ADAPTING CSA W59 ULTRASONIC INSPECTIONS FOR USE WITH DISTANCE-AMPLITUDE TECHNIQUES

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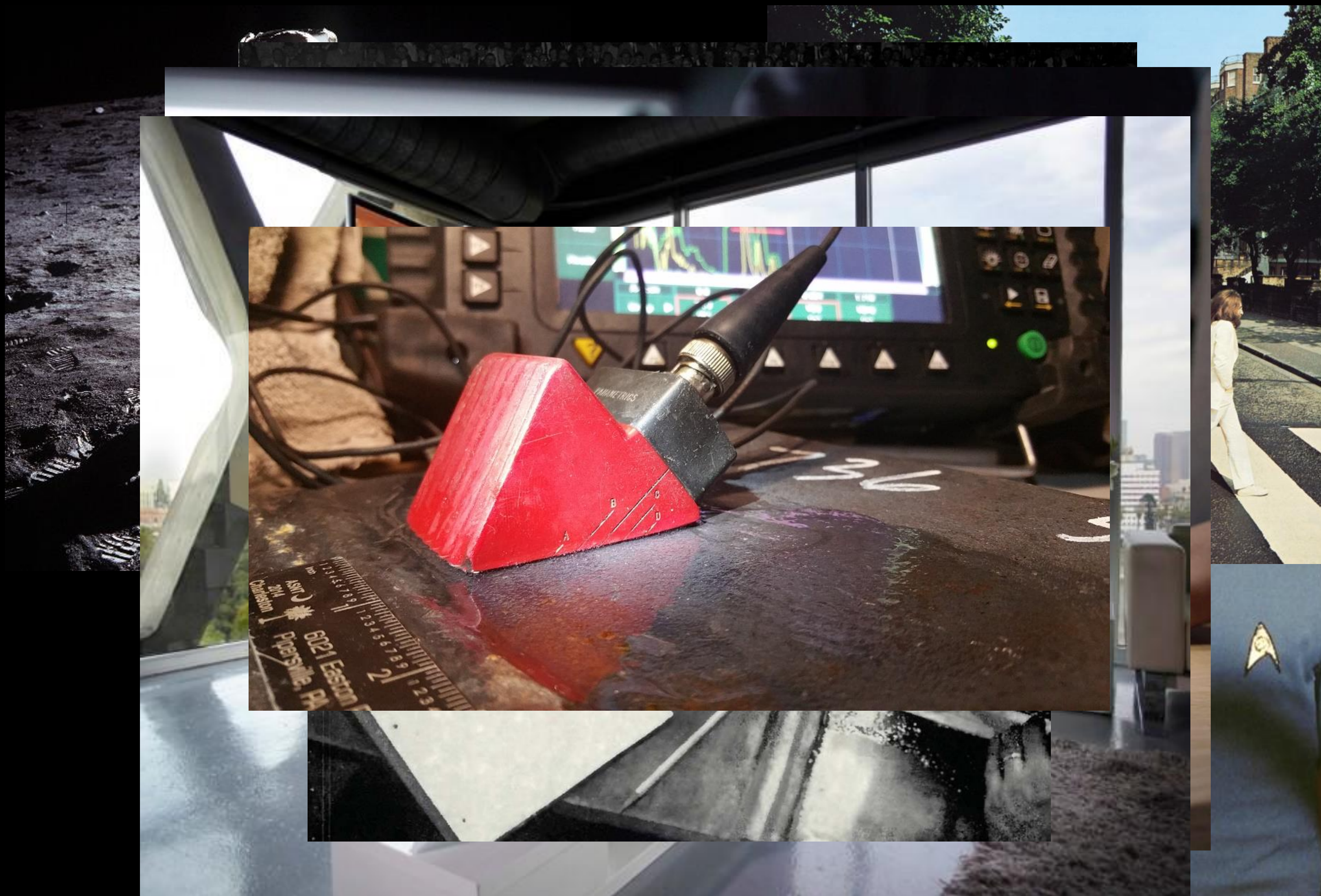
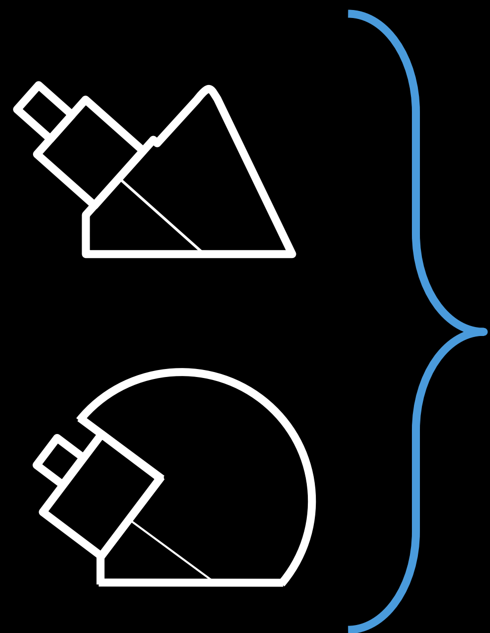
NDT in Canada
NDTiC 2017
Canada's NDT Conference
June 6 - 8
Centre des congrès de Québec
Québec City, Québec


6021 Easton
Pipersville, PA

STAYING THE COURSE

“FIXED ATTENUATION” TECHNIQUE

"FIXED ATTENUATION" TECHNIQUE



$$2\,\frac{\mathrm{dB}}{\mathrm{in}}$$

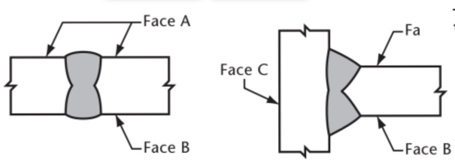
"FIXED ATTENUATION" TECHNIQUE

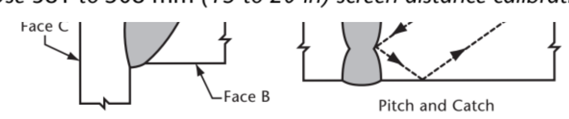
Table 8.3
Procedure chart
(See Clauses 8.2.8.5 and 8.2.8.6.)

	Procedure chart					
	Material thickness, mm (in)					
	8.0 to 38.0 (5/16 to 1-1/2)		> 38.0 to 45 (> 1-1/2 to 1-3/4)		> 45 to 60 (> 1-3/4 to 2-1/2)	
Weld type		*		*		*
Butt	1	O	1	F	1G or 4	F
T	1	O	1	F or XF	4	F or XF
Corner	1	O	1	F or XF	1G or 4	F or XF
Electrogas and electroslag	1	O	1	O	1G or 4	1†

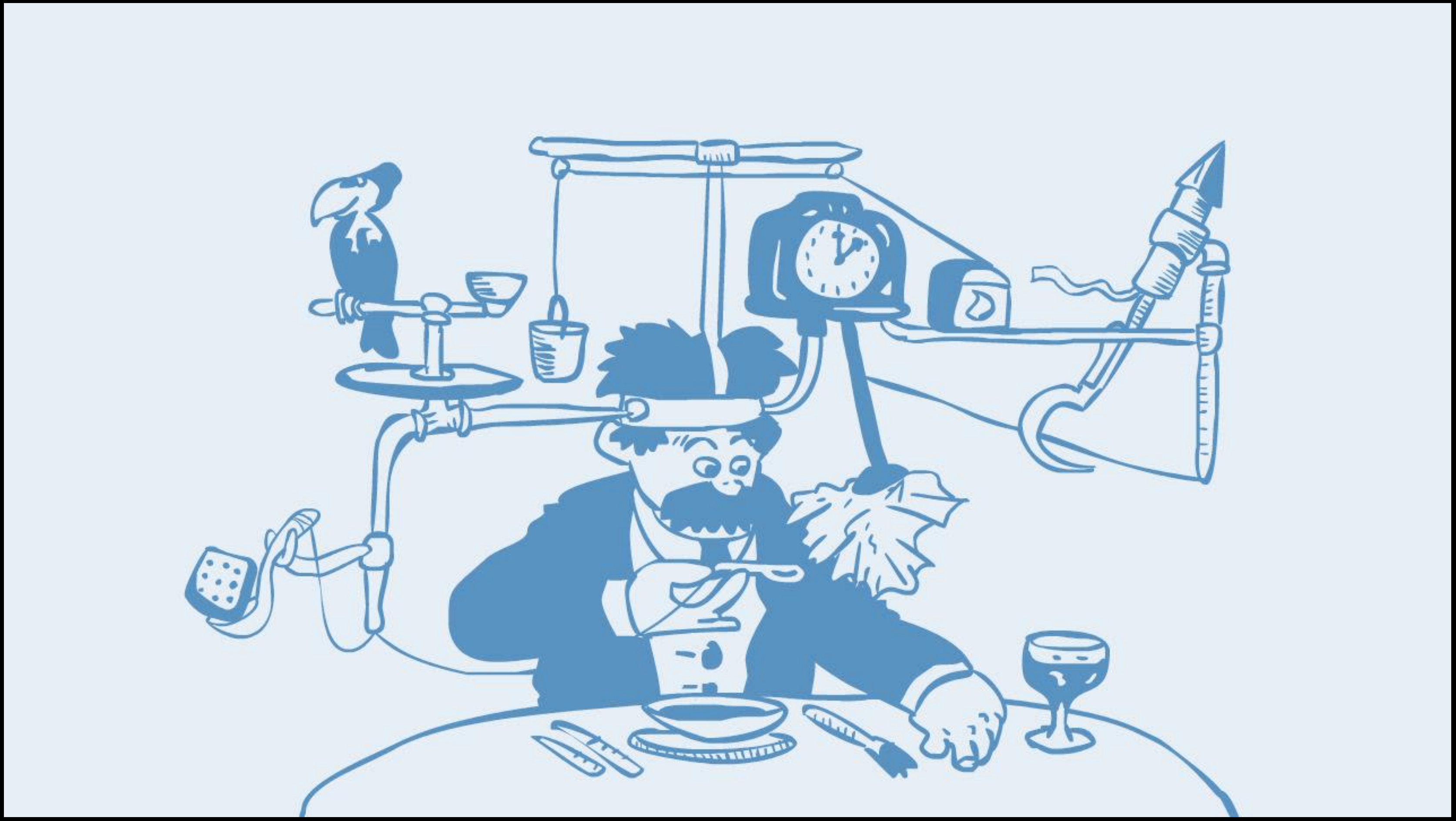
Procedure No.	Procedure legend: Region of weld thickness — Top quarter, degrees	Middle half, degrees	Bottom quarter, degrees
1	70	70	70
2	60	60	60
3	45	45	45
4	60	70	70
5	45	70	70
6	70 G A	70	60
7	60 B	70	60
8	70 G A	60	60
9	70 G A	60	45
10	60 B	60	60
11	45 B	70*	45
12	70 G A	45	70 G B
13	45 B	45	45
14	70 G A	45	45
15	70 G A	70 A B	70 G B

*Use 381 to 508 mm (15 to 20 in) screen distance calibration.



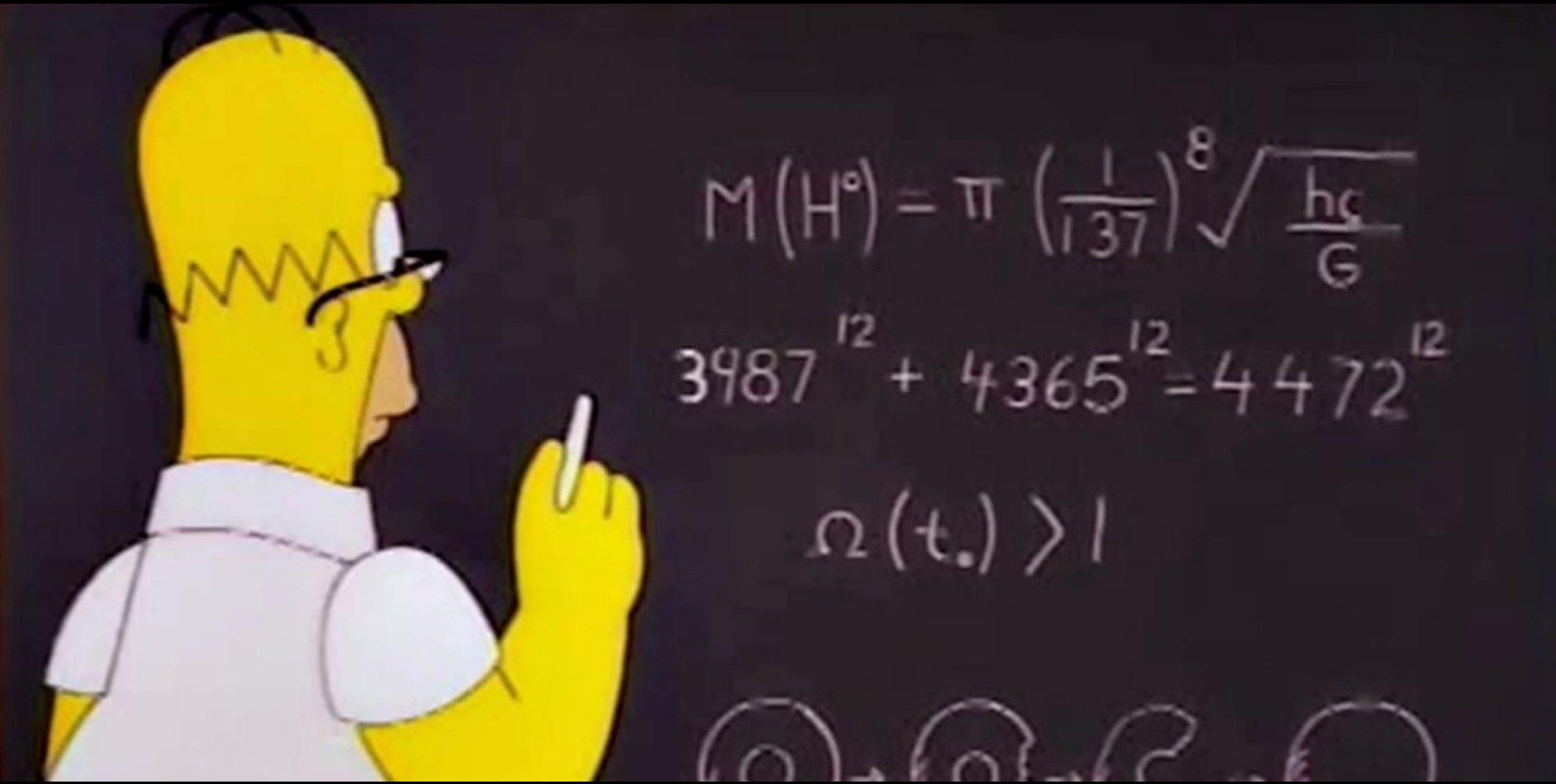


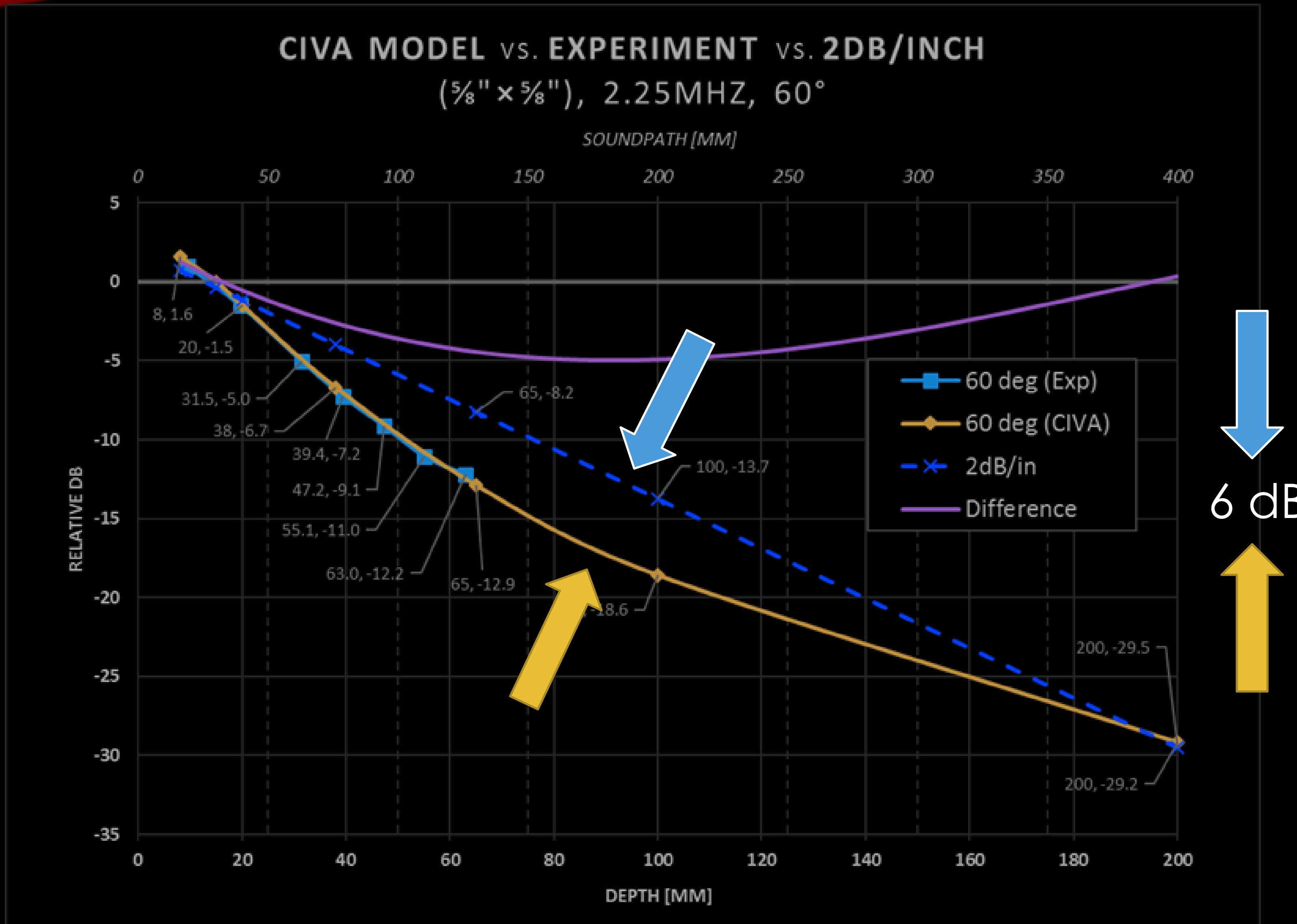
DRAWBACKS



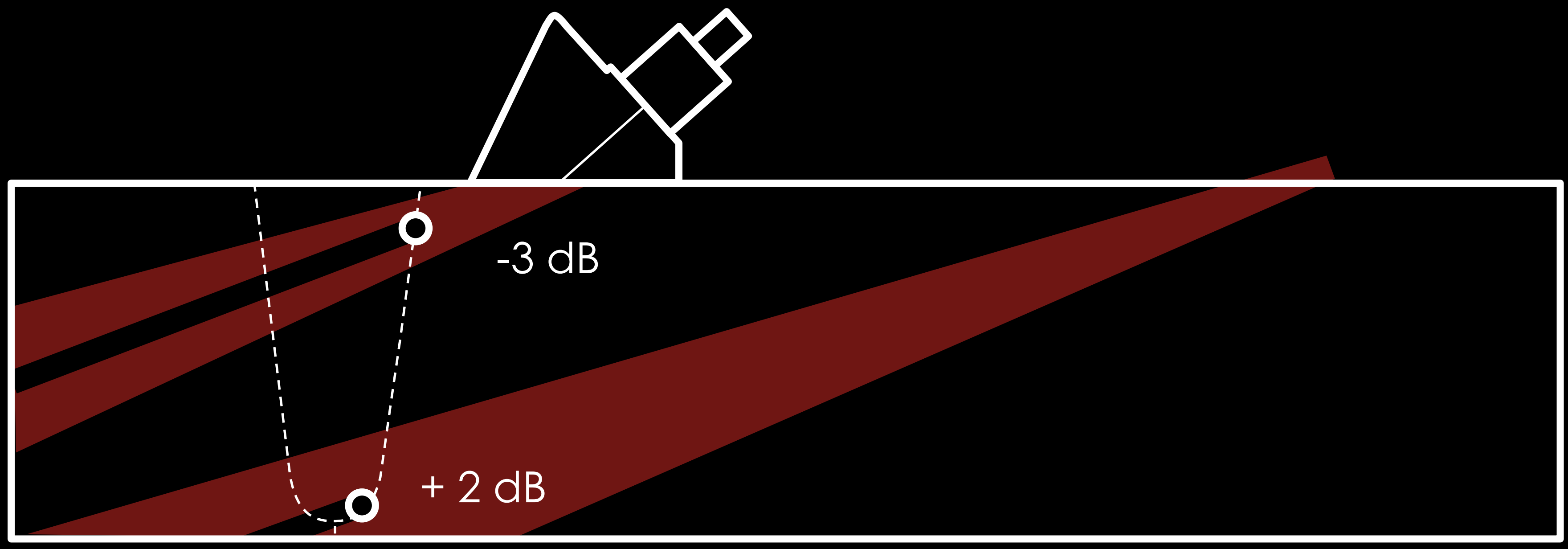
DRAWBACKS

DRAWBACKS


$M(H^{\circ}) = \pi \left(\frac{1}{137}\right)^{8} \sqrt{\frac{hc}{G}}$
$3987^{12} + 4365^{12} = 4472^{12}$
$\Omega(t_{0}) > 1$

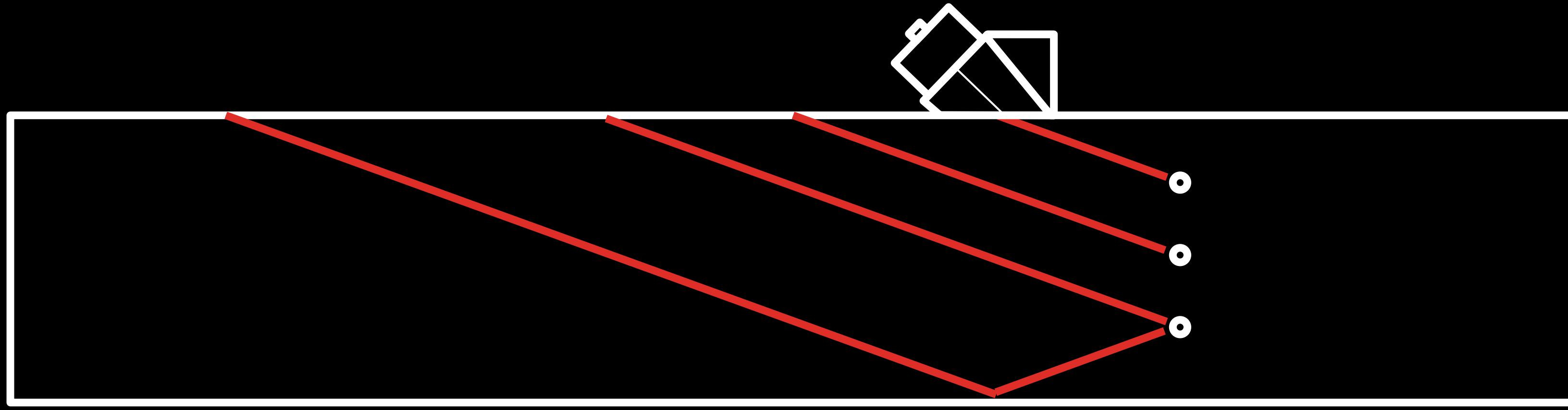

CIVA MODEL vs. EXPERIMENT vs. 2DB/INCH
(⅝" × ⅝"), 2.25MHZ, 60°
SOUNDPATH [MM]
0
50
100
150
200
250
300
350
400
RELATIVE DB
5
0
-5
-10
-15
-20
-25
-30
-35
DEPTH [MM]
0
20
40
60
80
100
120
140
160
180
200
8, 1.6
20, -1.5
31.5, -5.0
38, -6.7
39.4, -7.2
47.2, -9.1
55.1, -11.0
63.0, -12.2
65, -12.9
65, -8.2
100, -13.7
-18.6
200, -29.5
200, -29.2
60 deg (Exp)
60 deg (CIVA)
2dB/in
Difference
6 dB

DRAWBACKS

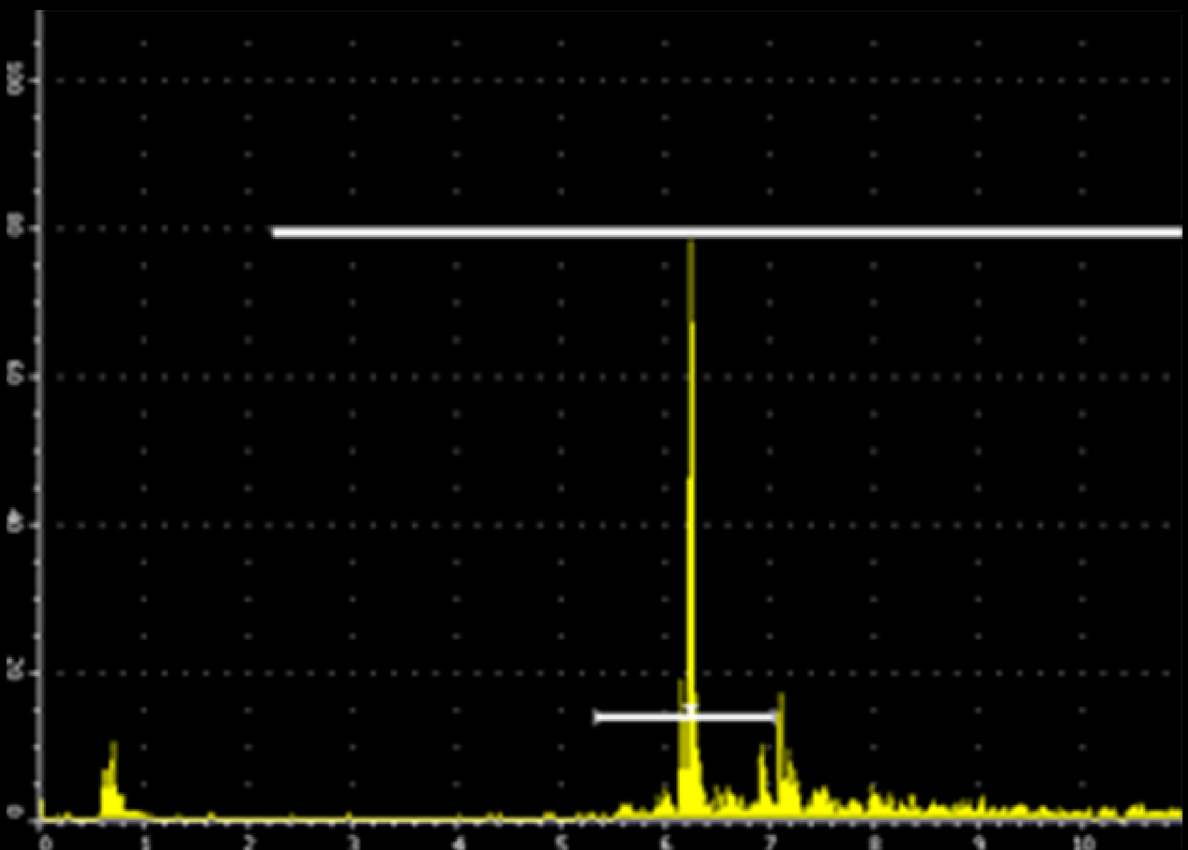


ALTERNATE TECHNIQUE

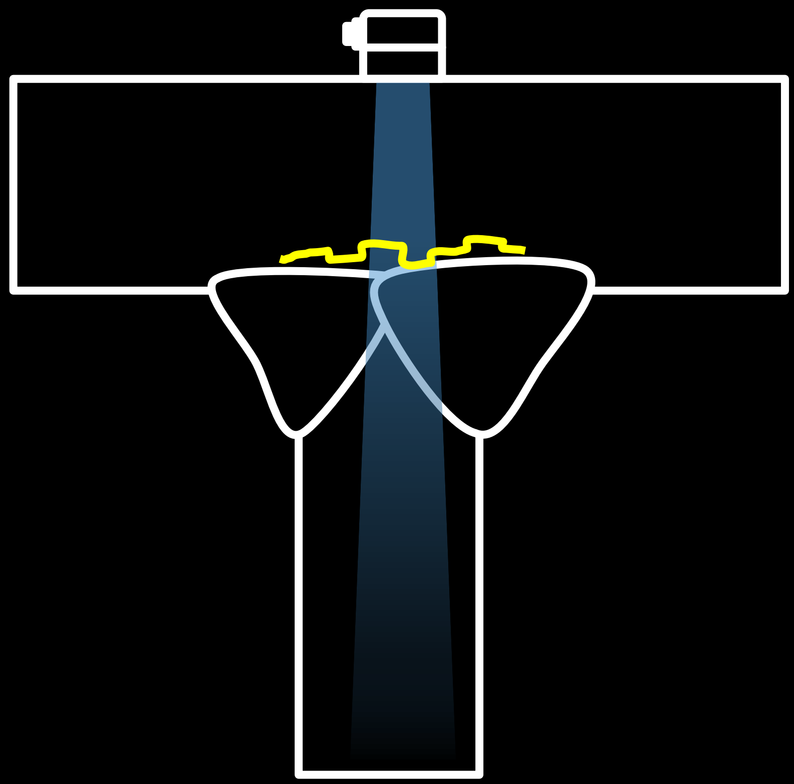
ALTERNATIVE TECHNIQUE

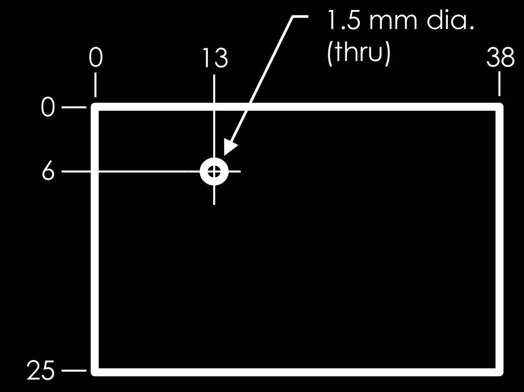


ALTERNATIVE TECHNIQUE



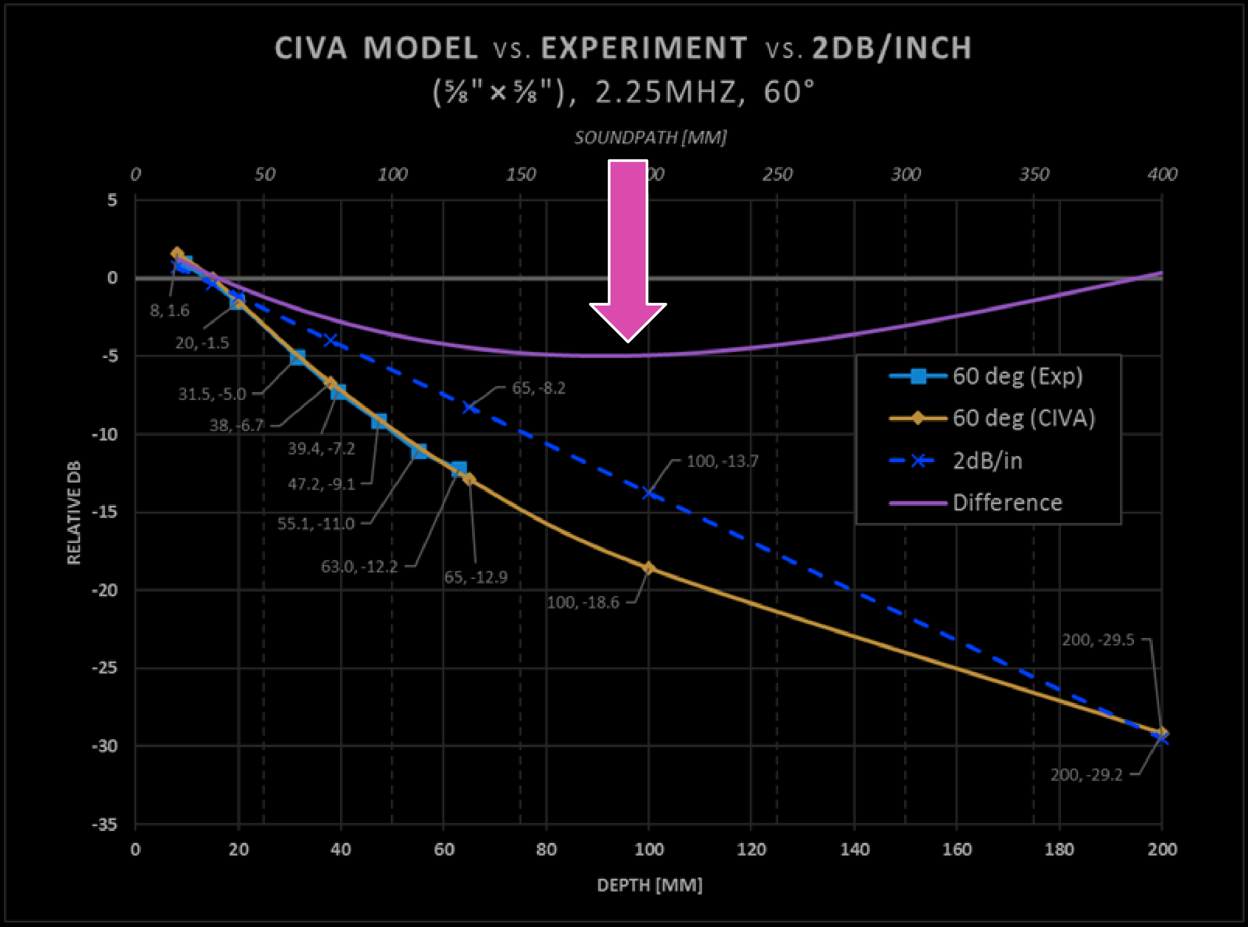
ALTERNATIVE TECHNIQUE





ADAPTING THE CRITERIA

ADAPTING THE CRITERIA



ADAPTING THE CRITERIA

Table 11.3
Ultrasonic acceptance criteria for statically-loaded structures
(See Clauses 8.2.8.6, 11.5.4.5, and 12.5.4.5 and Annex E.)

	Minimum acceptance levels (decibels)										
	Weld thickness and transducer angle										
	8 to 20 mm (5/16 to 3/4 in)	**> 20 to 38 mm (> 3/4 to 1-1/2 in)**	**> 38 to 65 mm (> 1-1/2 to 2-1/2 in)**			**> 65 to 100 mm (> 2-1/2 to 4 in)**			**> 100 to 200 mm (> 4 to 8 in)**		
Reflector severity	**70°**	**70°**	**70°**	**60°**	**45°**	**70°**	**60°**	**45°**	**70°**	**60°**	**45°**
Large reflectors	+6	+3	–1	+2	+4	–4	–1	+1	–6	–3	0
Small reflectors	+7	+4	+1	+4	+6	–2	+1	+3	–4	–1	+2
Minor reflectors	+8	+5	+3	+6	+8	+3	+3	+5	+3	+3	+4

Notes:

(1) *Discontinuities that have a more serious rating than those of minor reflectors shall be separated by at least 2L, L being the length of the larger discontinuity. Discontinuities not separated by at least 2L are considered to be one discontinuity whose length is determined by the combined length of the discontinuities plus their separation distance.*

(2) *Discontinuities that have a more serious rating than those of minor reflectors shall not begin at a distance smaller than 2L from weld ends carrying primary tensile stress, L being the discontinuity length.*

(3) *Discontinuities in the root-face areas of complete joint penetration double V-groove welds, double J-groove welds, double U-groove welds, and double bevel groove welds in tension only, detected at the scanning level shall be evaluated at an acceptance level* 4 dB *more sensitive than that prescribed by this Table; i.e., add + 4 units to the number in the Table.*

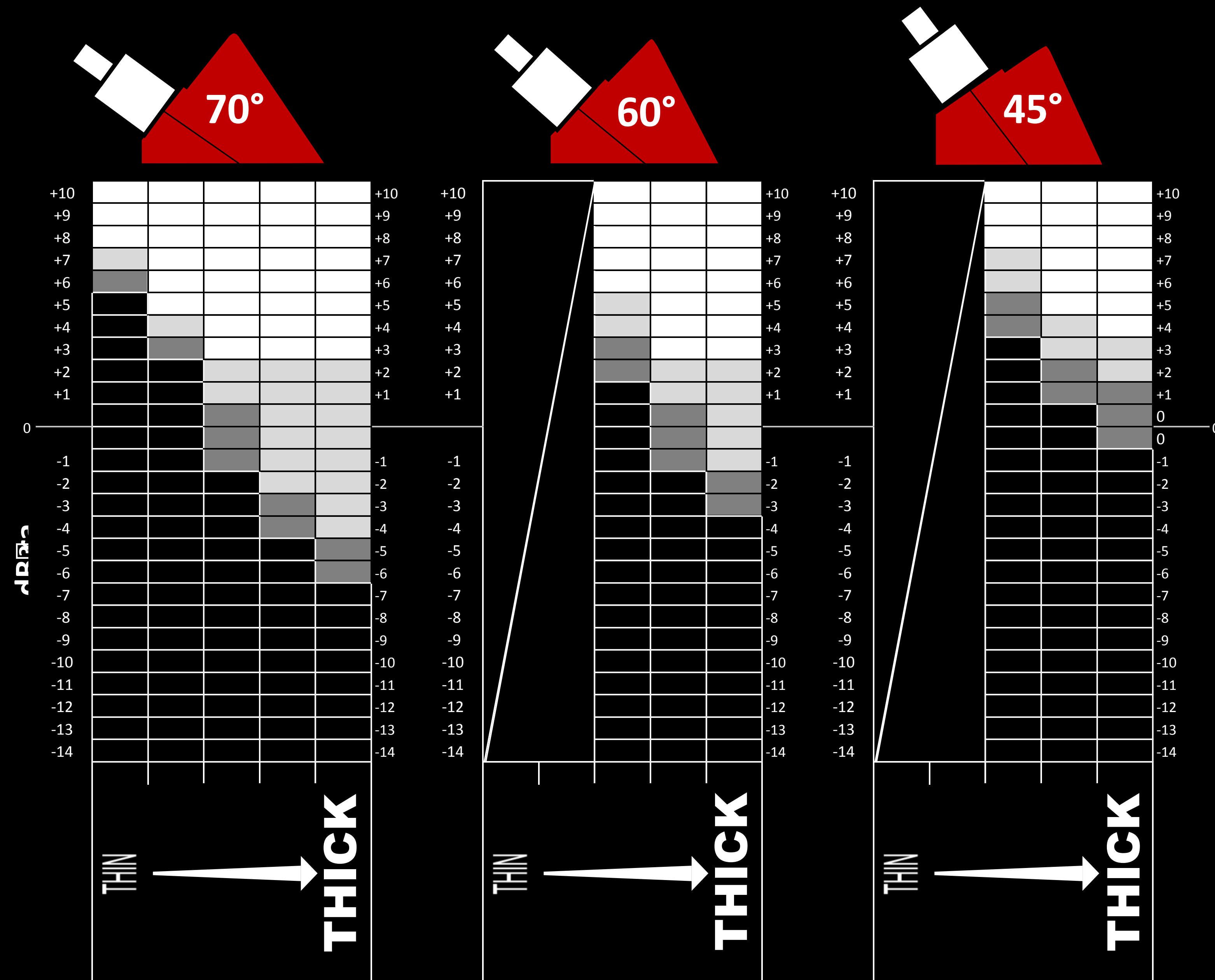
(4) *Electroslag and electrogas welds: Discontinuities that exceed* 50 mm *(2 in) in length and occur in the middle half of such welds shall be evaluated at an acceptance level 6 dB more sensitive than the above levels.*

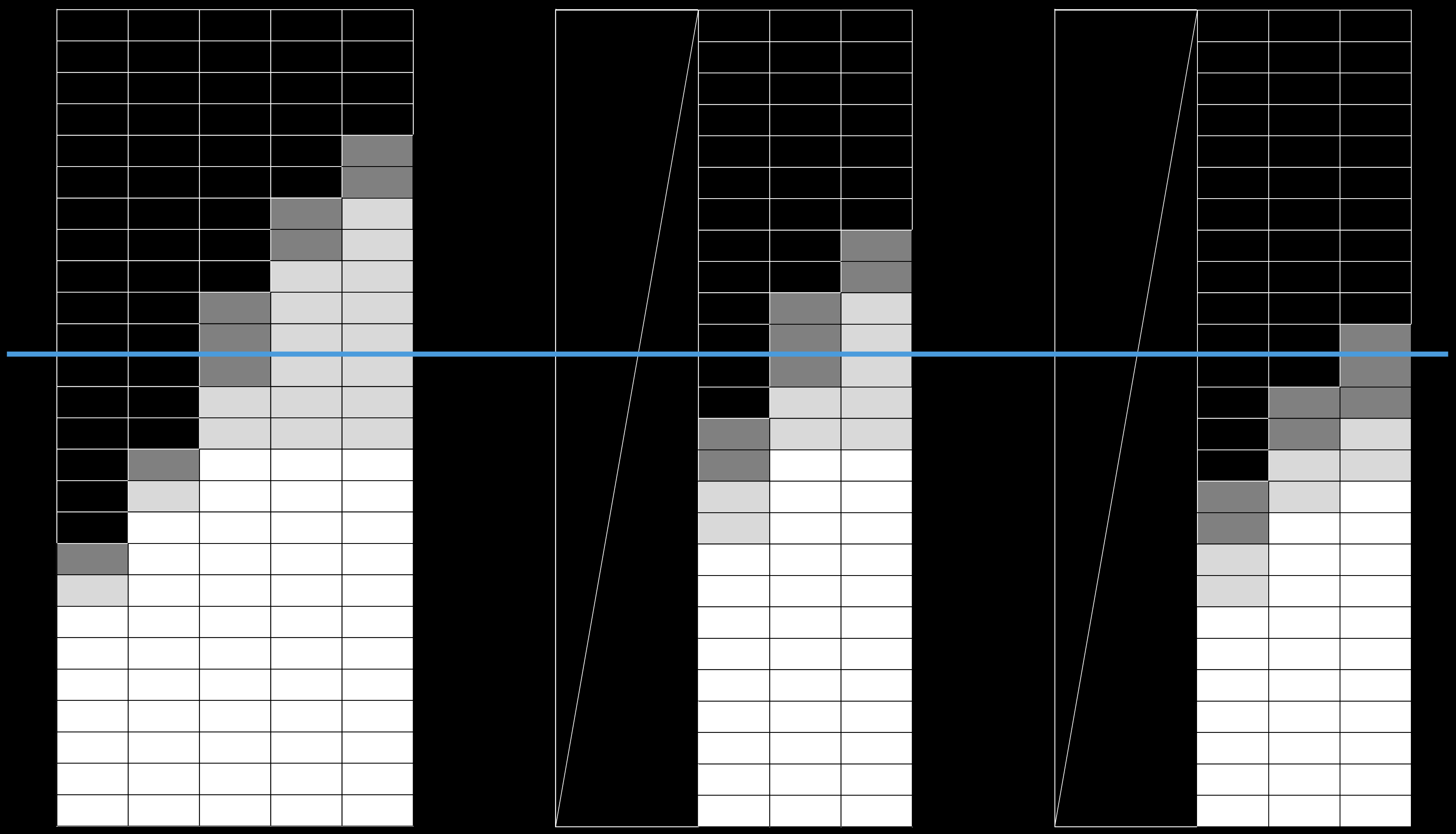
(5) *For indications that remain on the display as the search unit is moved, see Clause 8.2.8.4.*

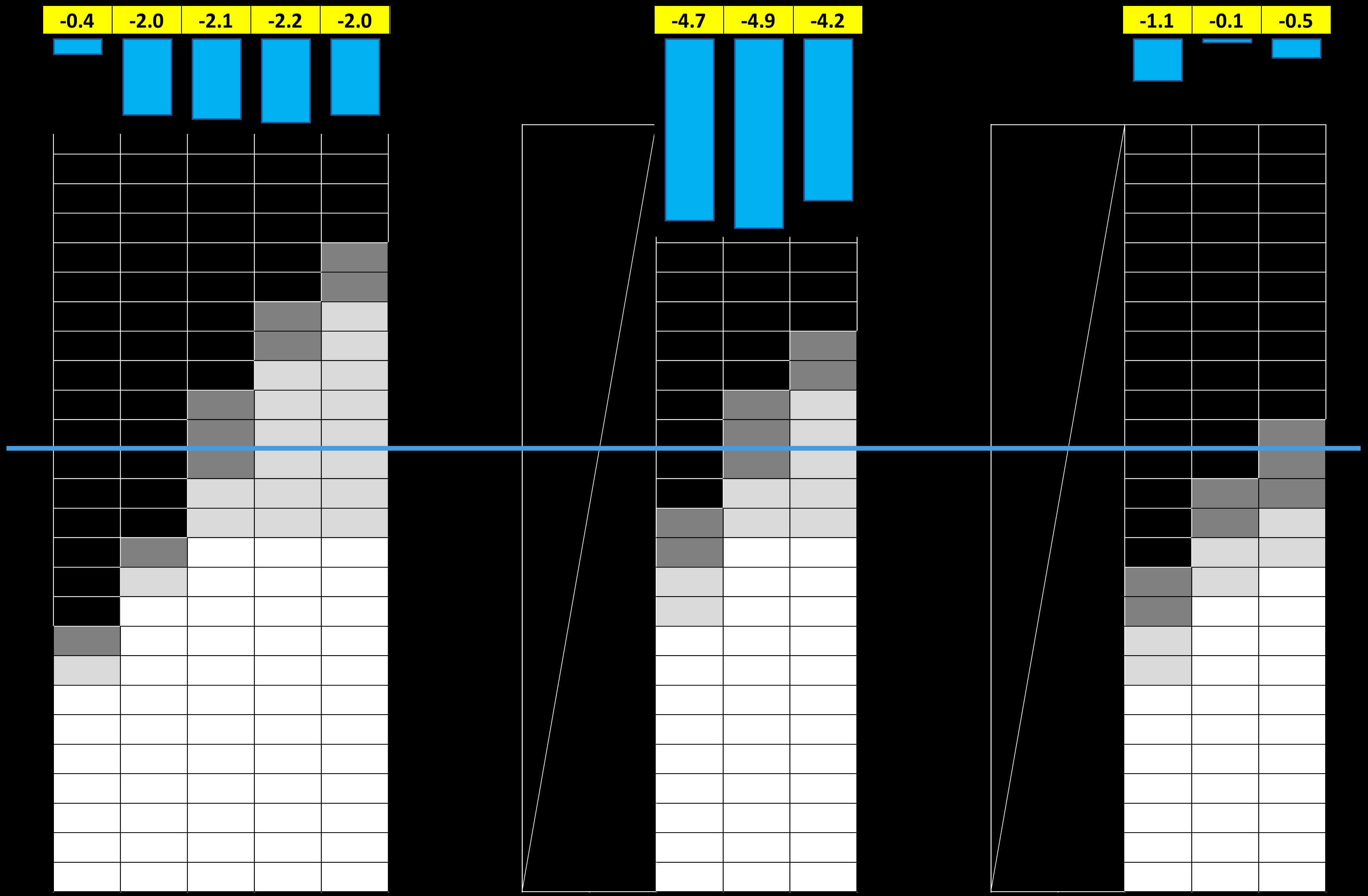
Large reflectors: *Any discontinuity, regardless of length, having a more serious rating (smaller number) than this level shall be rejected.*

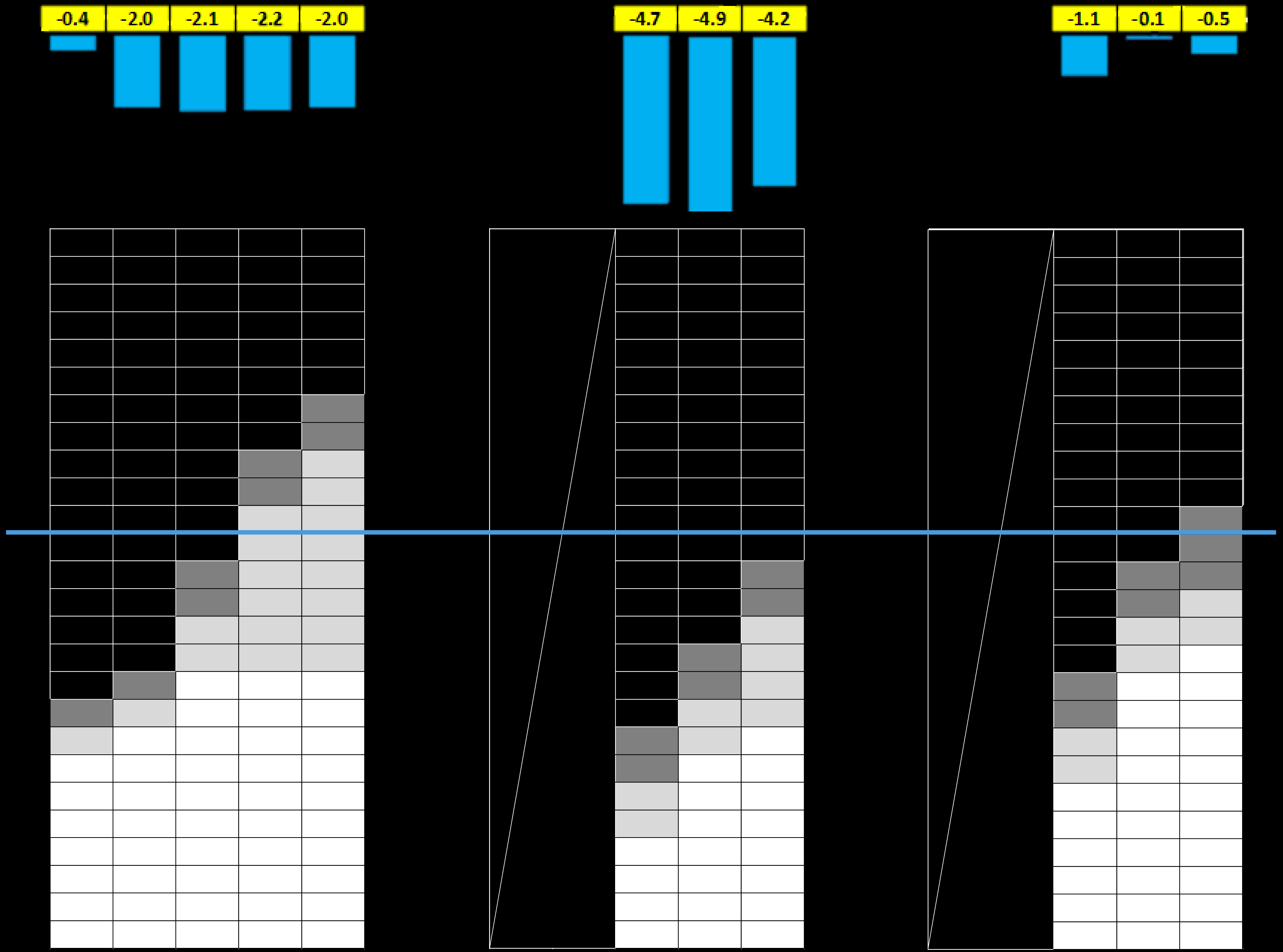
Small reflectors: *Any discontinuity longer than* 20 mm (7/8 in) *having a more serious rating (smaller number) than this level shall be rejected.*

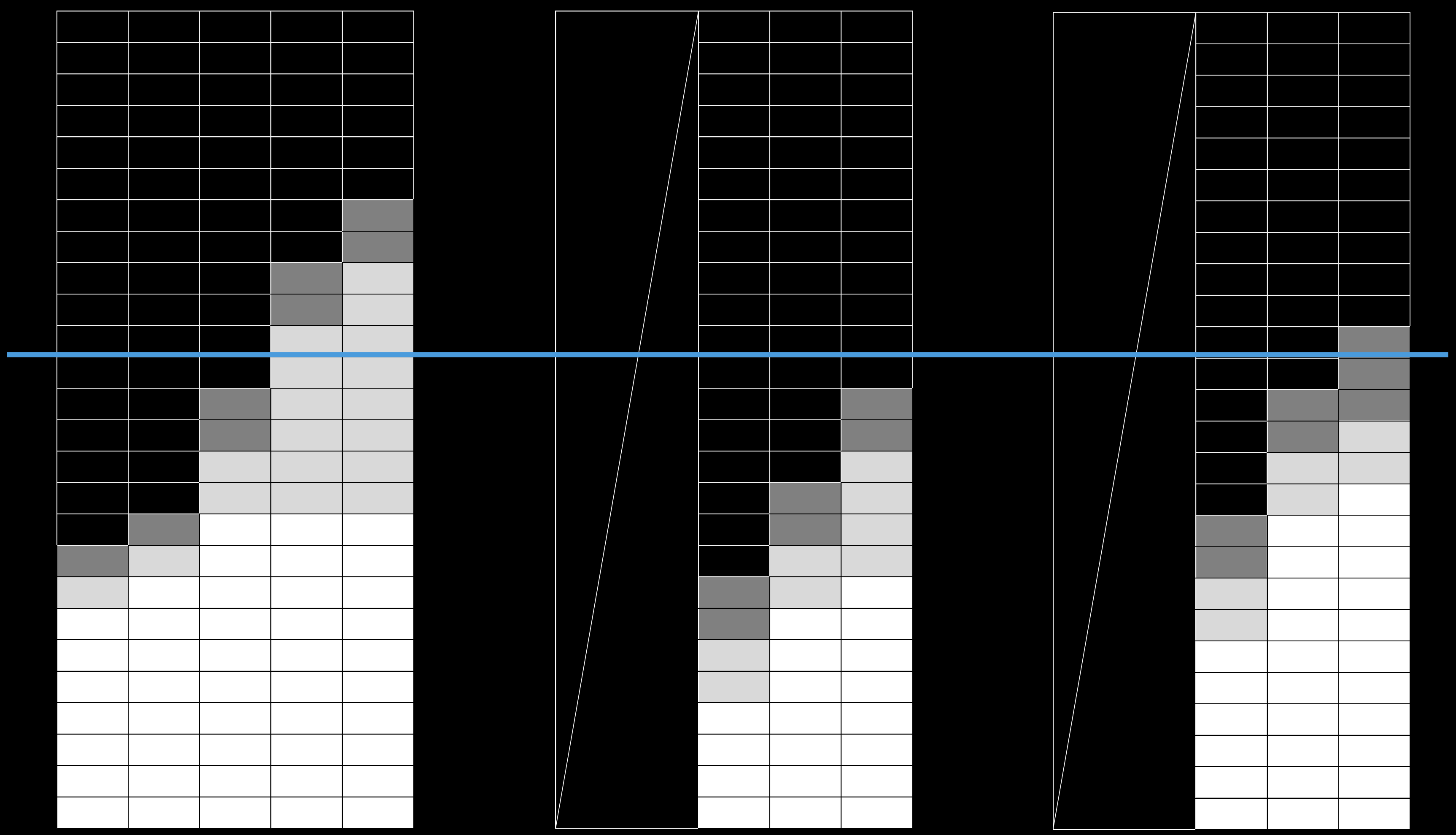
Minor reflectors: *Only those discontinuities exceeding* 50 mm (2 in) *in length and having a more serious rating (smaller number) than this level shall be rejected.*

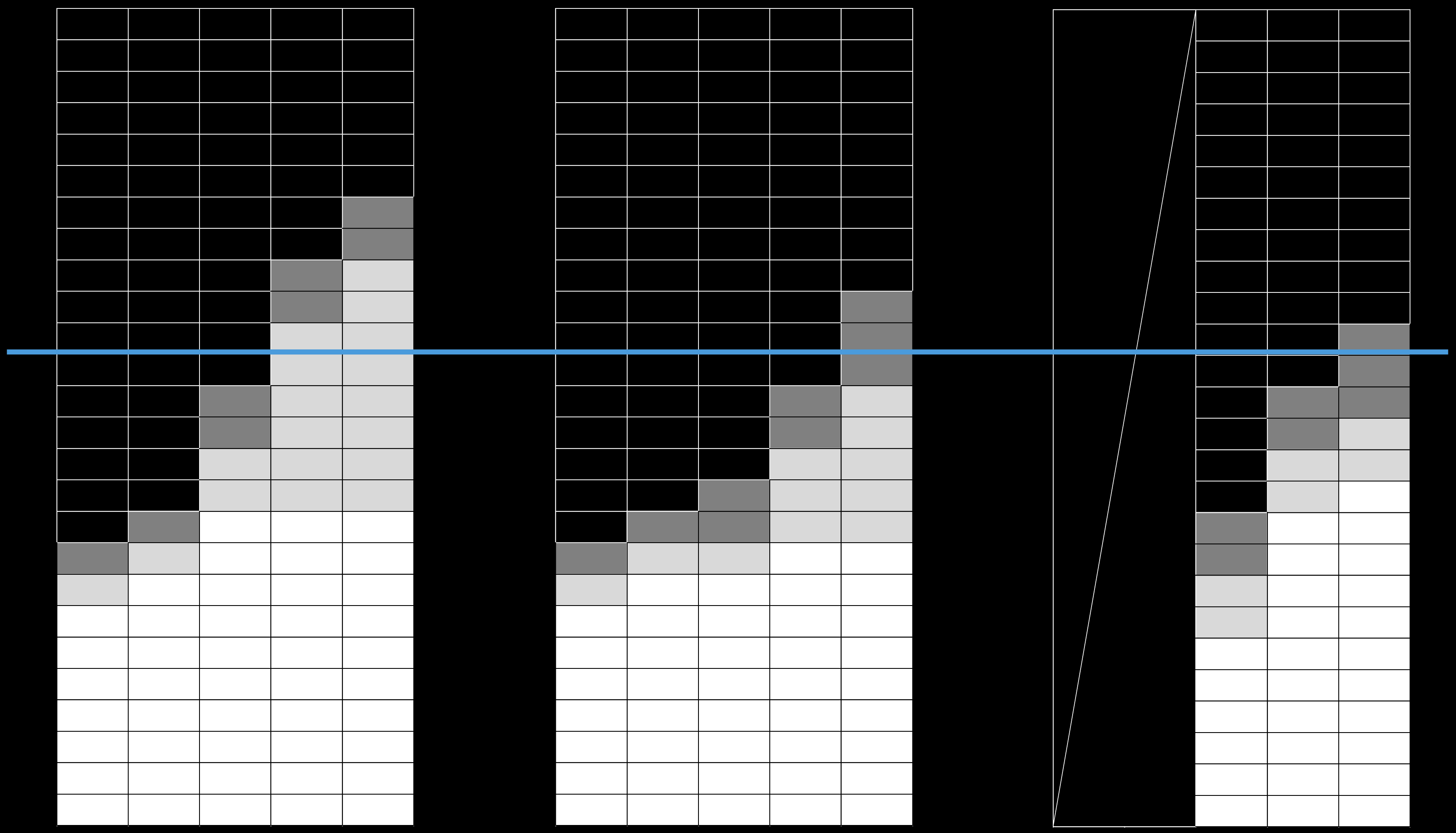

70°
60°
45°
+10
+9
+8
+7
+6
+5
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
THIN
THICK

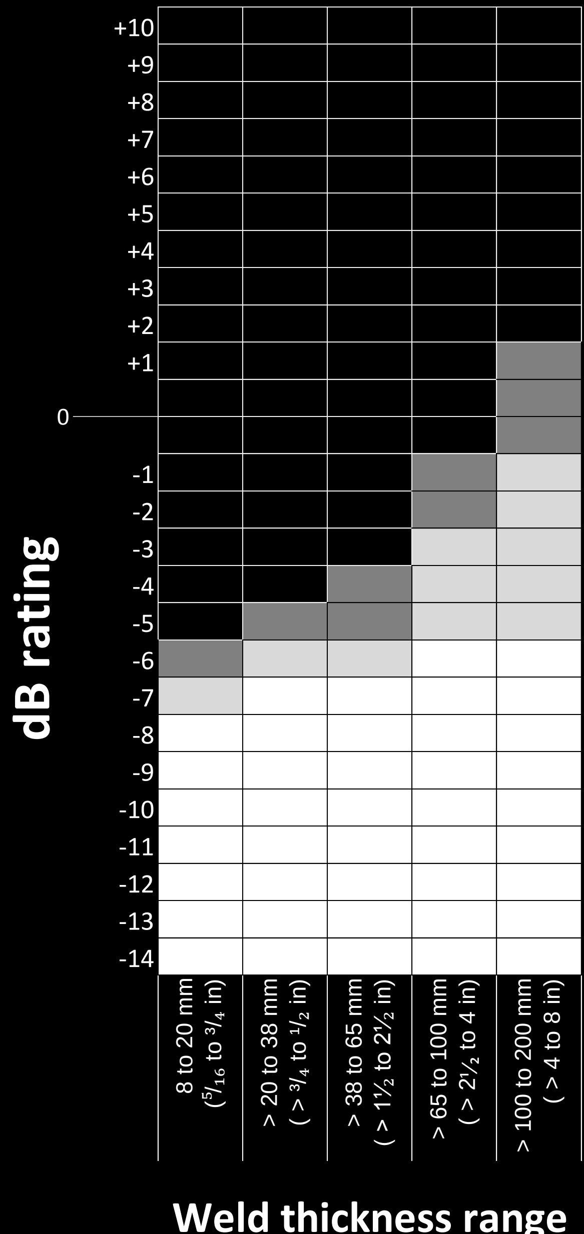


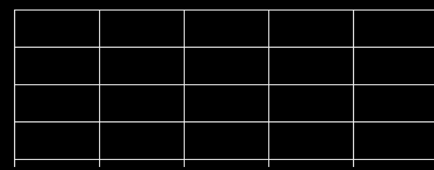

-0.4
-2.0
-2.1
-2.2
-2.0
-4.7
-4.9
-4.2
-1.1
-0.1
-0.5


-0.4
-2.0
-2.1
-2.2
-2.0
-4.7
-4.9
-4.2
-1.1
-0.1
-0.5









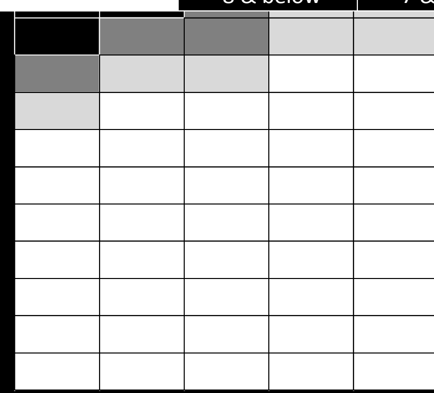


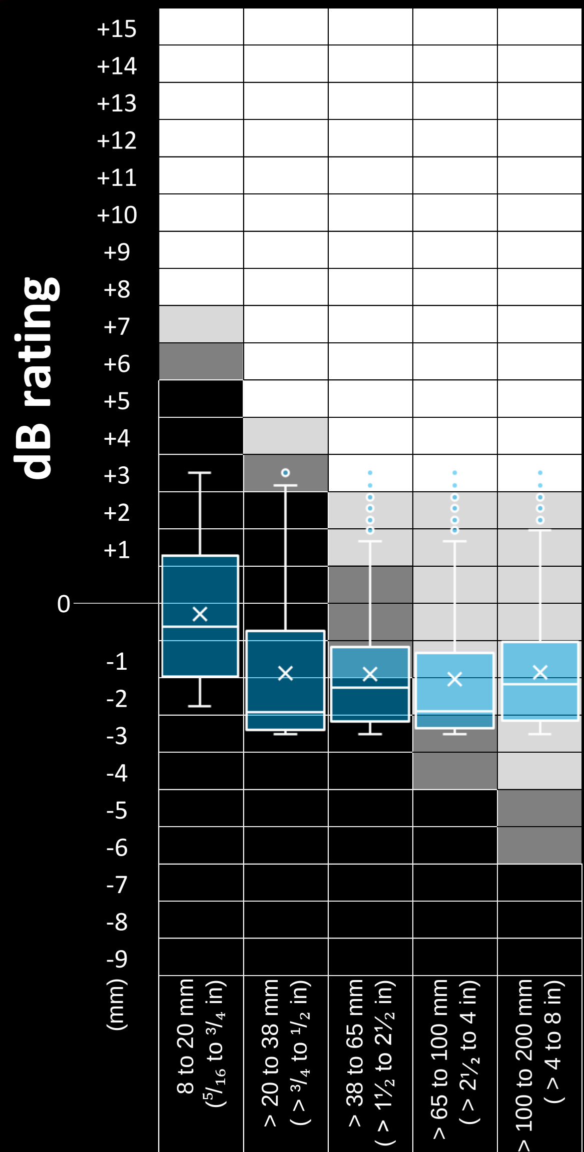
Table X.6

Ultrasonic acceptance criteria for statically-loaded structures (TCG technique)

	Weld thickness range				
	8 to 20 mm	**> 20 to 38 mm**	**> 38 to 65 mm**	**> 65 to 100 mm**	**> 100 to 200 mm**
Class	**($^5/_{16}$ to $^3/_4$ in)**	**(> $^3/_4$ to $1^1/_2$ in)**	**(> $1^1/_2$ to $2^1/_2$ in)**	**(> $2^1/_2$ to 4 in)**	**(> 4 to 8 in)**
A	-5 & above	-4 & above	-3 & above	0 & above	+2 & above
B	-6	-5	-4 to -5	-1 to -2	+1 to 0
C	-7	-6	-6	-3 to -5	-1 to -5
D	-8 & below	-7 & below	-7 & below	-6 & below	-6 & below

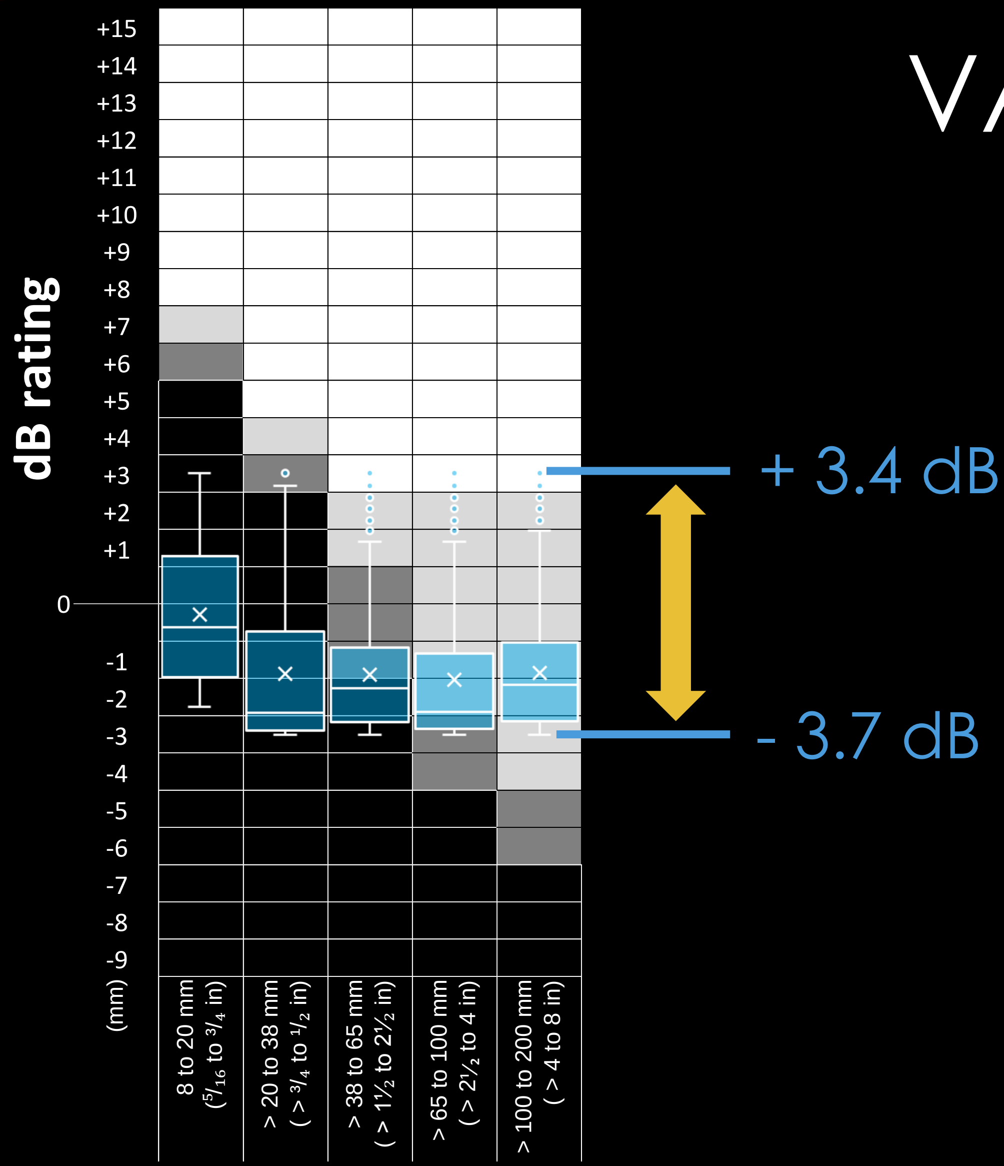
VALIDATION

VALIDATION

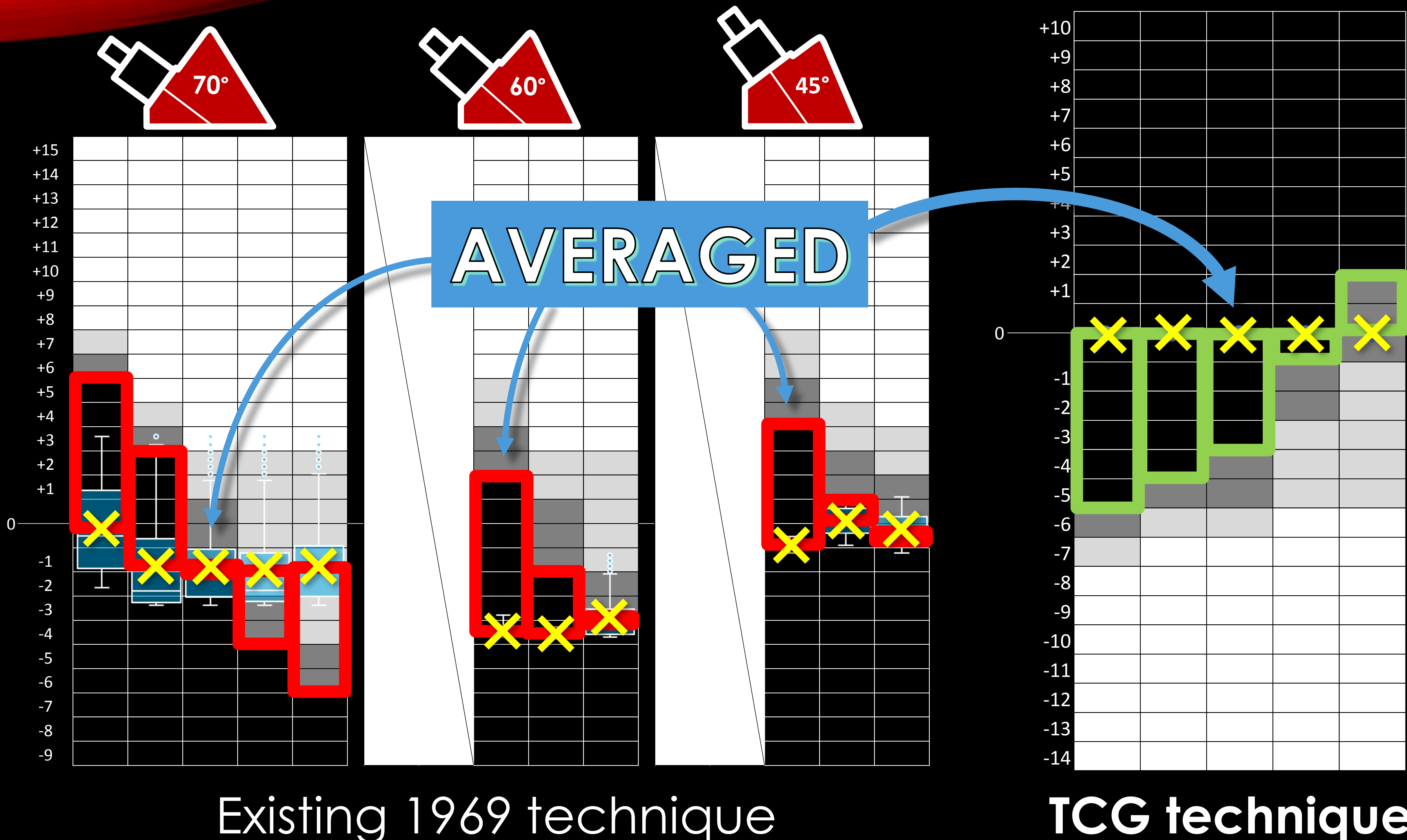


Rating range of reflector with 2 dB/inch model

VALIDATION

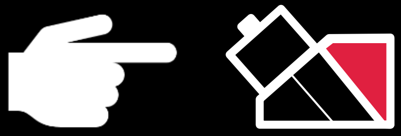


Over 7 dB variance possible with 2 dB/inch model


70°
60°
45°
AVERAGED
+15
+14
+13
+12
+11
+10
+9
+8
+7
+6
+5
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
Existing 1969 technique
TCG technique

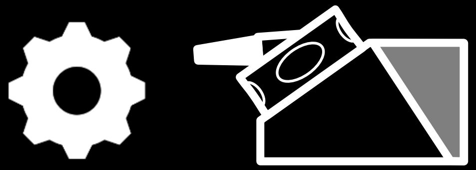
COMPARISON TO AWS

AWS D1.1-2015 : Annex Q

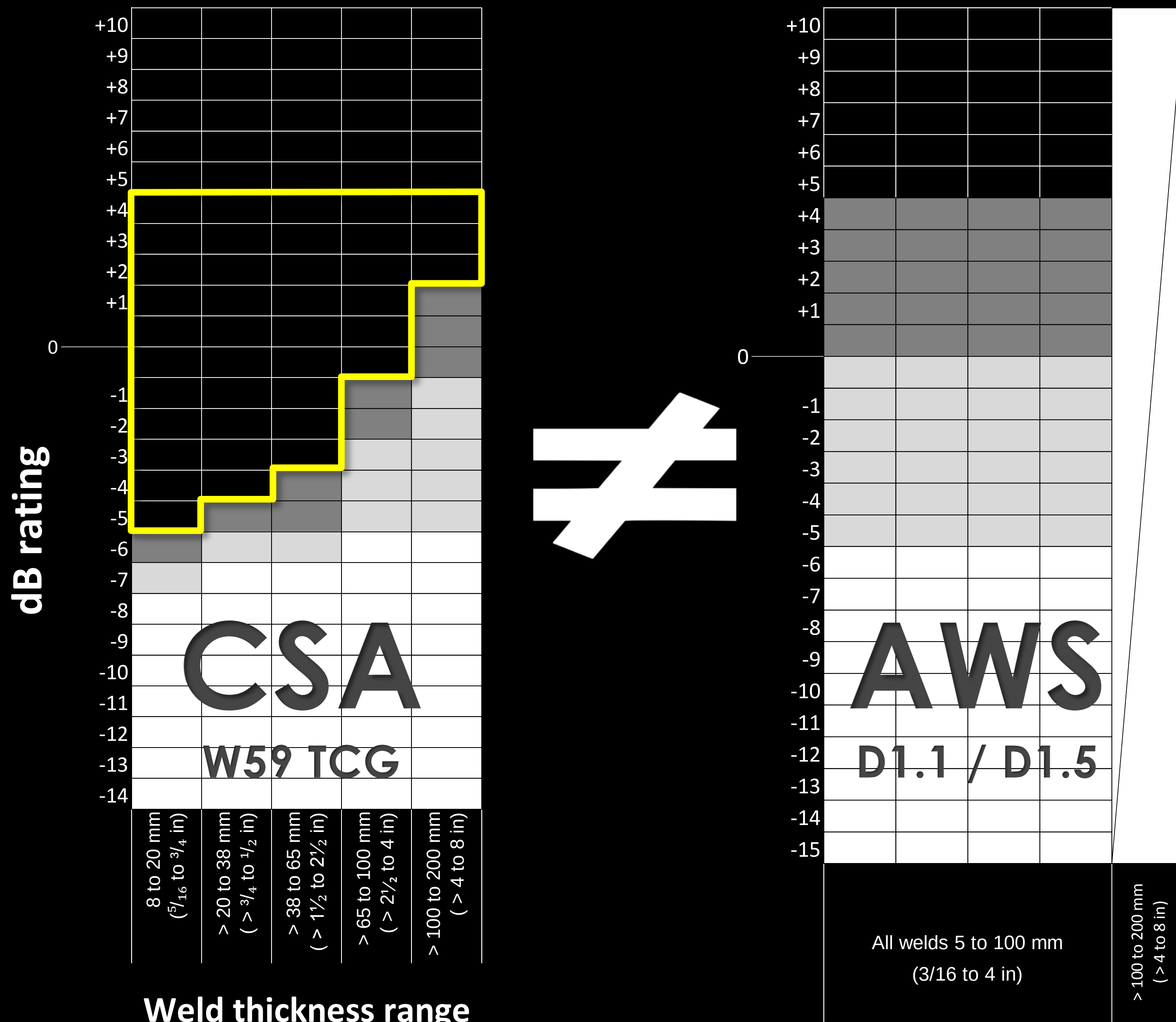


- Conventional UT with DAC calibration
- Transducers from ¼ in. diameter and up to 6 MHz

AWS D1.5-2015: Annex K



- Encoded PAUT with TCG calibration



dB rating
+10
+9
+8
+7
+6
+5
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
CSA
W59 TCG
8 to 20 mm (5/16 to 3/4 in)
> 20 to 38 mm (> 3/4 to 1 1/2 in)
> 38 to 65 mm (> 1 1/2 to 2 1/2 in)
> 65 to 100 mm (> 2 1/2 to 4 in)
> 100 to 200 mm (> 4 to 8 in)
Weld thickness range
≠
-15
AWS
D1.1 / D1.5
All welds 5 to 100 mm
(3/16 to 4 in)
> 100 to 200 mm
(> 4 to 8 in)

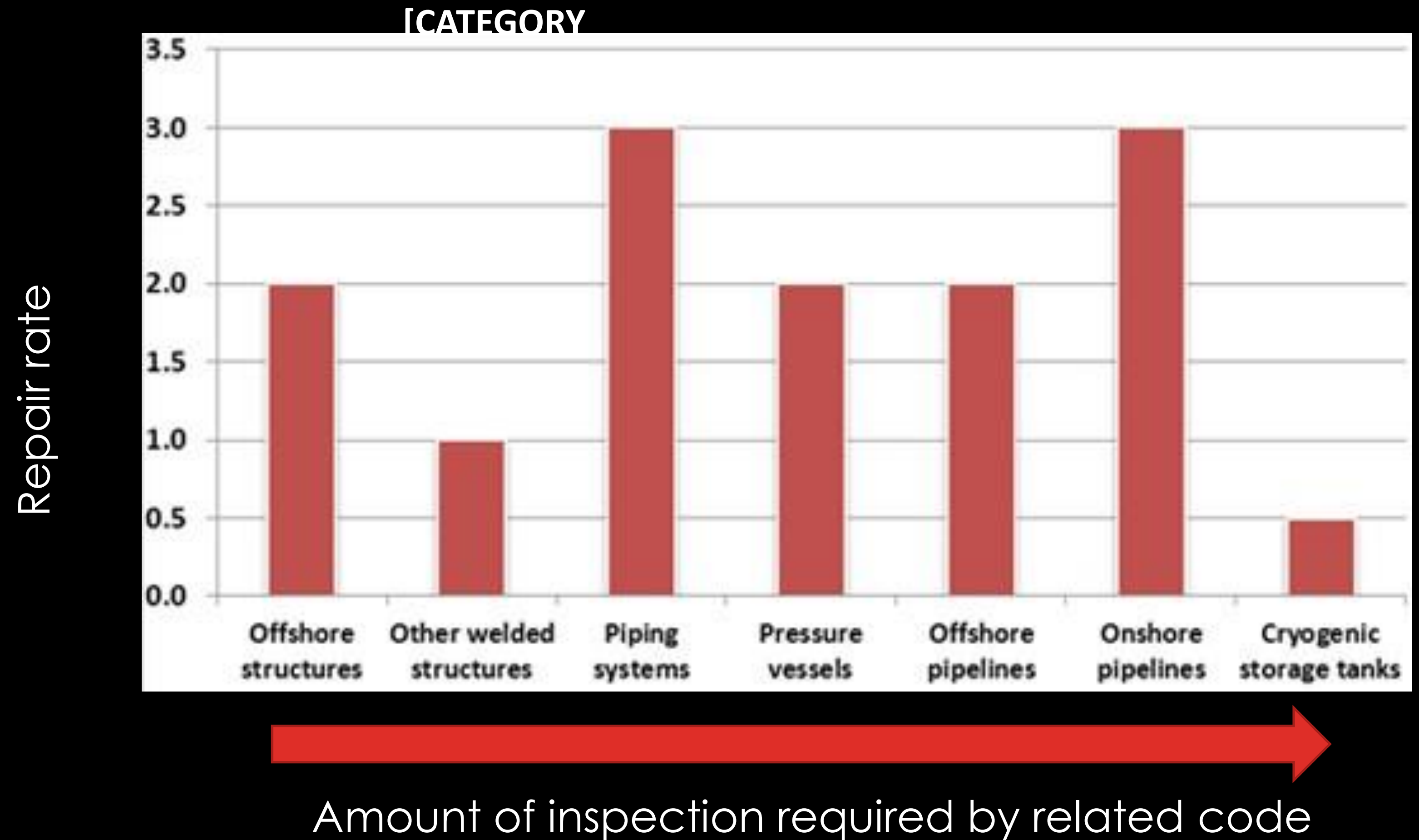
IMPACT ON PRODUCTION

- How to quantify costs?
- Repair rates?
- Experiment?

- FDOT Research Conclusion:

"…similar rejection rates seen for the three NDT techniques…"

IMPACT ON PRODUCTION



CONCLUSIONS

- Current technique unchanged since 1969
- Cannot adopt new technologies or practices
- Needed modern technique with flexibility
- Provide equivalent quality levels

These proposed changes to the code are currently in the public review stage

THANK YOU