

## Development of Non-Destructive Technique to Examine Weld Area Using Eddy Current

, , , ,

103-16

가 plus(+) point

. Plus-point

가

가

### Abstract

A plus(+) point eddy current test surface probe was designed for detecting the surface and subsurface flaws existing in the weld of the power plant components. A technique to measure the length of the flaw applying this probe was investigated. Experiments for the artificial defects such as the crack type notch and the flat bottom hole were conducted in order to evaluate the measurement characteristics of the detected flaw. It was shown that the eddy current test with the plus(+) point probe is applicable for surface inspection in stead of the conventional surface non-destructive tests such as the liquid penetrant test and the magnetic particle test

### 1.

가 . 1 가  
ASME code section XI  
(volumetric method) <sup>1)</sup> , 가 2mm

가 , 가 ,

(alternative surface method)

가

가 plus(+) point  
 sleeving , plus(+) point  
 Lift-off 가

2.

2.1 Plus(+) point

Plus - point

Fig. 1

"I"

(differential) (send - receive)  
 (differential)  
 plus - point 5mm  
 0.14mm

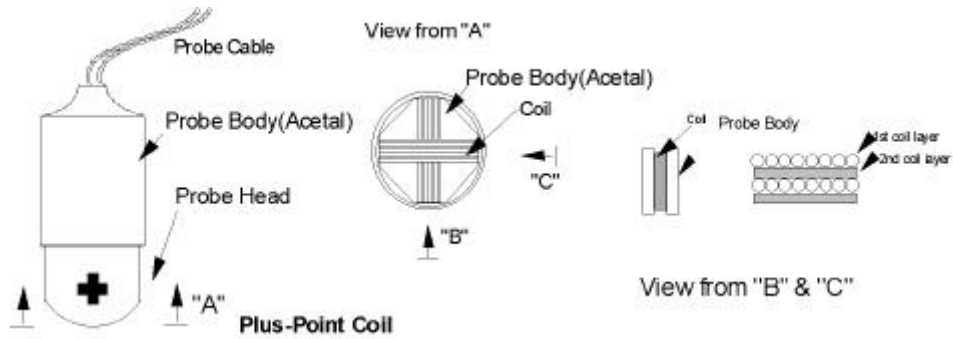


Fig.1 Schematic diagram of plus-point coil probe

2.2 Plus(+) point

2 Fig. 2

2 differential bobbin probe  
 , plus - point 2  
 “+” 2  
 lift - off 가 plus - point 가 lift - off  
 sleeving plus - point lift - off 가

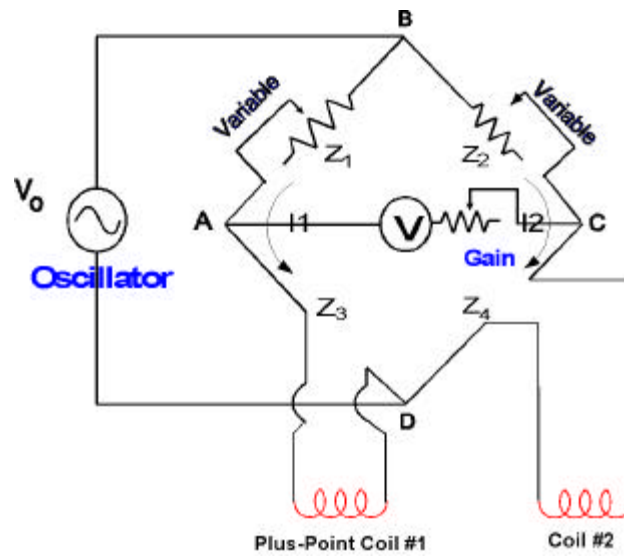


Fig. 2 Electric circuit of differential plus-point ECT probe

3.

3.1

Fig. 3

100Hz	40MHz	HP-4194A
GPIB interface		HP-vee data analysis
program		가
64	10kHz	1MHz
		Zetec Miz-30
		Zetec-eddynet <sup>®</sup>
calibration standard		
lift-off		

Fig. 3

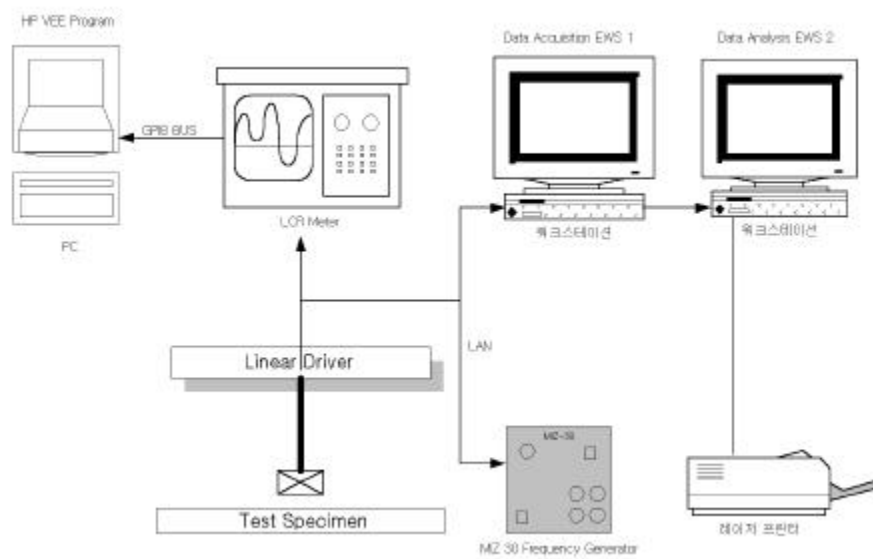


Fig. 3 Schematic view of plus-point ECT probe testing system



Fig. 4 Linear ECT scanning system

3.2

lift-off ,

S/N

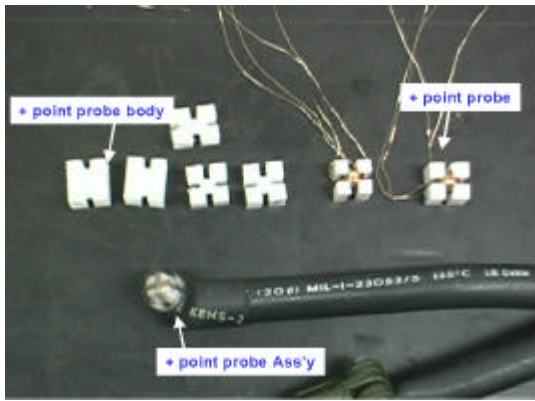


Fig.5 Plus-point ECT probe

plus-point

가

, plus-point

가

Fig.5 plus-point

. Table 1 plus-point

2가

22.5m

(Mil-C-RG

174, specific capacitance : 101pF/m)

Table 1 Probe coil characteristics

Plus-point coil	N (Turns)	Coil Dia. (OD,mm)	Inductance L in air ( $\mu$ H)@200kHz	Resistance in air(k )	Resonance Frequency in aired with Cable (kHz)	etc
			Air-cored			
	60	4.5	12	4	920	*Coil wire dia. : 0.14mm

3.3 standard

4mm SS-304

Fig. 6, 7, 8, 9,

4

standard

, SMAW

15mm

가

가

가

2가 가

0.2mm

가

Fig. 6

10, 15, 20, 30, 35, 40, 50, 60, 70, 80, 90,

100% 가

0.2mm, 가 20mm

20, 40, 60, 100%

Fig.10

가 10, 15, 30, 35, 50, 60, 70, 80, 90%

plus-point

가

가

EDM

10

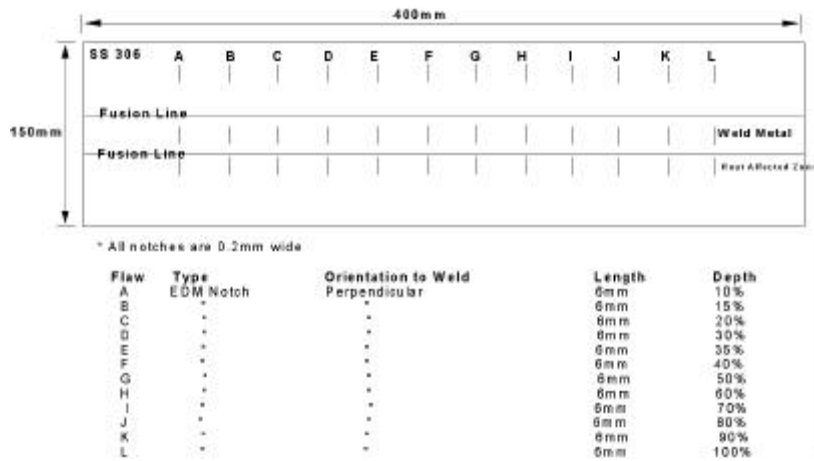


Fig. 6 Drawing of specimen #1

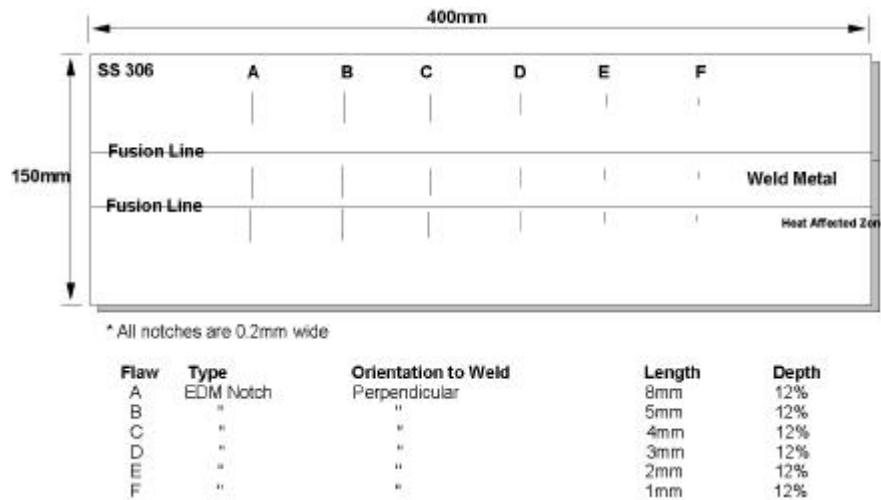
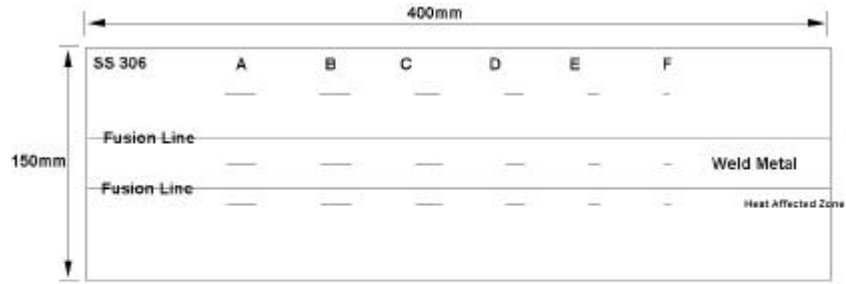


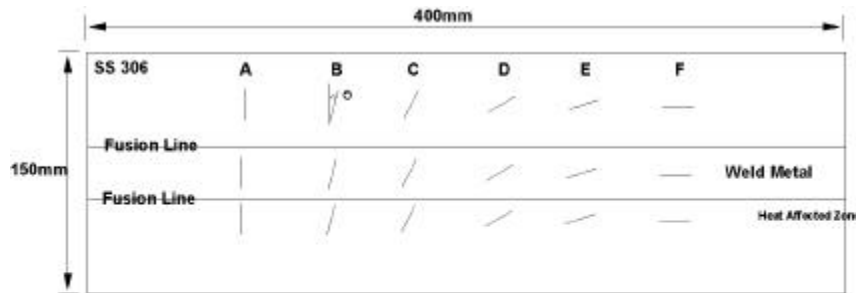
Fig. 7 Drawing of specimen #2



\* All notches are 0.2mm wide

Flaw	Type	Orientation to Weld	Length	Depth
A	EDM Notch	Perpendicular	8mm	12%
B	"	"	5mm	12%
C	"	"	4mm	12%
D	"	"	3mm	12%
E	"	"	2mm	12%
F	"	"	1mm	12%

Fig. 8 Drawing of specimen #3



\* All notches are 0.2mm wide

Flaw	Type	Orientation to Weld (°)	Length	Depth
A	EDM Notch	Perpendicular	8mm	20%
B	"	10 degrees	8mm	20%
C	"	20 degrees	8mm	20%
D	"	45 degrees	8mm	20%
E	"	60 degrees	8mm	20%
F	"	Parallel	8mm	20%

Fig. 9 Drawing of specimen #4

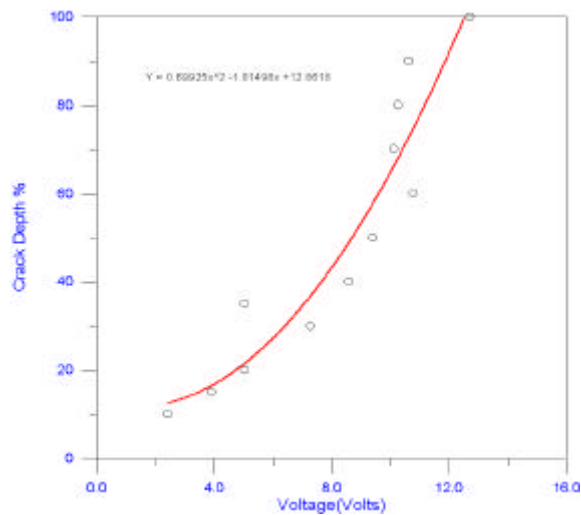


Fig.10 Plus-point calibration curve of crack depth vs voltage ratio, for 800kHz data

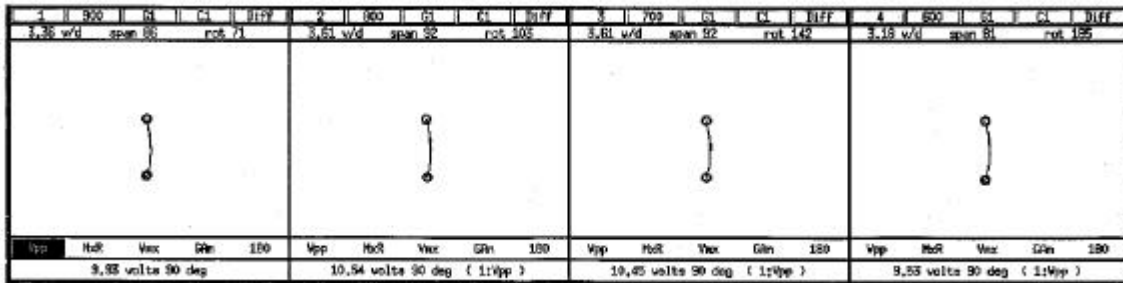


Fig.11 Frequency response of the plus point coil (at 900, 800, 700, 600 kHz, 60% notch)

4.

4.1

(differential) plus-point Fig. 11 800kHz  
 가 , Fig.12  
 2 , 가 가 가  
 , 45. Fig. 7  
 Fig.8 # 2, 3 plus-point ( 0.2mm)가  
 , )  
 가 0.5mm 가 1mm 가

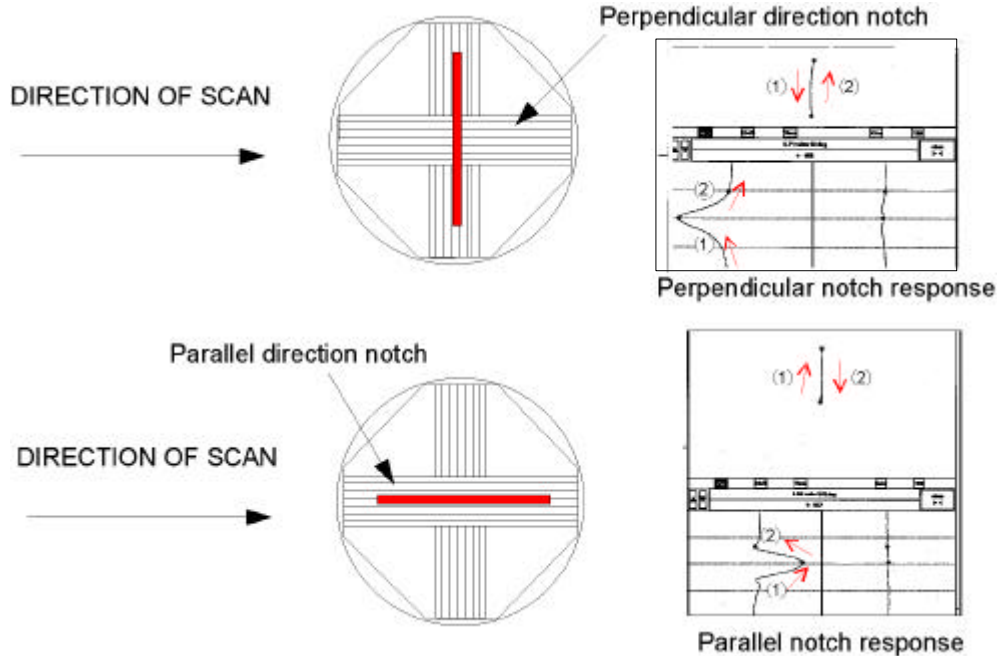


Fig.12 Directional properties of notch signal

4.2

plus-point Fig.13 가  
 (absolute mode)  
 800kHz 1 , 600kHz 400kHz 2 ,  
 lift-off,

가 2 Fig.10 (flat bottomed hole)

S/N 가 가 plus-point 가

Fig. 14

( ) 가 Fig.12

2가 가 Plus-point 가 20mm 가 80%

Fig. 15 (V<sub>pp</sub>) 가 45. 가 1/3

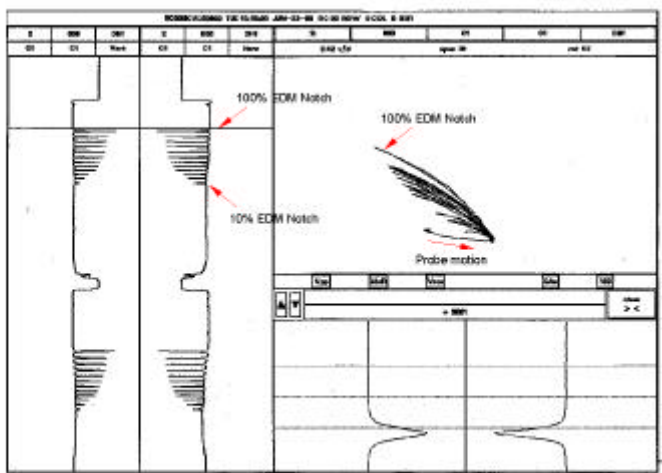


Fig. 13 Plus-point ECT probe signal response from crack-like EDM notches

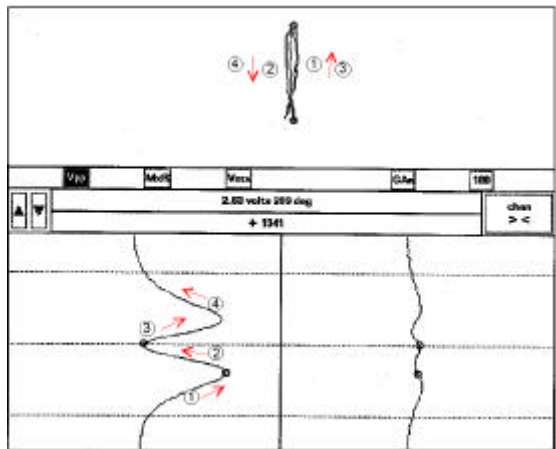


Fig. 14 Plus-point ECT probe signal response from a FBH (flat bottomed hole)



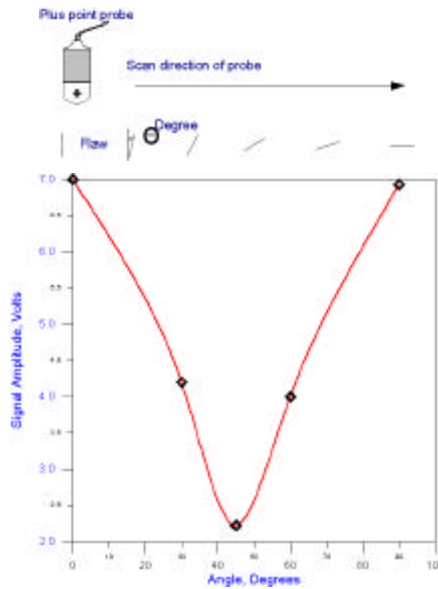


Fig. 15 Plot of signal amplitude vs defect orientation for a differential plus-point probe at 800kHz. EDM notches 80% deep by 20mm long in a SS-306 specimen

4.2.1

Plus - point

. Lift-off , EDM

lift-off

Fig.16

가

800kHz

plus - point

knee

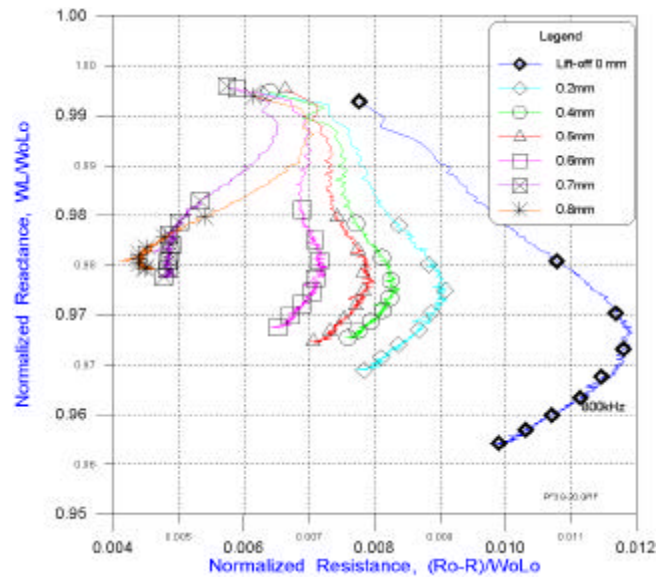


Fig. 16 Normalized impedance diagram of the plus-point probe

4.2.2

800kHz      60%      가 10% 90%      ± 3.2%      가  
 Fig.17      Fig.17      800kHz      가 10 90%

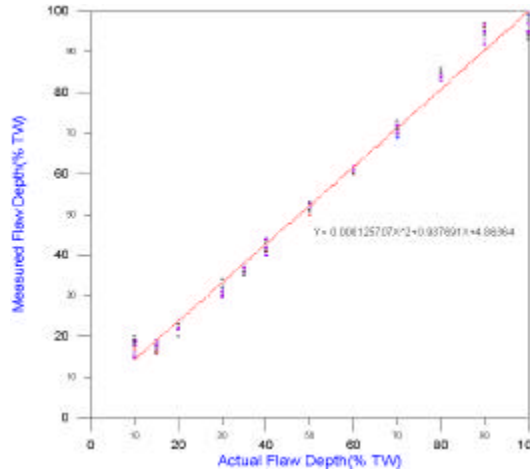


Fig. 17 Crack-like notch depth examination of plus-point ECT probe

5.

Plus - point

가

plus - point

가

plus - point

가

1) (differential) plus - point

가

가 1.0mm      가 0.5mm

2)

가

3) Plus - point

45°      1/3

6.

1) American society of Mechanical Engineers, ASME code section XI, "Rules for Inservice Inspection of Nuclear power Plant Components", 14p (1989)

2) Zetec Inc. USA, MIZ-30 Operation Manual(1994)