exposures taken 120 ^{o} to each other shall be made. For weld in components with has 3,5 inches (89 mm) or less in nominal outside diameter, the ***Double Wall Viewing*** is a technique may be used in which the radiation passes through two walls and the weld in both walls is viewed for acceptance on the same radiograph.

Table 1. Summary of Radiography test material and equipment

Parameter	Description
Radiation type	Iridium – 192
Film type	AFGA D7
Screen Type	PB 0.125 mm
Focal Spot size	Ø 3 x 3 mm
Densitometer	
Penetrameter	ASTM 1 B
SFD	Outside Diameter
Radiographic Tecnique	Double Wall Single Image (DWSI)
Density	2-4
Joint design	Single V
Sensitivity	± 2 %

The minimum source to object distance should not be exceeded for any radiography examination under this procedure. It is based on the assumption that the required value fur Geometric Unsharpness (Ug) is given in table 2 is not exceeded

The formula of calculation the minimum source-to object is as follow :

$$SOD_{min} = \frac{F \times SSOF}{Ug} ....(1)$$

Where :

Ug = geometric unsharpness (mm)

F = the maximum projected dimension of the radiating source in the plan perpendicular to the distance SOD from the weld or object being radiographed (mm)

SOD_{min} = minimum distance from source of radiation to weld or object being radiographed (mm).

SSOF = distance from the source side to weld or object being radiographed (mm).

SOD_{min} and SSOF is determined at the approximate center of the area of interest.

Table 2. Maximum Geometric Unsharpness

Material thickness (mm)	Ug max (mm)
Under 50	0,51
50,8 – 75	0,76
75 – 100	1,02
Greater than 100	1,78

ACCEPTANCE STANDARD

Weld joints radio graphed are evaluated against the following acceptance standards :

1. Full radiography of welded joint

Welds and their heat affected zone shall be free from :

a. Any indication characterized as a crack, zone of incomplete fusion or penetration, regardless of length.

b. Any individual elongated indication characterized as inclusions or cavities which has a length greater than : 6 mm for T up 19 mm, 1/3 T for T from 19 mm to 57 mm and 19 mm for T over 57 mm , where T is the thickness of the material excluding any allowable reinforcement.

c. Any group of aligned indications that have an aggregate length greater than T in a length of 12 T, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group.

d. Rounded indications exceeding those specified in Appendix 4 Section VIII Div.I for welds in accordance with ASME Section VIII Div.I.

e. Rounded indications exceeding those specified in Appendix A-250 of Section I for welds in accordance with ASME Section I and ASME B31.1

f. Root concavity when there is an abrupt change in density as indicated on the radiograph for welds in accordance with ASME B31.1.

2. Spot radiography of welded joint

For welds in accordance with ASME Sect VIII Div.1 that is subjected to Spot Radiography, radiography examination is to be performed only on sections of the weld length. The acceptability of welds examined by spot radiography should be judged by the following standards:

a. Welds in which indication are characterized as crack or zones of

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incomplete fusion or penetration shall be unacceptable.

b. Welds in which indication are characterized as slag inclusion or cavities shall be unacceptable if the length of any such indication is greater than 2/3 T where T is the thickness of the material excluding any allowable reinforcement. For a butt weld joining two members having different thicknesses at the weld , T is the thinner of these two thicknesses. If a full penetration weld includes a filled weld, the thickness of the throat of the fillet shall be included in T. If several indication within the above limitations exist in line, the welds shall be judged acceptable if the sum of the longest dimensions of all such indications is not more than T in a indication length of 6T and if the longest indications considered are separated by at lasts 3 L of acceptable weld metal where L is the length of the longest indication. The maximum length of acceptable indications shall be 19 mm. Any such indication shorter than 6 mm shall be acceptable for any plate thickness.

c. Rounded indications are not a factor in acceptability of welds not required to be fully radio graphed.

Table 3 shows the Acceptance standard for weld parts and their base metal fabricated according to ASME B31.3 shall be defined in Table 341.3.2 of ASME B31.3 for each relevant types of weld and service condition, where Tw is the nominal wall thickness of the thinner of two components joined by a butt weld.

RESULTS AND DISCUSSION

There were nine (9) field specimens were selected to examine the results of the radiography test that was carried out for all pressured part of HRSG. There are a lot of radiography test results were accepted because of accepted criterion that is given in ASME standard that given in table 3. Some unaccepted results of these radiography tests are summarized in table 4 until 12 and shown in figure 2 until figure.10.

Figure 2.Radiographic image of field specimen No 1 (HP 1 RY SH Inlet pipe)-porosity and slag inclusion indications

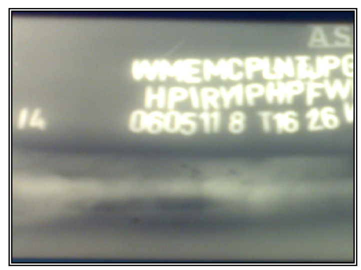

Figure 3. Radiographic image of field specimen No 1 (HP 1 RY SH inlet pipe) - incomplete penetration and WH

Figures 2, 3 and Table 4 show radiographic image of a specimen no 1. It is a High Pressure 1 RY Super Heater Inlet Pipe and HP feed water pipe that is made from SA 106 C. It's diameter and thickness are 8 inch and 18,28 mm respectively. From table 4 it could be seen that there many defects occurred in the specimen. Although the joint No F08 has 2 mm Porosity (POR) and joint no F011 has 3,5 mm Slag Inclusion (SI), these results are accepted because the lengths of POR and SI are sorter than the acceptable value limits that given in Table 3. But from the Table 4 and Figure 2 it could be seen that a specimen has two welding defects, they are POR and SI for joint no F12 , these results are rejected and should be repaired. Specimen no 1 also have Incomplete Penetration and Worm Holes defects at joint No F17 as are shown in figure 3. The slag inclusion often associated with undercut, incomplete penetration and lack of fusion in welds. Insufficient cleaning between multi-pass welds and incorrect current and electrode manipulation can leave slag and unfused sections along the weld joint. Slag inclusions not only reduce cross sectional area strength of the joint but also may serve as an ignition point for serious cracking. Incomplete penetration (IP) defect as shows Figure 3 is very dangerous, it occurred when the weld metal did not form a cohesive bond with the base metal to the required depth, resulting in insufficient throat thickness. This defect is usually caused by incorrect welding condition. The cumulative length on incomplete penetration is larger than 35 mm, therefore this results is rejected.

Figure 4.Radiographic image of field specimen No 2 (HP Feed water piping) -Internal concavity (IC) indications

Figure 5.Radiographic image of field specimen No 3 (HP EVA RISER Pipe) - Internal concavity indication

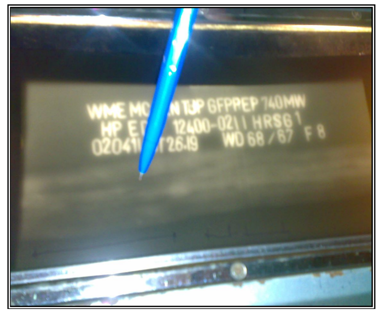

Figure 6. Radiographic image of field specimen No 4 (HP EVA Down commerce pipe) Incomplete fusion indication

Porosity, Slag Inclusion also occurred on specimen No 3, 4 ,5, 6 and 7. Some of these defects are accepted and some are rejected as could seen in table 5 until table 9.

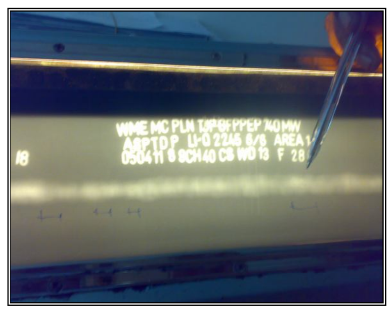

Figure 7.Radiographic image of field specimen No 5–Auxiliary steam piping HRSG1 Slag inclusion and cluster porosity

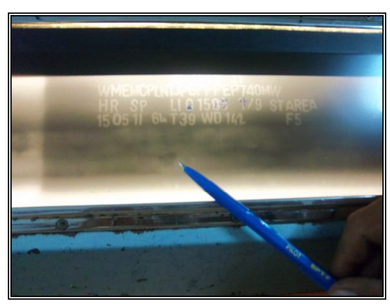

Figure 8.Radiographic image of field specimen No 6-Hot reheat steam piping HRSG1

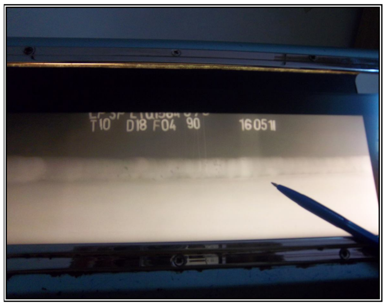

Figure 9. Radiographic image of feld specimen No 7–LP steam piping slag inclusion and worm holes

Figure10.Radiographic image of field specimen No 8 – IP super heater inlet pipe& IP feed water pipe-worm holes

The RT results of specimen No 2 are given in Figure 4 and Table 5. The specimen No 2 is HP Feed Water Piping of HRSG1. From Table 4 it may be seen that 3 joints were examined by Radiographic testing. The radiographic images in Figure 4 and 5 indicated the rejectable Internal Concavity occurred on specimen No 2 and 3 respectively. It is a condition where the weld metal has contracted as it cools and has been drawn up into the root of the weld. Internal Concavity (IC) also occurred on specimen No 5 as could be seen in Table 7.

Most of the specimens have Porosity (P) defects, it is a conditions in which gas pockets or voids occurred in a metal as a result of contamination or poor protection of the molten solidifying metal. It is generally accepted that porosity in weld metals is formed by the entrapment of evolved gases in the solidifying weld metal. The discontinuity formed is generally spherical but may be cylindrical. The joint no F04 and F06 of specimen No 2 have many defects especially Porosity and Slag Inclusion. These results are rejected because of acceptable value limits,, therefore they are should be repaired

The incomplete fusion found at joint No F08 of specimen No 4 as could be seen in figure 6 and Table 7. This welding imperfection is rejected, because a cumulative length of lack of fusion is larger than 38 mm. It is also found the incomplete fusion at joint No F27 of specimen No 5. The depth of lack of fusion is larger than 0.2 of the thickness of piping, hence needed to be repaired.

From figure 10 and table 11, it could be seen that the worm hole (WH) occurred at joint No F06 of specimen No 8. This specimen is the IP Super Heater Inlet Piping HRSG1 that is made from SA 106 B. It's diameter and thickness are 10 inch and 9,27 mm respectively. The worm hole is a form of pores that is roughly elliptical in shape and has its major axis normal to the advancing solidification wave. Where irregular shaped voids are present or where cavities occur in group, these are perhaps due to mechanical entrapped gas caused by arc instability.

The imperfect shape in form of undercut occurred in the specimen No 9 as may be seen in table No 12. This specimen is HP Steam Drum that is made from SA 106 C. It's diameter and thickness are 14 inch and 53 mm respectively. This defect is generally associated with either improver welding techniques or excessive welding current, or both. Undercut discontinuities create a mechanical notch at the weld fusion boundry.

Table 3. Acceptable criteria for welds and examination methods for evaluating weld imperfections.

Symbol	Measure	Acceptable Value Limits
A	Extent of imperfection	Zero
B	Depth of Incomplete Penetration Cumulative length of Incomplete Penetration	≤ 1 mm and ≤ 0.2 Tw ≤ 38 mm in any 150 mm weld length
C	Depth of lack of fusion & Incomplete Penetration Cumulative length of lack of fusion & Incomplete Penetration	≤ 0.2 Tw ≤ 38 mm in any 150 mm weld length
D	Size and distribution of Internal Porosity	See BPV Code, Section VIII, Division 1, Appendix 4
E	Size and distribution of Internal Porosity	For Tw ≤ 6 mm, limit is same as D For Tw > 6 mm, limit is 1.5 x D
F	Slag Inclusion, Tungsten Inclusion or Elongated Inclusion • Individual length • Individual width • Cumulative length	≤ Tw/3 ≤ 2.5 mm and ≤ Tw/3 ≤ Tw in any 12 Tw weld lenth
G	Slag Inclusion, Tungsten Inclusion or Elongated Inclusion • Individual length • Individual width • Cumulative length	≤ 2 Tw ≤ 3 mm and ≤ Tw/2 ≤ 4 Tw in any 150 mm weld lenth
H	Depth of Undercut	≤ 1 mm and ≤ Tw/4
I	Depth of Undercut	≤ 1.5 mm and ≤ Tw/4
J	Surface Roughness	≤ 500 min
K	Depth of roof surface concavity	Total joint thickness, incl reinf ≥ Tw

Table 4. Radiographic examination results of specimen No1 – HP 1 RY SH Inlet pipe & HP feed water pipe HRSG1

Joint No	Welder stamp No	Film Location	Standard	Material	Thickness	Weld Defect	Remark
F08	071	14 -21	ASME VIII DIV1	SA106C	Ǿ8"'x18,25 mm	Porosity 2 mm	Accepted
F11	071/075	7 - 14	ASME VIII DIV1	SA106C	Ǿ8"'x18	Slag Inclusion (3,5mm)	Accepted
F12	075	7-14	ASME VIII DIV1	SA106C	Ǿ8"'x18,25 mm	Slag Inclusion	Repair
F12	075	14-21	ASME VIII DIV1	SA106C	Ǿ8"'x18,25 mm	Porosity and Slag Inclusion	Repair
F13	075	0-7	ASME VIII DIV1	SA106C	Ǿ8"'x18,25 mm	Porosity (3mm)	Accepted

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Table 5. Radiographic examination results of specimen No 2 – HP feed water piping HRSG1

Joint No	Welder stamp No	Film Locatio n	Standard	Material	Thickness	Weld Defect	Remark
F01	053	7-14	ASME B31.3	C/S	Ǿ10"' SCH 160	Internal Concavity	Repair
F04	052/083	0-7	ASME B31.3	C/S	Ǿ10"' SCH 160	Porosity and Slag Inclusion	Repair
F04	052/083	7 - 14	ASME B31.3	C/S	Ǿ10"' SCH 160	Porosity and Slag Inclusion	Repair
F04	052/083	14 - 21	ASME B31.3	C/S	Ǿ10"' SCH 160	Slag Inclusion	Repair
F04	052/083	21 - 28	ASME B31.3	C/S	Ǿ10"' SCH 160		Accepted
F04	052/083	28-0	ASME B31.3	C/S	Ǿ10"' SCH 160	Slag Inclusion	Repair
F06	052/083	0-7	ASME B31.3	C/S	Ǿ10"' SCH 160	Slag Inclusion	Repair
F06	052/083	7 - 14	ASME B31.3	C/S	Ǿ10"' SCH 160	Porosity and Slag Inclusion	Repair
F06	052/083	14 - 21	ASME B31.3	C/S	Ǿ10"' SCH 160	Slag Inclusion	Repair
F06	052/083	21 - 28	ASME B31.3	C/S	Ǿ10"' SCH 160		Accepted
F06	052/083	28-0	ASME B31.3	C/S	Ǿ10"' SCH 160		Accepted

Table 6. Radiographic examination results of specimen No 3 – HP EVA riser piping HRSG1

Joint No	Welder stamp No	Film Location	Standard	Material	Thickness	Weld Defect	Remark
F05	068	0 -9	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm	Porosity 2 mm	Accepted
F05	068	9 -18	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm	Porosity and Slag Inclusion	Repair
F05	068	18 - 0	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm		Accepted
F11	071/075	0-7	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm	Porosity 1 mm	Accepted
F11	071/075	7 - 14	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm		Accepted
F11	071/075	14 - 21	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm	Internal Concavity	Repair
F11	071/075	21 - 0	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm		Accepted
F15	086	0-7	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm	Slag Inclusion 3 mm	Accepted
F15	086	7 - 14	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm		Accepted
F15	086	14 - 21	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm		Accepted
F15	086	21 - 0	ASME VIII DIV 1	SA 106 C	Ǿ8" x 15,09 mm	Accepted	Repair

Table 7. Radiographic examination results of specimen No 4 – HP EVA down commerce piping HRSG1

Joint No	Welder stamp No	Film Location	Standard	Material	Thickness	Weld Defect	Remark
F04	109/110	0-7	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm		Accepted
F04	109/110	7 - 14	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm	Porosity	Repair
F04	109/110	14 - 21	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm		Accepted
F04	109/110	21 - 28	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm	Slag Inclusion 4 mm	Accepted
F08	068/067	0-7	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm	Incomplete Fusion	Repair
F08	068/067	7 - 14	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm	Porosity 3 mm	Accepted
F08	068/067	14 - 21	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm		Accepted
F08	068/067	21 - 28	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm	Porosity 1 mm	Accepted
F08	068/067	28-35	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm	Incomplete Fusion	Repair
F08	068/067	35 - 42	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm		Accepted
F08	068/067	42 - 0	ASME VIII DIV 1	SA 106 C	Ǿ16” x 26,19 mm	Incomplete Fusion	Repair

Table 8. Radiographic examination results of specimen No 5 – Auxiliary steam piping HRSG1

F26	083	0-9	ASME B31.3	C/S	Ǿ8” x 8,18 mm	Porosity	Repair
F26	083	9 - 18	ASME B31.3	C/S	Ǿ8” x 8,18 mm	Burn Through	Repair
F26	083	18 - 0	ASME B31.3	C/S	Ǿ8” x 8,18 mm	Cluster Porosity	Repair
F27	013	0 - 9	ASME B31.3	C/S	Ǿ8” SCH 40	Incomplete Fusion	Repair
F27	013	9 - 18	ASME B31.3	C/S	Ǿ8” SCH 40	Cluster Porosity 1 mm	Accepted
F27	013	18 - 0	ASME B31.3	C/S	Ǿ8” SCH 40	Incomplete Fusion	Repair
F28	013	0 - 9	ASME B31.3	C/S	Ǿ6” SCH 40		Accepted
F28	013	9 - 18	ASME B31.3	C/S	Ǿ6” SCH 40		Accepted
F28	013	18 - 0	ASME B31.3	C/S	Ǿ6” SCH 40	Slag Inclusion and Cluster Porosity	Repair

Table 9. Radiographic examination results of specimen No 6 Hot reheat steam piping HRSG 1

Joint No	Welder stamp No	Film Location	Standard	Material	Thickness	Weld Defect	Remark
F06	160/161	0 - 12	ASME VIII DIV 1	SA 106 B	Ǿ26”’ 39 mm		Accepted
F06	160/161	12- 24	ASME VIII DIV 1	SA 106 B	Ǿ26”’ 39 mm	Cluster Porosity 6 mm	Accepted
F06	160/161	24 - 36	ASME VIII DIV 1	SA 106 B	Ǿ26”’ 39 mm	Slag Inclusion (3 mm)	Accepted
F06	160/161	36 - 48	ASME VIII DIV 1	SA 106 B	Ǿ26”’ 39 mm	Slag Inclusion and Cluster Porosity	Repair
F06	160/161	48 - 60	ASME VIII DIV 1	SA 106 B	Ǿ26”’ 39 mm		Accepted
F06	160/161	60 - 72	ASME VIII DIV 1	SA 106 B	Ǿ26”’ 39 mm	WH	Repair
F06	160/161	72 - 0	ASME VIII DIV 1	SA 106 B	Ǿ26”’ 39 mm	Incomplete Penetration	Repair

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Table 10 Radiographic examination results of specimen No 7 LP steam piping

Joint No	Welder stamp No	Film Location	Standard	Material	Thickness	Weld Defect	Remark
F04	090	0 - 12	ASME VIII DIV 1	SA 672 GRB	Ǿ18"' 10 mm	Slag Inclusion & WH	Repair
F04	090	12- 24	ASME VIII DIV 1	SA335 P12	Ǿ18"' 10 mm	Incomplete Fusion	Repair
F04	090	24 - 36	ASME VIII DIV 1	SA335 P12	Ǿ18"' 10 mm		Accepted
F04	090	36 - 48	ASME VIII DIV 1	SA335 P12	Ǿ18"' 10 mm		Accepted
F04	090	48 - 0	ASME VIII DIV 1	SA335 P12	Ǿ18"' 10 mm	Porosity	Repair
F06	080	0 - 12	ASME VIII DIV 1	SA335 P12	Ǿ18"' 10 mm		Accepted
F06	080	12- 24	ASME VIII DIV 1	SA335 P12	Ǿ18"' 10 mm	Slag Inclusion	Repair
F06	080	24 - 36	ASME VIII DIV 1	SA 106 C	Ǿ18"' 10 mm	Cluster Porosity	Repair
F06	080	36 - 48	ASME VIII DIV 1	SA 106 C	Ǿ18"' 10 mm		Accepted
F06	080	48 - 0	ASME VIII DIV 1	SA 106 C	Ǿ18"' 10 mm	Slag Inclusion (4mm) and Cluster Porosity (1mm)	Accepted

Table 11. Radiographic examination results of specimen No 8 IP super heater Inlet piping HRSG 1

Joint No	Welder stamp No	Film Location	Standard	Material	Thickness	Weld Defect	Remark
F06	042	0 - 11	ASME VIII DIV 1	SA 106 B	Ǿ10"' 9,27 mm	Worm Holes	Repair
F06	042	11 - 22	ASME VIII DIV 1	SA 106 B	Ǿ10"' 9,27 mm	Worm Holes	Repair
F06	042	22 - 0	ASME VIII DIV 1	SA 106 B	Ǿ10"' 9,27 mm		Accepted
F07	42/67	0 - 11	ASME VIII DIV 1	SA 106 B	Ǿ10"' 9,27 mm	Porosity 1 mm	Accepted
F07	42/67	11 - 22	ASME VIII DIV 1	SA 106 B	Ǿ10"' 9,27 mm		Accepted
F07	42/67	22 - 0	ASME VIII DIV 1	SA 106 B	Ǿ10"' 9,27 mm	Incomplete Fusion	Repair

Table 12. Radiographic examination results of specimen No 9 HP steam drum

F04	063/080	0 - 7	ASME VIII DIV 1	SA 106 C	Ǿ14"' 53 mm	Undercut 4 mm	Accepted
F04	063/080	7 - 14	ASME VIII DIV 1	SA 106 C	Ǿ14"' 53 mm		Accepted
F04	063/080	14 - 21	ASME VIII DIV 1	SA 106 C	Ǿ14"' 53 mm	Undercut	Repair
F04	063/080	21 - 28	ASME VIII DIV 1	SA 106 C	Ǿ14"' 53 mm	Undercut	Repair
F04	063/080	28-35	ASME VIII DIV 1	SA 106 C	Ǿ14"' 53 mm		Accepted
F04	063/080	35 - 42	ASME VIII DIV 1	SA 106 C	Ǿ14"' 53 mm		Accepted
F04	063/080	35 - 42	ASME VIII DIV 1	SA 106 C	Ǿ14"' 53 mm		Accepted

CONCLUSION

From the above discussion it could be concluded that :

a. The rejectable defects were found in the most of selected specimens for the joining of pressure parts of HRSG piping.
b. There was no crack founded in the selected specimens of the piping. The rejectable Incomplete Penetration was found in the specimen No 6 i.e. Hot Reheat Steam Piping HRSG1. Some Porosities and Slag Inclusion are rejected because their size and length are longer than acceptable value limits, therefore should be repaired. However some of the results are accepted and no need to be repaired.
c. Internal Concavities were found in specimen No 2 and 3 whereas Incomplete Fusions occurred in specimens no 4, 5 and 8.
d. The rejected Worm Holes is found the IP Super Heater Inlet Piping of HRSG1 whereas the undercut occurred in specimen No9 HP Steam Drum of HRSG.

REFFERENCE

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