PNCT N341 83-17

A paper presented at the Winfrith SGHWR -
the Fugen first technical exchange meeting,
held on 13 - 14 october, 1983

INSERVICE INSPECTION IN THE FUGEN

October, 1983

Power Reactor and Nuclear Fuel
Development Corporation

Inservice Inspection in the Fugen

1. Introduction

Pressure tube type reactors have specific components or structures, compared with light water reactors.

They are

(1) steam drums
(2) reactor inlet headers
(3) reactor inlet and outlet pipies
(4) pressure tubes.

Much attention is paid upon Inservice Inspection (ISI) of the above components.

2. Examination categories of specific components in the Fugen

Examination categories of specific components in the Fugen, such as steam drum, reactor inlet header, reactor inlet and outlet pipes, and pressure tube assembly, are shown in Table 1 to 4 and Fig. 1 and 2; which were set considering JEAC-4205 (almost the same as ASME Boiler and Pressure Vessel Code Section XI). There may find some difference between Fugen's and Section XI.

3. ISI in Fugen and its R & D

ISI has been made since the first annual inspection and the results are summarized in Table 5. In the third annual inspection, 4 defects were found in one loop of the HPCI system by ISI. It was found that the defects were resulted from transgranular corrosion caused by chlorine and salfate compound coming out of valve packings, and the loop was replaced by new piping.

3.1 ISI of steam drum and reactor inlet header

ISI of nozzle welds of the steam drum and reactor inlet header, are carried out using Kraut Kramer MWB60-N2 (with ultrasonic beam of 2MHz and 60° of incidence angle); which had been backed up by mock up tests (2B, 6B and 8B).

For circumferential and longitudinal welded lines, ISI has been done manually with ultrasonic beam of 5MHz and 0°, 45° and 60° of incidence angle.

3.2 ISI of reactor inlet and outlet pipes

ISI of reactor inlet and outlet pipes is carried out with semi-automatic inspection equipment which is shown in Fig. 3. When inspecting reactor inlet and outlet pipes, the semi-automatic inspection equipment is manually set on the pipes (Fig. 4), while inspection and data processing are automatically made. Ultrasonic beam, having 4MHz of frequency and 70° of incidence angle, is used for making ISI of reactor inlet and outlet pipes.

Fig. 5 shows a typical ISI data of a reactor inlet pipe.

Table 1 Examination categories

Components examined : Steam drum

ASME Sec.XI (1983)				Fugen		
Examination category	Parts examined	Examination method	Extent of examination	Examination method	Extent of examination	Remarks
B—B	Pressure retaining welds in vessels other than reactor vessels Circumferential Longitudinal	 Volumetric Volumetric	 100% 100%	 UT UT	 5% 10%	Same as ASME Sec. XI (1971)
B—D	Full penetration welds of nozzles in vessels	Volumetric	100%	UT	50%	
B—E	Pressure retaining partial penetration welds in vessels	Visual	25%	VT	100%	

Table 1 Examination categories (continued)

Components examined : Steam drum

ASME Sec. XI (1983)				Fugen		
Examination category	Parts examined	Examination method	Extent of examination	Examination method	Extent of examination	Remarks
B–F	Pressure retaining dissimilar metal welds	Volumetric and surface	100%	UT PT	50%	
B–G–2	Pressure retaining bolting, 2in. and less in diameter.	Visual	100%	VT	100%	
B–H	Integral attachments for vessels	Volumetric	10%	PT	10%	

Table 2 Examination categories

Components examined : Inlet header

ASME Sec. XI (1983)				Fugen		
Examination Category	Parts examined	Examination method	Extent examination	Examination method	Extent of examination	Remarks
B—B	Pressure retaining welds in vessels other than reactor vessels circumferential	Volumetric	100%	UT	5%	Same as ASME Sec. XI —1971
B—D	Full penetration welds of nozzles in vessels	Volumetric	100%	UT PT	50%	
B—E	Pressure retaining partiail penetration welds in vessels	Visual	25%	VT	100%	
B—H	Integral attachments for vessels	Volumetric	10%	PT	10%	

Table 3 Examination categories

Components examined : Piping

ASME Sec. XI (1983)				Fugen		
Examination category	Parts examined	Examination method	Extent of examination	Examination method	Extent of examination	Remarks
B—J Pressure retaining welds in piping	Inlet tube (2B) Outlet tube (3B)	Surface	25%	UT	10%	
	Other reactor coolant piping (≧4B)	Volumetric and surface	25%	UT PT	25%	
	Other reactor coolant Piping (<4B)	Surface	25%	UT (≧2B) PT (<2B)	25%	

Table 4 Examination categories

Components examined : Pressure tube assembly

ASME Sec. XI (1983)				Fugen		
Examination category	Parts examined	Examination method	Extent of examination	Examination method	Extent of examination	Remarks
B—A	Pressure retaining welds in reactor vessels	Volumetric	100%	PT	5%	Same as ASME Sec. XI —1971
B—D	Full penetration welds of nozzles in vessels	Volumetric	100%	VT	10%	
B—F	Pressure retaining dissimilar metal welds	Volumetric and surface	100%	VT	10%	
B—N—I	Interior of reactor vessels	Visual	Accessible areas	VT	10%	
—	Pressure tube (Zr — 2.5wt % Nb)	—	—	UT VT Dimension	5 tubes	

Table 5 ISI Results in Fugen

Annual inspection	Number of welded parts inspected	Result of inspection	Subject
1st annual inspection (Feb.1980～Apr.1980)	UT…… 15 welds PT……150 // VT……360 //	No indication	——
2nd annual inspection (Apr.1981～Oct.1981)	UT……150 welds PT…… 31 // VT……429 //	No indication	——
3rd annual inspection (Sept.1982～Feb.1983)	UT……152 welds PT…… 49 // VT……337 // additional ISI in HPCI and LPCI systems, similar condition to HPCI systems UT……129 welds	1 indication (HPCI system) } No indication 3 indications (HPCI system)	○4 indications were found in one loop of the HPCI piping system ○Defect size, depth ……about 1～3mm length……about 6～15mm ○The defects were resulted from transgranular corrosion craking caused by chlorine and sulfate compound dissolved from packings of valve

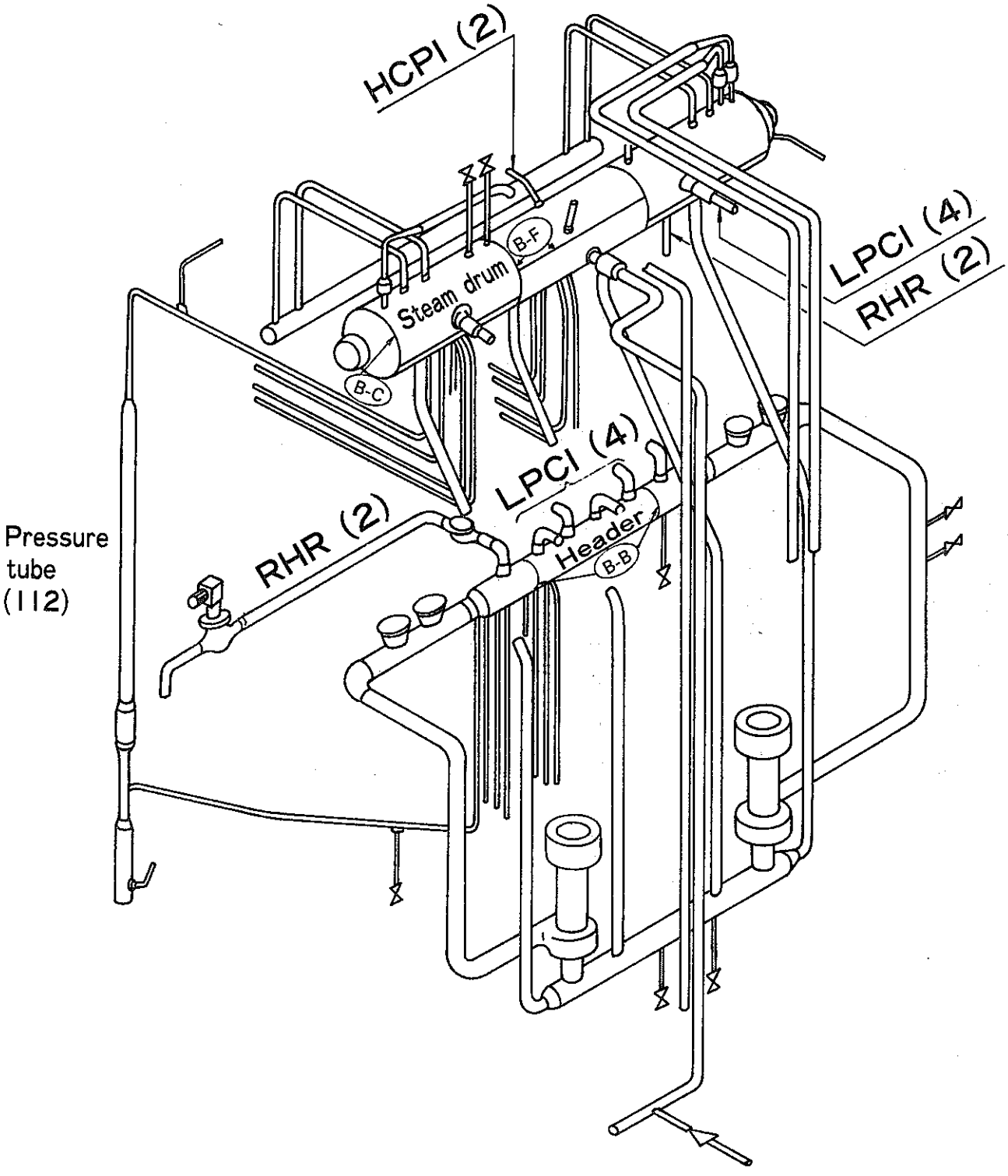

Fig. 1 Schematic view of primary cooling system

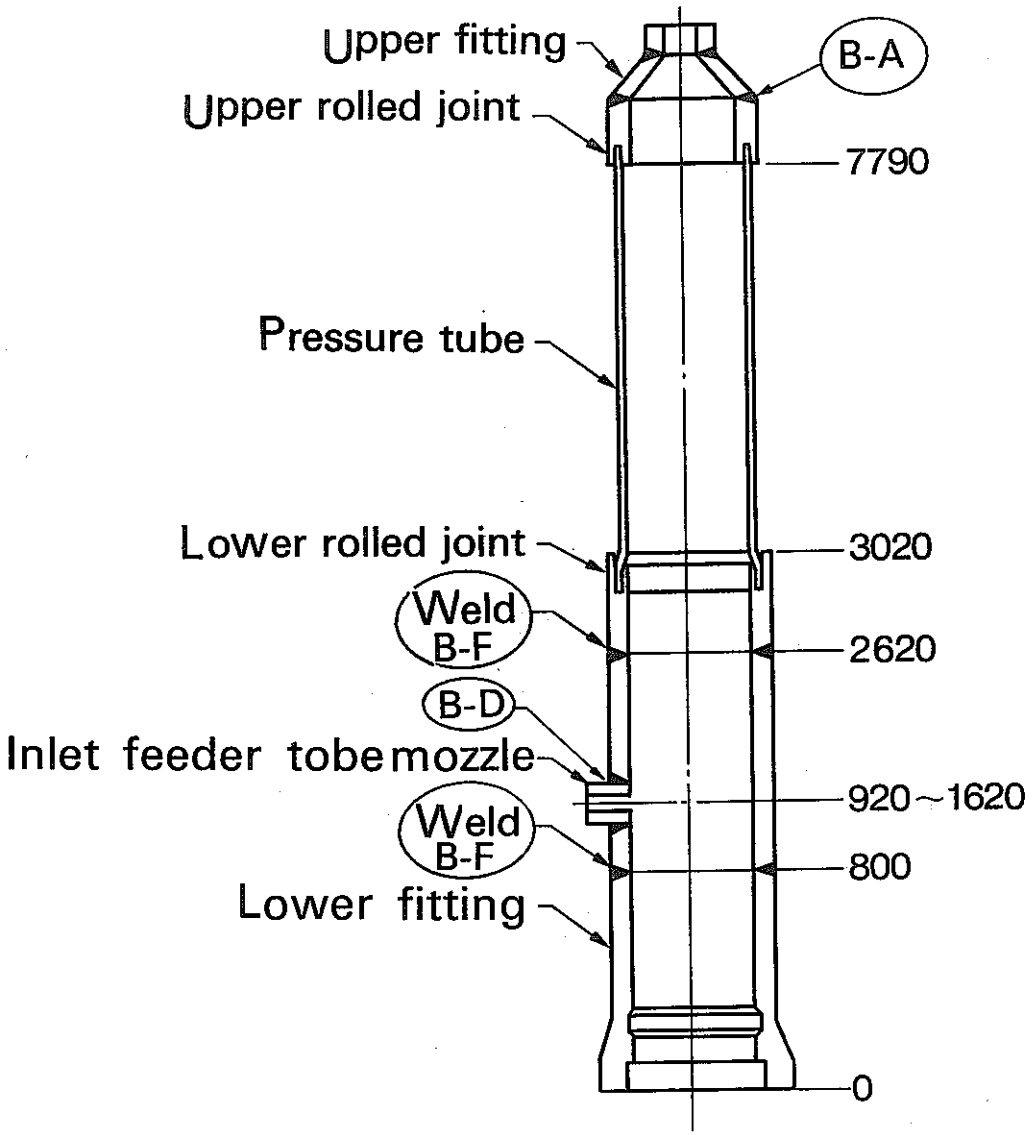

Fig. 2 Schematic cross section of pressure tube assembly

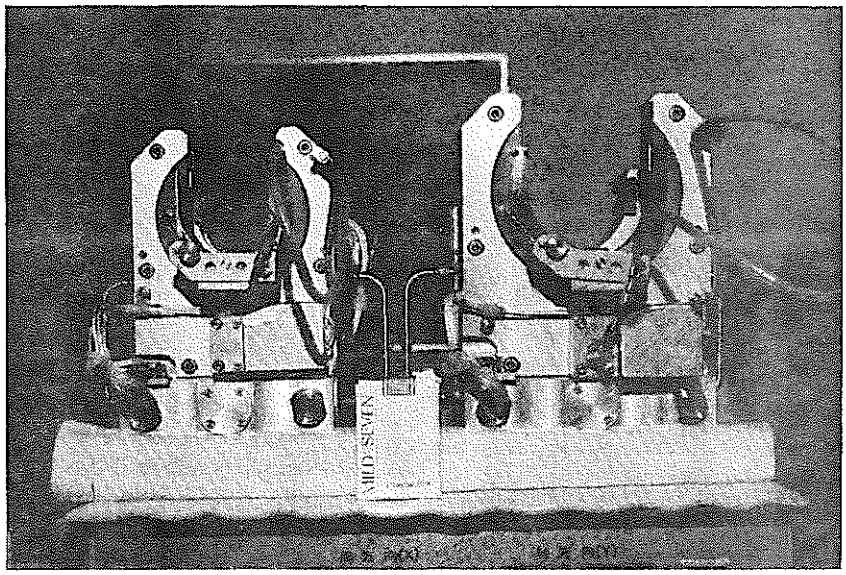

Fig. 3(A) Semi-automatic ISI equipment

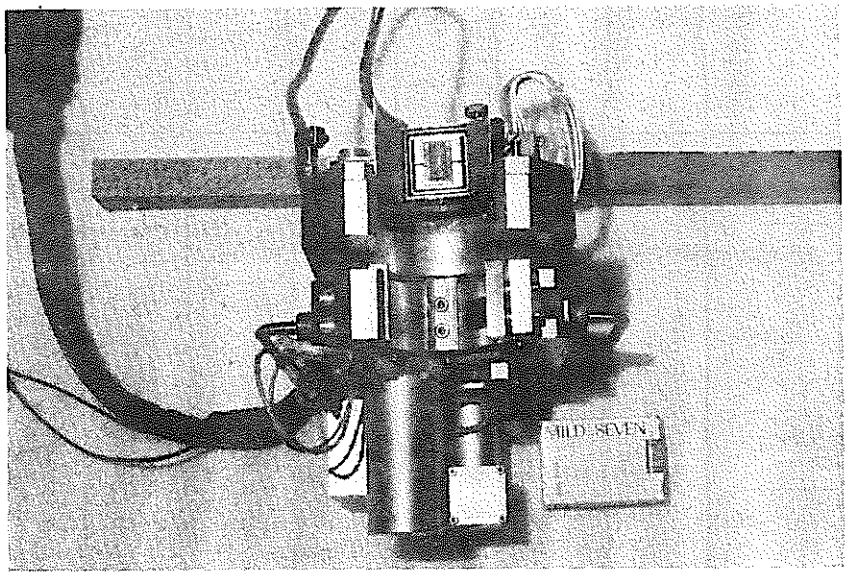

Fig. 3(B) Semi-automatic ISI equipment

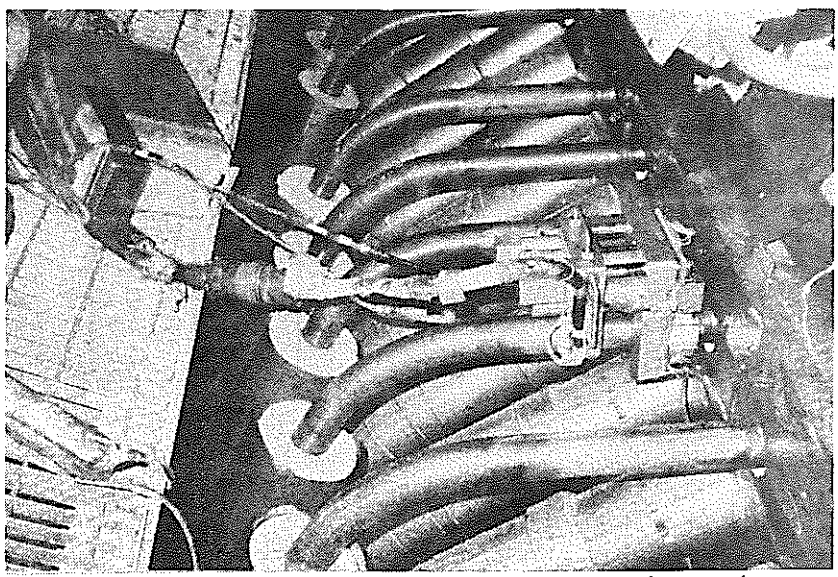

Fig. 4 Semi-automatic ISI equipment

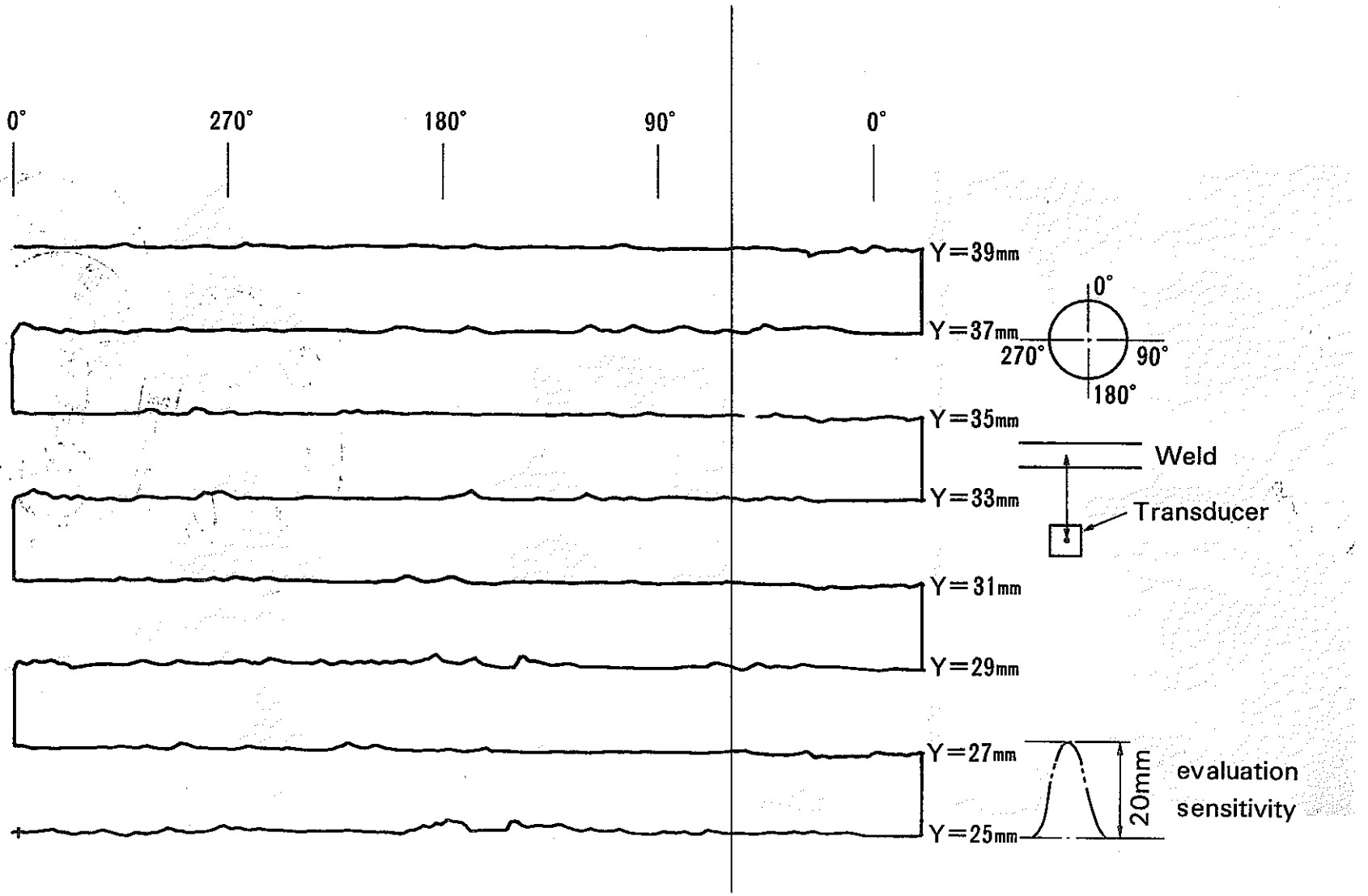

Fig. 5 Inspection result of reactor inlet pipe