BIT Inspection Technology

(NDT/ Weld Inspection Training / Consultancy/ Third Party Inspection)

Technical Justification

Doc. no. BIT/TJ/ 002

Ultrasonic response analysis

Location : **BIT Inspection Technology, Chennai, India**
UT Operator : **Saikumar,** PCN UT 3.1,3.2,3.9
Analyst : **R.Baskar,** ASNT Level 3 RT,UT,PT,MT,VT,ET / PCN NDT level 3 RT,UT,PT,MT / AWS – SCWI / CSWIP 3.2

1. Abstract

Gap analysis performed to distinguish echo response analysis between

Vertically oriented lack of fusion defects at fusion face in a **main member** with lack of fusion defect at fusion face in a **branch member**

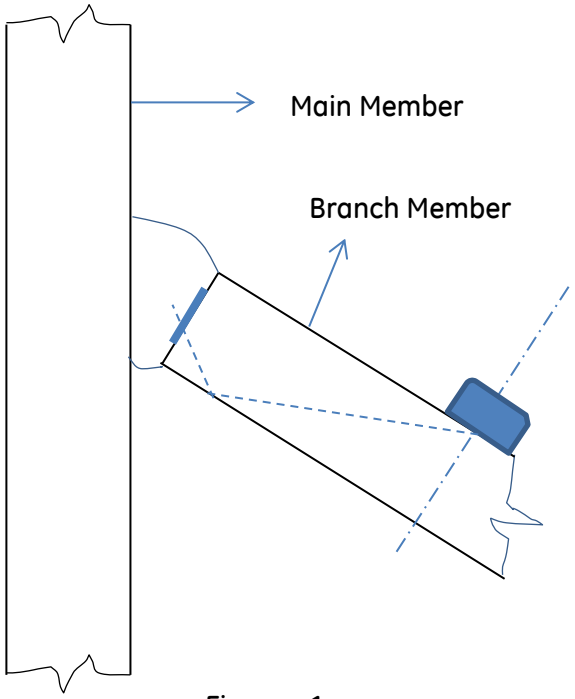


Figure - 1

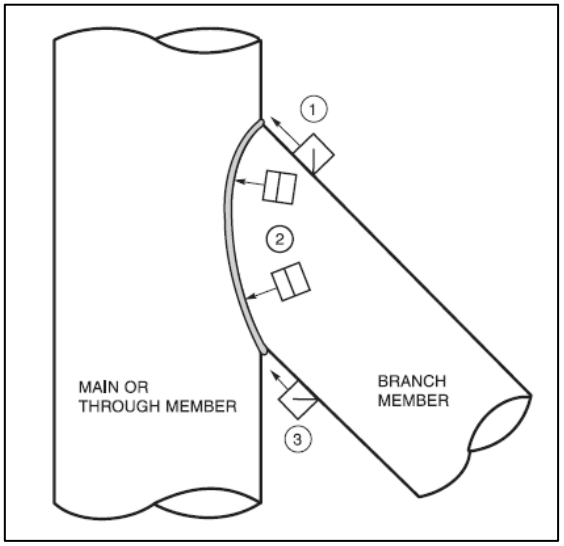


Figure - 2

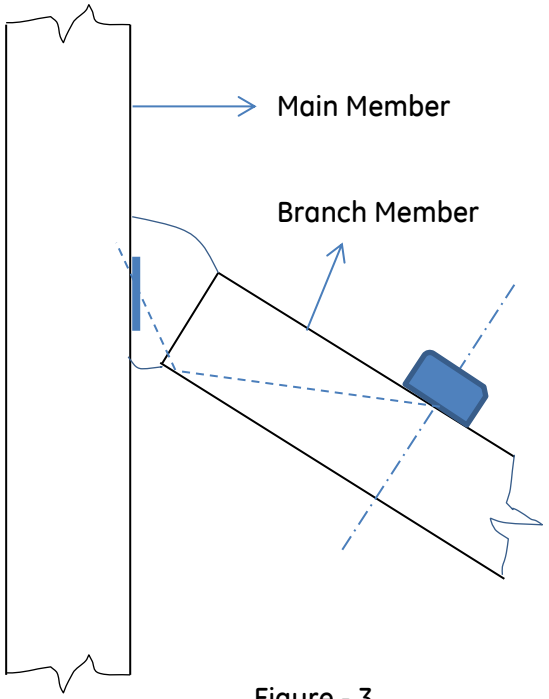


Figure - 3

Note:

Figure -1: Scanning pattern as per position - 2 as shown in Figure - 2, targeting lack of fusion defect at fusion face in a **branch member**

Figure -2: Scanning pattern

Figure -3: Scanning pattern as per position - 2 as shown in Figure - 2, targeting vertically oriented lack of fusion defects at fusion face in a **main member**

2. Reference documents

- **EN 1713** - UT characterization of indication
- **AWS D1.1** - Structural welding code - Steel

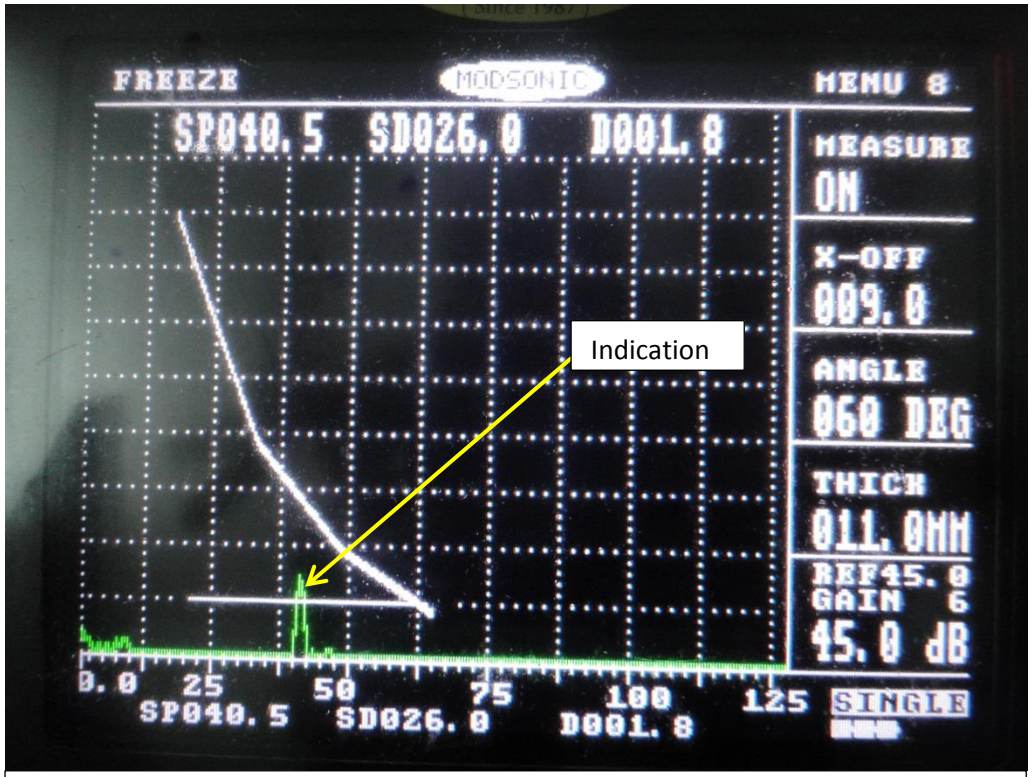
3. Gap Analysis Reference

- Main member segment - **20" x sch 80 (25mm WT)**, Branch pipe - **6" Dia x sch 80 (11mm WT)**
- Reference block : 38mm thick with **3mm SDH**
- Weld specimen material: **Carbon steel**
- Reference (DAC): **45 dB**

4. Parameter synchronized

- **Both lack-of-fusion defects kept at same depth of approximately 2mm** from scanning surface in a TKY weld connection in order to maintain **similar beam path and hence same material attenuation.**
- So echo response is only based on **type** and **orientation of defect**

5. Echo response of vertically oriented Lack of fusion defects at fusion face in a main member and lack of fusion defect at fusion face in a branch member @ reference 45 dB



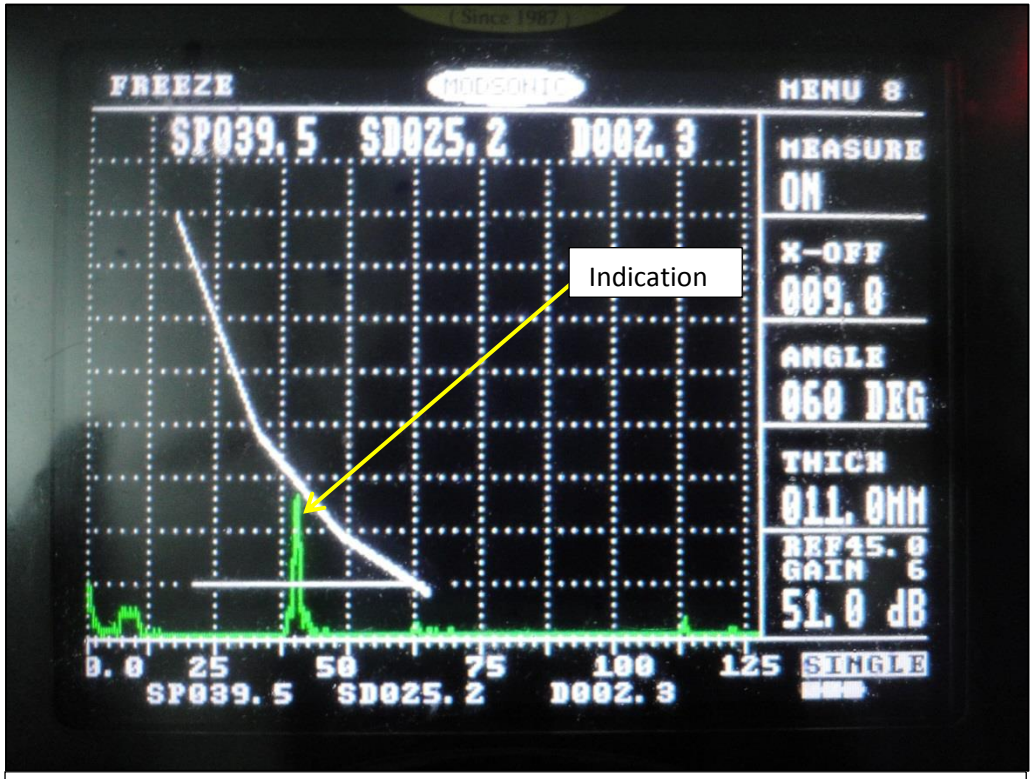
Vertically oriented lack of fusion defects at fusion face in a **main member @ DAC (45 dB)**

Lack of fusion defect at fusion face in a **branch member @ DAC (45 dB)**

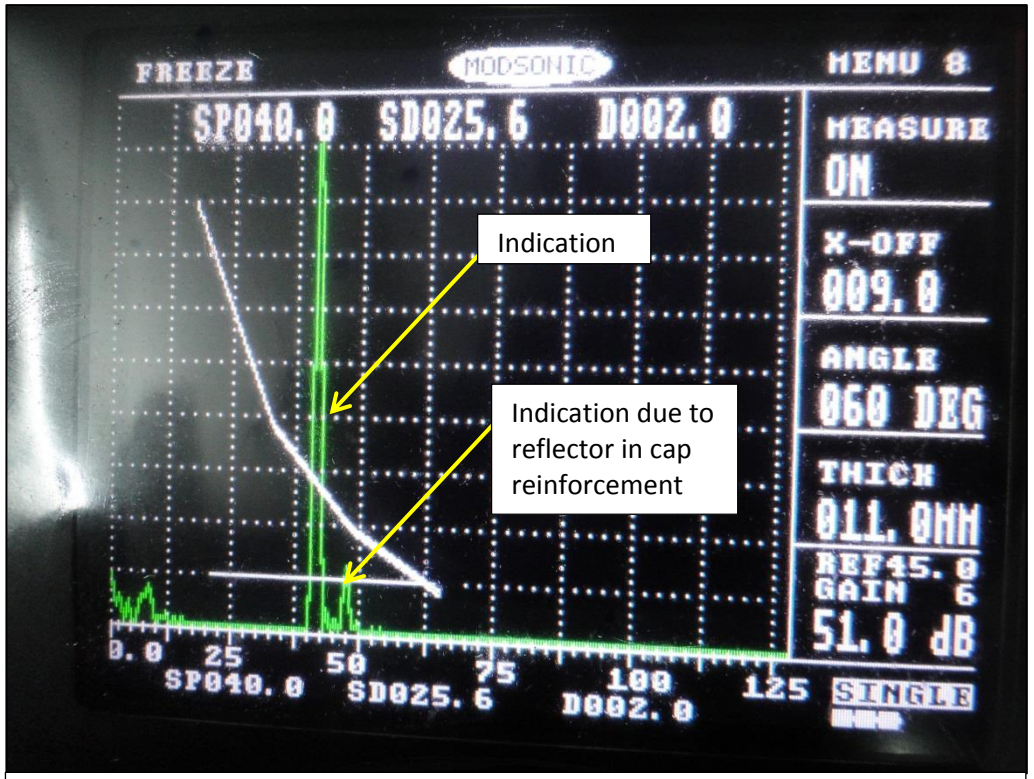
Observation:

Parameters	Vertically oriented lack of fusion defects at fusion face in a **main member @ DAC (45 dB)**	Lack of fusion defect at fusion face in a **branch member @ DAC (45 dB)**
Amplitude % FSH	**15 % FSH** **Note:** From the above CRT display noticed that, ultrasonic sound response from vertically oriented lack of fusion defects at fusion face in a **main member** is **reduced** due to vertical orientation of lack of fusion, which **results loss of sound energy due to reflection to other direction and mode conversion**. That is the reason amplitude response is reduced and **amplitude height is below the DAC reference curve.**	**43% FSH** **Note:** From the above CRT display noticed that, ultrasonic sound response from lack of fusion defect at fusion face in a **branch member** is **optimized** due to **lack of fusion defect orientation close to normal to sound beam**, which results maximum response. That is the reason amplitude response is increased and amplitude height is above the DAC reference curve **even at only DAC reference dB.**
Time base width	**1 mm**	**1mm**

6. Echo response vertically oriented Lack of fusion defects at fusion face in a main member and lack of fusion defect at fusion face in a branch member @ reference 45 dB + 6 dB



Vertically oriented lack of fusion defects at fusion face in a **main member@DAC (45 + 6 dB)**

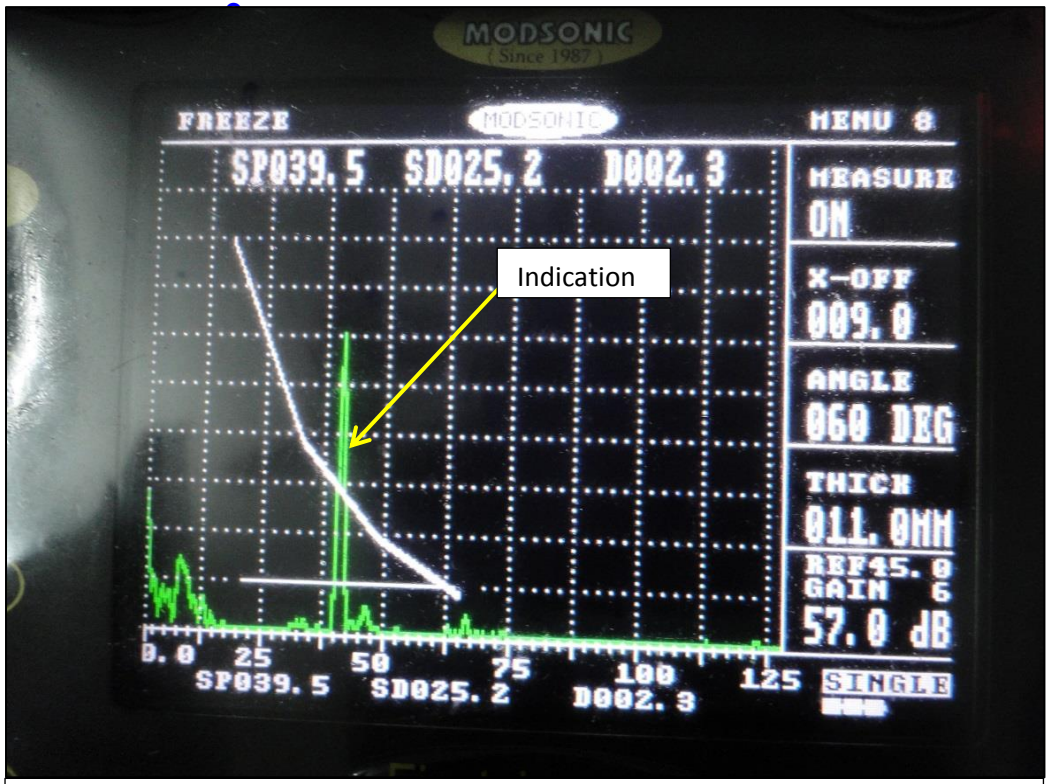


Lack of fusion defect at fusion face in a **branch member @ DAC (45 + 6 dB)**

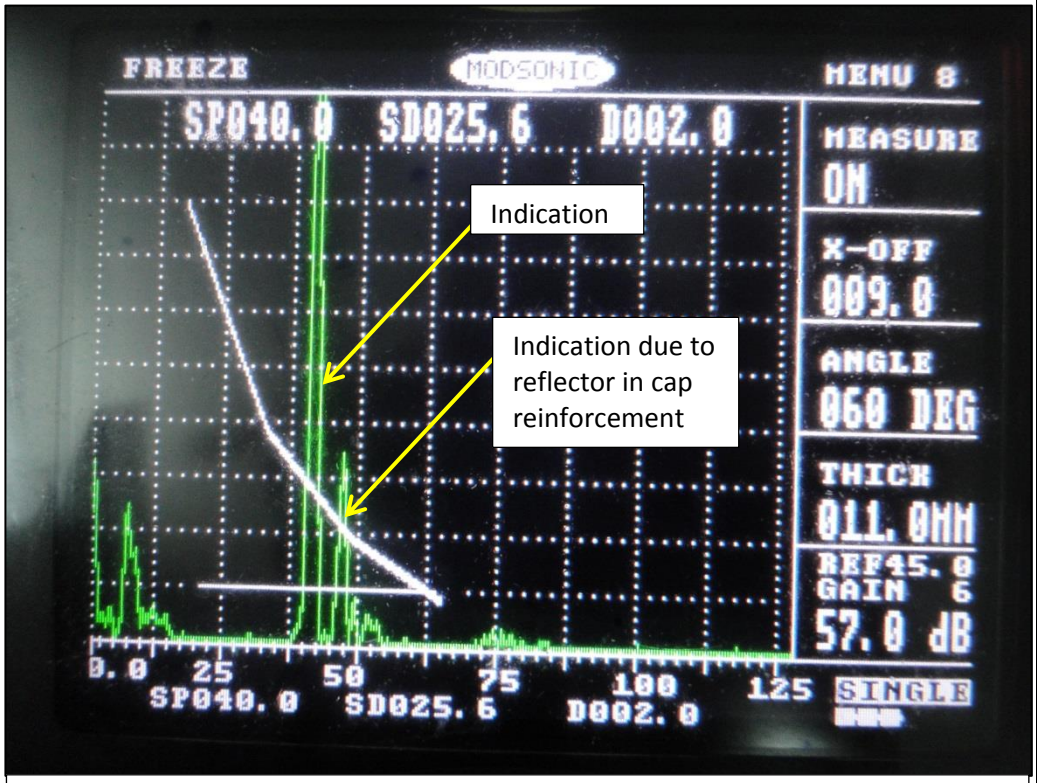
Observation:

Parameters	Vertically oriented lack of fusion defects at fusion face in a **main member @ DAC (45 + 6 dB)**	Lack of fusion defect at fusion face in a **branch member @ DAC (45 + 6 dB)**
Amplitude % FSH	28 % FSH **Note:** Noticed from the above CRT display noticed that, sound response equivalent to 3mm Ø reflector (touches DAC reference curve) only at **DAC (45 + 6 dB)** Reference block : 38mm thick with **3mm SDH**	90% FSH **Note:** From the above CRT display noticed that, ultrasonic sound response from lack of fusion defect at fusion face in a **branch member** is **optimized** due to **lack of fusion defect orientation close to normal to sound beam**, which results maximum response. That is the reason amplitude response is increased and amplitude height is above the DAC reference curve.
Time base width	**1 mm**	**1mm**

7. Echo response Vertically oriented planner defects at fusion face in a main member and planner defect at fusion face in a branch member @ reference 45 dB + 12dB



Vertically oriented lack of fusion defects at fusion face in a **main member@DAC (45 + 12 dB)**

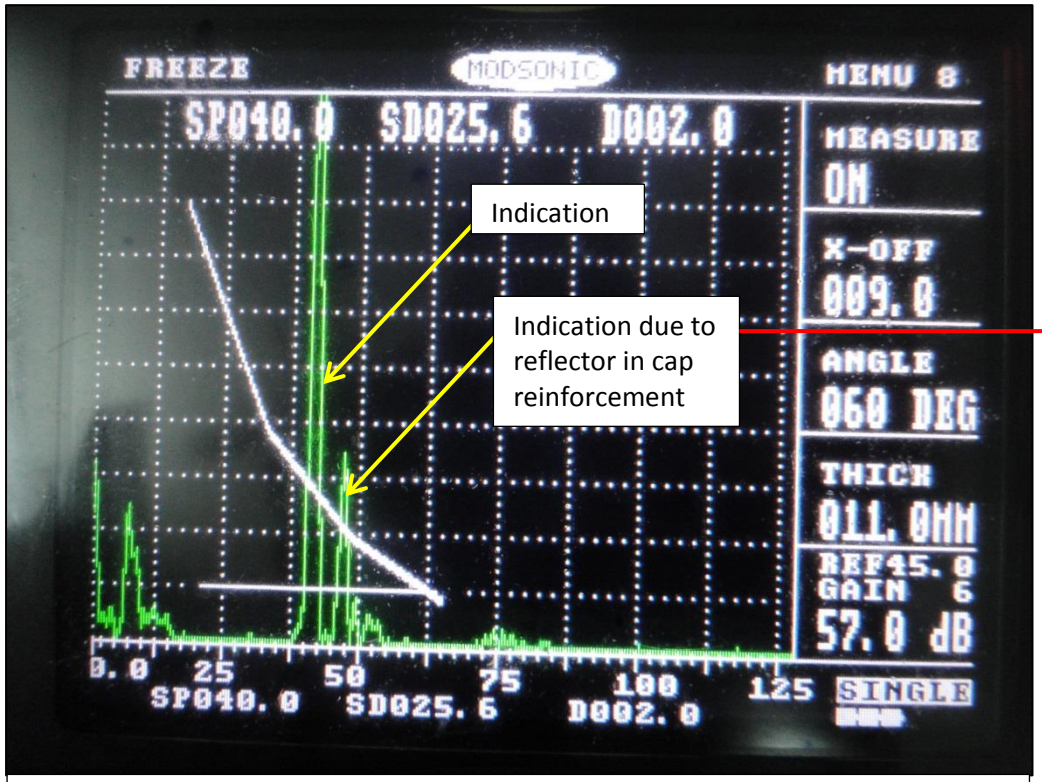


Lack of fusion defect at fusion face in a **branch member @ DAC (45 + 12 dB)**

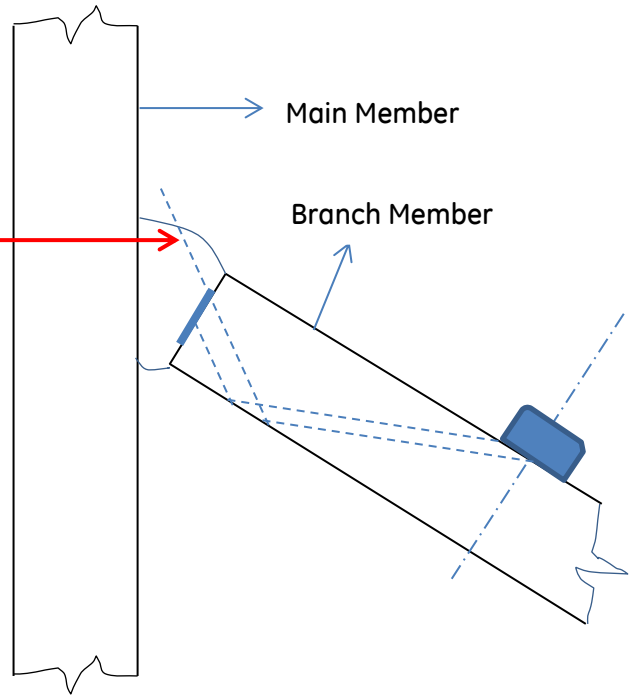
Observation:

Parameters	Vertically oriented lack of fusion defects at fusion face in a **main member @ DAC (45 + 12 dB)**	Lack of fusion defect at fusion face in a **branch member @ DAC (45 + 12 dB)**
Amplitude % FSH	60 % FSH **Note:** Noticed from the above CRT display noticed that, sound response above the DAC reference curve, only at **DAC (45 +12 dB)** Reference block : 38mm thick with **3mm SDH**	>100% FSH **Note:** From the above CRT display noticed that, ultrasonic sound response from lack of fusion defect at fusion face in a **branch member** is **optimized** due to **lack of fusion defect orientation close to normal to sound beam**, which results maximum response. That is the reason amplitude response is increased and amplitude height is above the DAC reference curve and **even above full screen height.**
Time base width	**1 mm**	**2mm**

8. Noise indication interpretation



Lack of fusion defect at fusion face in a **branch member** @ DAC (45 + 12 dB)



9. Summary of observation

Parameters	Vertically oriented lack of fusion defects at fusion face in a **main member**	Lack of fusion defect at fusion face in a **branch member**	Remarks
Amplitude comparison			
Amplitude % FSH @ DAC	**15** (Note -1)	**43** (Note - 2)	
Amplitude % FSH @ DAC + 6 dB	**28**	**90**	
Amplitude % FSH @ DAC **+ 12 dB**	**60** (Note - 3)	**>100 % FSH**	
Time base comparison			
Time base width in mm @ DAC	**1**	**1**	No variation observed
Time base width in mm @ DAC + 6 dB	**1**	**1**	No variation observed
Time base width in mm @ DAC + 12 dB	**1**	**2**	Variation observed, but ignorable

Note -1: Ultrasonic sound response from vertically oriented lack of fusion defects at fusion face in a **main member** is **reduced** due to vertical orientation of lack of fusion, which **results loss of sound energy due to reflection to other direction and mode conversion**. That is the reason amplitude response is reduced and **amplitude height is below the DAC reference curve.**

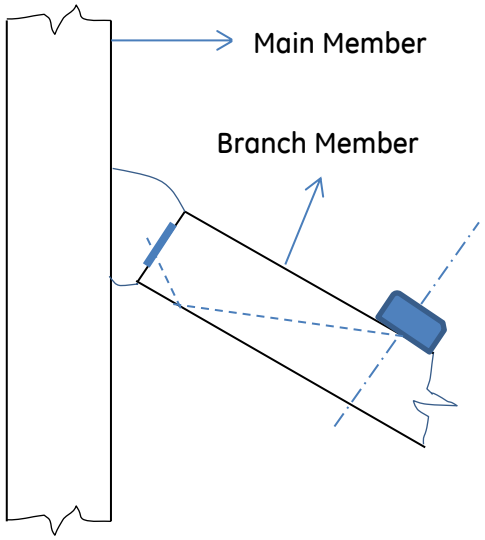
Note -2: Ultrasonic sound response from lack of fusion defect at fusion face in a **branch member** is **optimized** due to **lack of fusion defect orientation close to normal to sound beam**, which results maximum response. That is the reason amplitude response is increased and amplitude height is above the DAC reference curve **even at only DAC reference dB.**

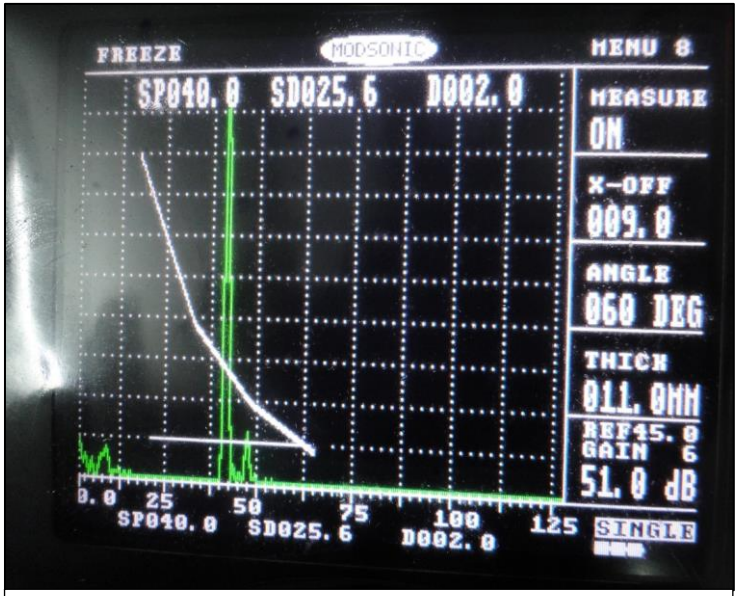
Note -3: Sound response above the DAC reference curve, **only at DAC (45 +12 dB)**

11. Conclusion

Ultrasonic testing of Node and Nozzle weld:

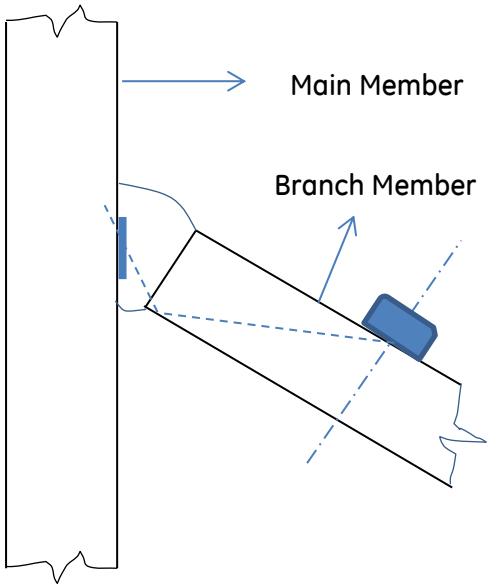
- While scanning and **targeting fusion type of defects** at fusion face in a **branch member,** recommend to use scanning sensitivity **DAC reference + 6 dB**

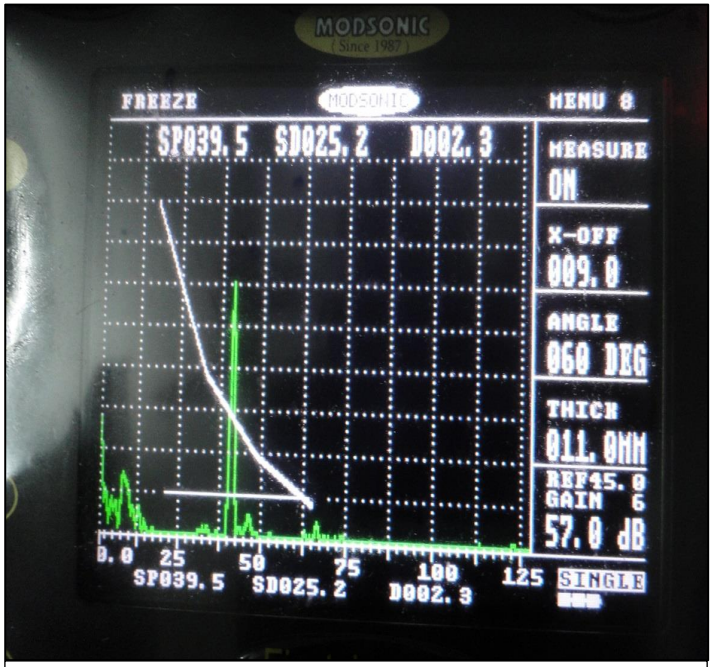




Lack of fusion defect at fusion face in a **branch member @ DAC (45 + 6 dB)**

- While scanning and **targeting fusion type of defects** at fusion face in a **main member,** recommend to use scanning sensitivity **DAC reference + 12 dB and sizing by – 6dB** from scanning sensitivity.





Vertically oriented lack of fusion defects at fusion face in a **main member@DAC (A5 + 12 dB)**

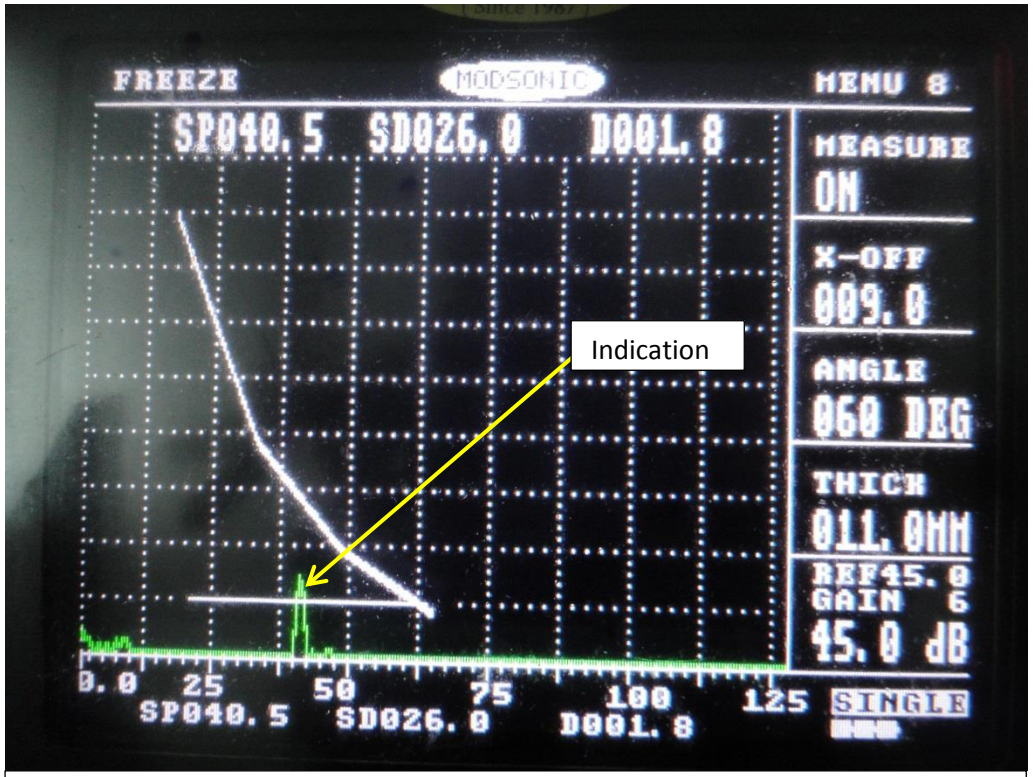
- Reason for the above recommendation

    - While scanning and **targeting fusion type of defects** at fusion face in a **main member , sound response reduced** due to vertical orientation of expected fusion type of defects and sound beam meets the reflector at an angle, which **results loss of sound energy due to reflection to other direction and mode conversion**

- Scanning with **DAC reference level**, sound energy meets the vertically oriented reflector in a main member fusion face is **equivalent to 0.75mm Ø spherical reflector** (calculated with reference to distance law for side drilled hole) due to **reflection to other direction and mode conversion not equivalent to 3 mm Ø spherical reflector in a reference block.**

- Even scanning with DAC + 6 dB, achieved amplitude is **equivalent to 3mm Ø spherical reflector.** Take this as base and **add + 6 dB more for scanning sensitivity.** That is the reason recommend to use scanning sensitivity **DAC reference + 12 dB and sizing by – 6dB** from scanning sensitivity.

- **Based on difference in sound response, we can clearly emphasize to NDT personnel.**



Vertically oriented lack of fusion defects at fusion face in a **main member @ DAC (45 dB)**