TECHNICAL NOTE

Civil

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CCT 18-09

Calibration and Settings Ultrasonic Testing of Rail

AUDIENCE	MAIN POINTS	VERSION HISTORY
~ Civil Maintenance Engineer ~ Routine Maintenance Manager ~ Maintenance Superintendents ~ Track Supervisors ~ NDT operators	~ Defines annual, weekly and daily calibrations regime ~ Includes some tips to function check settings on site ~ Operators are to have on hand a register of starting settings	~ 1st Issue

1. Introduction

The technical note defines three levels of calibrations and settings done with manual ultrasonic test units in CRN.

The ultrasonic units used by JHR in CRN are *USM Go*, and *USM Go* + type. The USM units can have starting settings stored on an SD card in the unit which are then recalled for each probe used. Alternatively, the NDT operator can manually input the starting settings for each probe.

This technical note includes a requirement that operators tabulate the starting settings on a register. Operators can adjust settings to suit site conditions.

2. Calibration Regime and Settings Approach

Ultrasonic test units shall have the following calibration regime;

(i) Certificate of calibration - Annual
(ii) Detailed calibration/setting check - Weekly or before use whichever is the greater or where visual damage is noted
(iii) Daily condition and functional check - Daily or if site conditions or examination type changes

2.1 Certificate of calibration

This calibration is a completed in accordance with AS 2083 which confirms the internal accuracy of the unit against linearity criteria (CRN contract this test out to qualified expert NDT companies). There is no latitude, the unit must be calibrated before the expiry of the previous calibration. A calibration certificate and a calibration sticker on the unit are required. The annual calibration is not described in detail in this note.

The annual calibration certificate is to be kept with the unit.

2.2 Detailed calibration/setting check

The detailed calibration/setting check is conducted by an operator with the competency *TLIS 31010 - Test rail using ultrasonic equipment*, and is to test the probe function, including angles are within

tolerance, sensitivity, and probe delays, using standard calibration blocks to confirm starting settings for each probe are still correct or adjusted.

The detailed process for calibrating each probe with calibration blocks is covered in ultrasonic training and notes and is not reproduced here, a summary of the steps required are detailed below;

(i) Confirm that the annual calibration certificate and sticker are up to date
(ii) Confirm that a standard size defect generates a correct return signal in ideal conditions with the designated probes, the defect is a 1.5mm side drilled hole (SDH) at a specified depth in a test block. The depths from the top of the block for the respective probes are tabulated in *Table 1*.
(iii) Confirm that the sole, or shoe, of angled probes haven't worn to the point that the angle is out of tolerance. The angle tolerances for the respective probes are tabulated in *Table 1*.
Zero probe angle is assessed by visual examination only
(iv) Confirm that the probe delay is accurate, and that return signals give correct distances for the ranges appropriate for the task.

Probe	Depth of 1.5mm Diameter Side Drilled Hole (SDH)	Angle tolerance	Appropriate Range
0	50mm	0° ±2°	200mm
35	50mm	38° ±2°	200mm
70	25mm	70° ±2°	200mm

Table 1 – Test block calibration and angle tolerances

(v) Confirm that the starting settings in the unit are correct or updated for each probe used.

Operators must register and verify their starting settings on a register. The settings register shall be kept with the unit, along with annual calibration certificate. The Settings Register Form is in Appendix 1and is available electronically from the CRN Track Engineer, David Hyne. (David.hyne@jhg.com.au) until CRN CM 224 is updated.

Two starting sensitivities are recorded, a "scanning sensitivity" and an "evaluation sensitivity". Adjusting the gain to achieve 80% Full Screen Height (FSH) for the Side Drilled Hole depth specified will give evaluation sensitivity settings, adding 6dB Gain to that will give scanning settings. The starting sensitivities and probe angles measurement and tolerances required for weekly calibration are to be included in the register form

2.3 Daily condition and function check

The daily condition and function check is completed by the operator with the competency *TLIS 31010 - Test rail using ultrasonic equipment* and is a test to ensure that (a) there are no gross errors in settings, and (b) that the unit is functioning correctly with actual site surface conditions.

The starting settings as determined in the Detailed Calibration/Setting Check and give correct sensitivity for ideal conditions (clean steel surface, coupling fluid type etc), and are a good place to start, but are required to be verified or adjusted to suit conditions using the below checks.

Note
- *The Range can be adjusted to suit the rail dimension*
- *The Gain may be adjusted to suit coupling fluid, surface condition, and the operators' judgement of the signal being returned to the probe and should only be reduced below the starting settings if the operator is confident that conditions allow satisfactory defect detections. Any significant variation in the gain that the operator had to make to Gain settings should be noted on the examination documentation*

- *The probe delay settings should not typically vary from day to day, and minor tolerances (+/- 5%) won't affect the robustness of the examination for rail purposes.*

At the beginning of each day, and if site conditions or examination type changes, carry out the following checks;

(i) Confirm the register of starting settings is available and has been verified within the last week
(ii) Visual examination of probes and if applicable pogo sticks condition, to ensure they are suitable for use
(iii) Visual examination of cables and plugs
(iv) Complete function check and adjust if needed for the relevant probe. Adjust the settings to suit site conditions as outlined in the relevant section under section 2.3.1 below, and
(v) Record the daily condition and function check on either;
  a) The first examination works order of the day (if a scheduled ultrasonic examination);
  b) The first weld test return of the day; or
  c) Blank lines on the settings register (if doing an ad hoc examination)

2.3.1 Site function check, adjustment and tips for each probe

SEB 2-0 E probe ("Twin Zero"; "Big zero"; "Normal zero")

(i) Plug in, Turn on
(ii) Load pre-sets, or starting settings from the register
(iii) Adjust the range to suit rail dimensions to position the Back Wall Echo (BWE) in the right hand half of the screen, if 53kg rail is being examined, setting the range at 200mm will position the ~150-155mm BWE in the right hand half of the screen
(iv) Adjust the Gain based on assessment of rail surface condition and the quality of the visible BWE

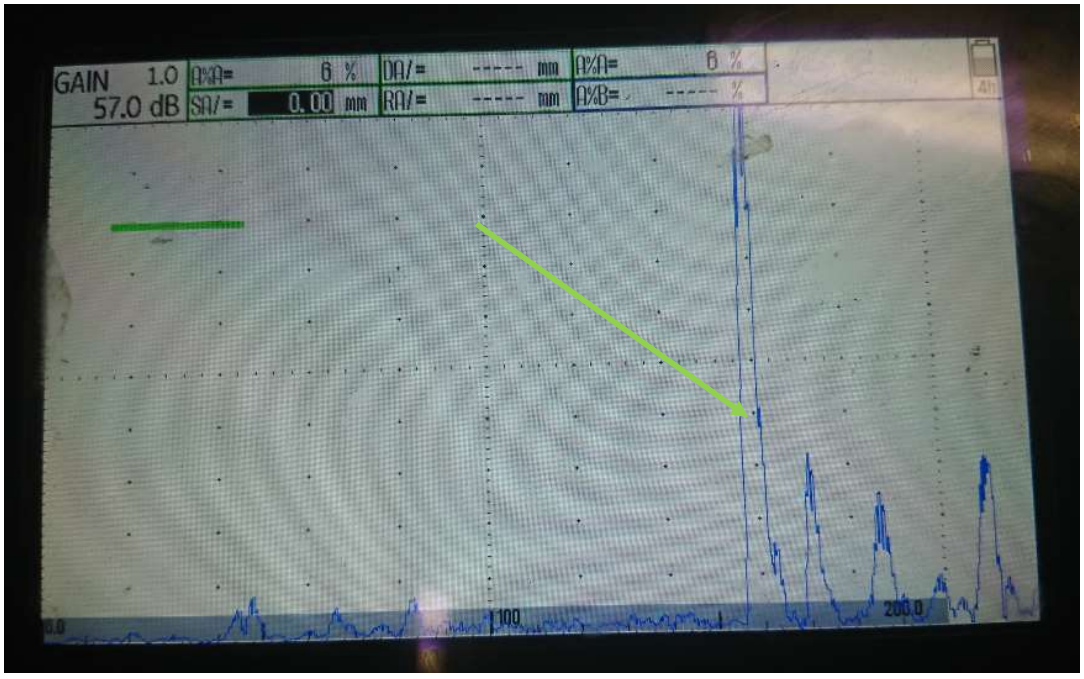

Figure 1 – Example of good BWE in defect free rail

Note

- *In defect free rail the BWE echo should correspond with the range scale as the depth of rail. BWE signal height should typically be at or above FSH height for scanning, and any loss of BWE below ~ 50% FSH requires assessment.*

WB 35-2 ("Normal 38°")

(i) Plug in, Turn on
(ii) Load pre-sets, or starting settings from the register
(iii) Adjust the Range and Gain based on the rail dimensions, examination purpose, rail surface condition and observation of the rolling signal corresponding to the base of the rail

Note

- *In defect free rail the range can be adjusted to position the return signal from a bolt hole at approximately one third of the way across the screen (figure 2). The sensitivity can be adjusted to ensure that a good "rolling" return signal is seen. It will be near the right hand edge of the screen, corresponding to the base of the rail, ~ approx. 190mm in 53kg rail (this will also be a double check of range).*

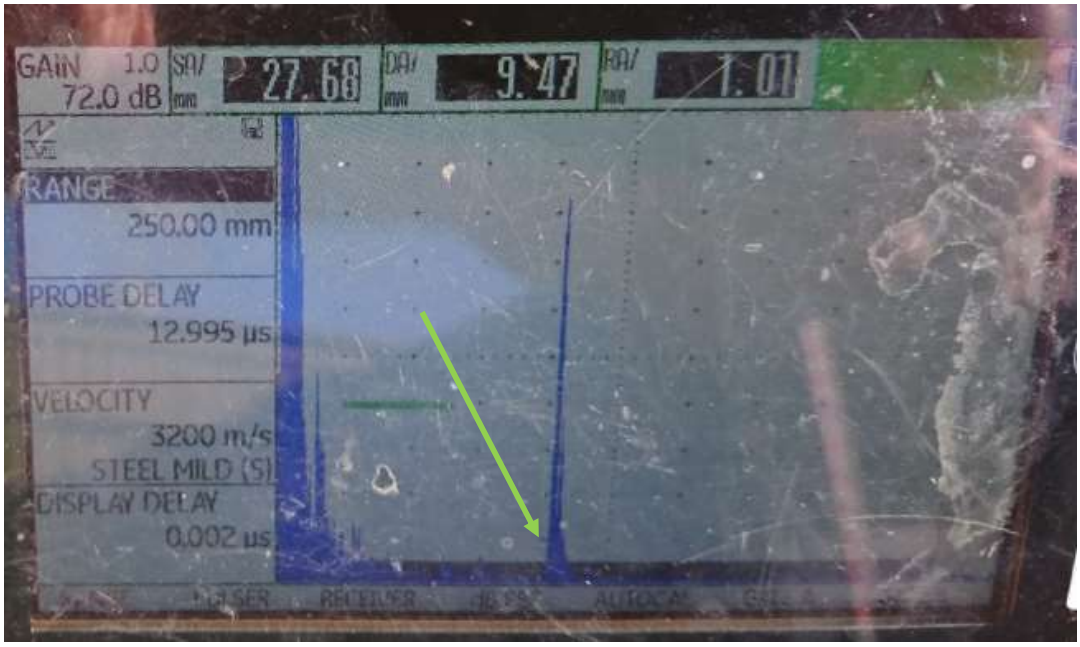

Figure 2 - *Appropriate positioning of bolt hole return signal with 35° probe*

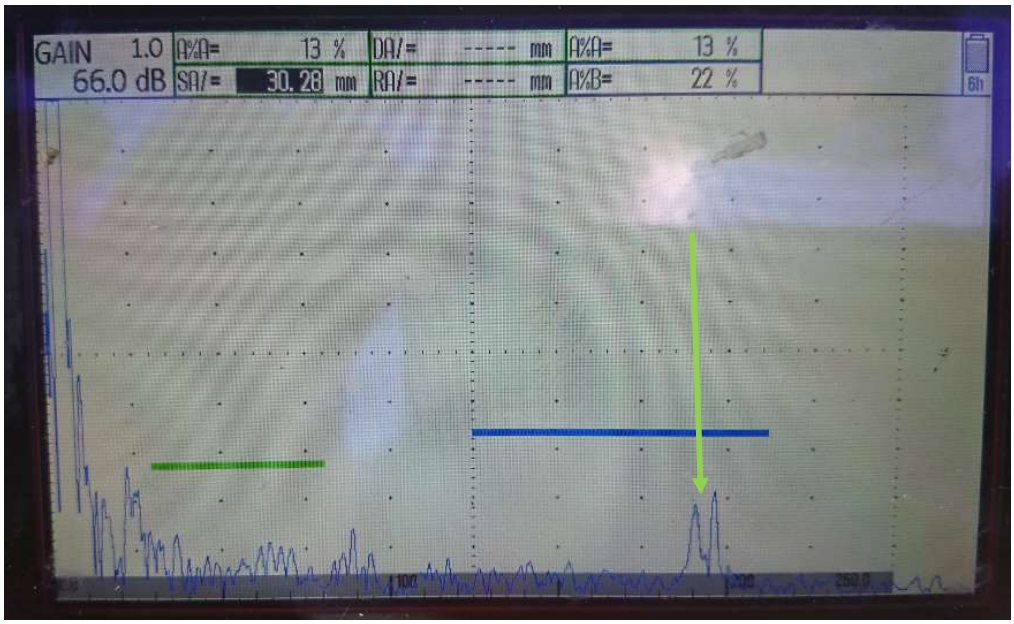

Figure 3 – Appropriate positioning of a "rolling" partial return from the rail base.

WB 70-2 ("Normal 70°")

(i) Plug in, turn on
(ii) Load pre-sets, or starting settings from settings register
(iii) The 70° probe should detect down far enough into the rail web to see a return signal from the top of a bolt hole. Do a check scan around bolt holes, the range can be adjusted to register the return signal from a bolt hole at the right hand edge of the screen, for example at ~ 200mm for 53kg rail. If the signal from the bolt hole is ~ 40-60%% FSH the sensitivity will be about right for scanning defects that occur between the rail surface and the bolt hole.

Figure 4 – Appropriate return signal position and strength from a bolt hole using 70 degree probe (53kg rail)

4.3.4 VS 70-04 (Mini zero; Single zero)

(i) Plug in, Turn on
(ii) Load pre-sets, or starting settings from the register
(iii) Set the range to suit the rail dimension being scanned (ie across head, or rail depth)
(iv) During the examination adjust the gain (sensitivity) based on surface condition and observation of reliable BWE.

Note
- *A common use of the mini zero probe is to scan across a rail head for VSH, a check scan across the rail head from a gauge face to the field face (or vice versa) should give a BWE at ~70mm in 53kg rail, and the return signal at about FSH, adjust the gain to achieve this for the rail surface conditions*

Figure 5 – *Check across rail head with mini zero*

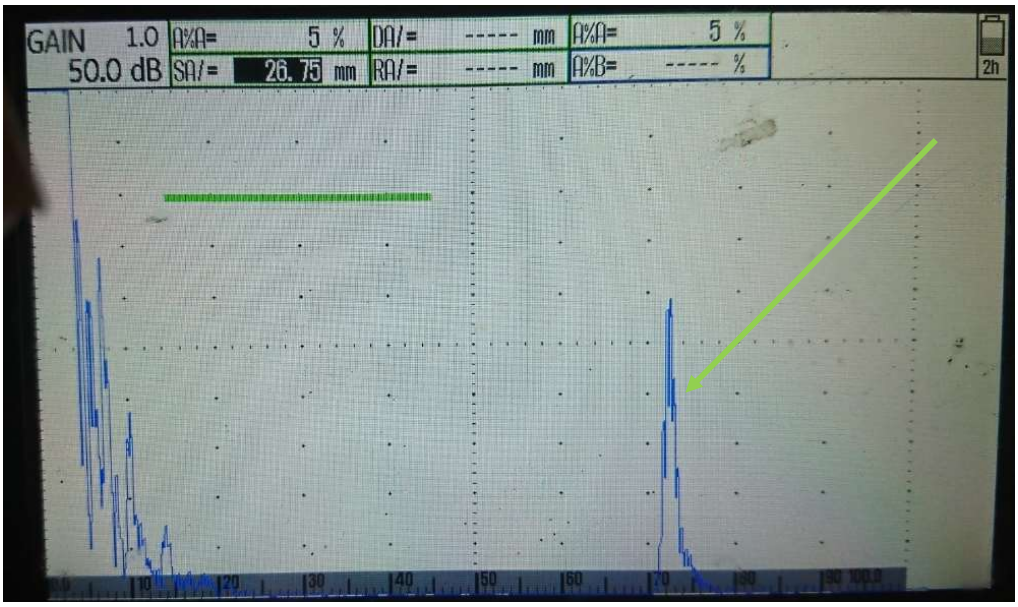

Figure 6 – Appropriate position of BWE from across a rail head (in this example the return signal is a little weak, consider increasing the gain to achieve 60-80% FSH, but balance that against seeing too much "grass")

MB4F-E (Twin 70)

(i) Plug in, turn on
(ii) Load pre-sets, or starting settings from the settings register
(iii) Set the Range to suit the dimensions of the examination
(iv) During the examination adjust the gain (sensitivity) based on surface condition or observation of return signal from a known edge such as the opposite rail foot, or a saw cut rail end.

Note
- *Make sure the rail surface is clean or brushed etc with plenty of coupling fluid; in defect free rail the return signal from the opposite rail foot should register a solid return signal at the correct range ie a signal ~ 70% FSH, at ~ 110mm for 53kg rail. This is not the correct examination, just a check measure.*

Figure 7 – Miniature 70 prob aimed across the rail foot as function check (note this is not the orientation of probe for weld foot check)

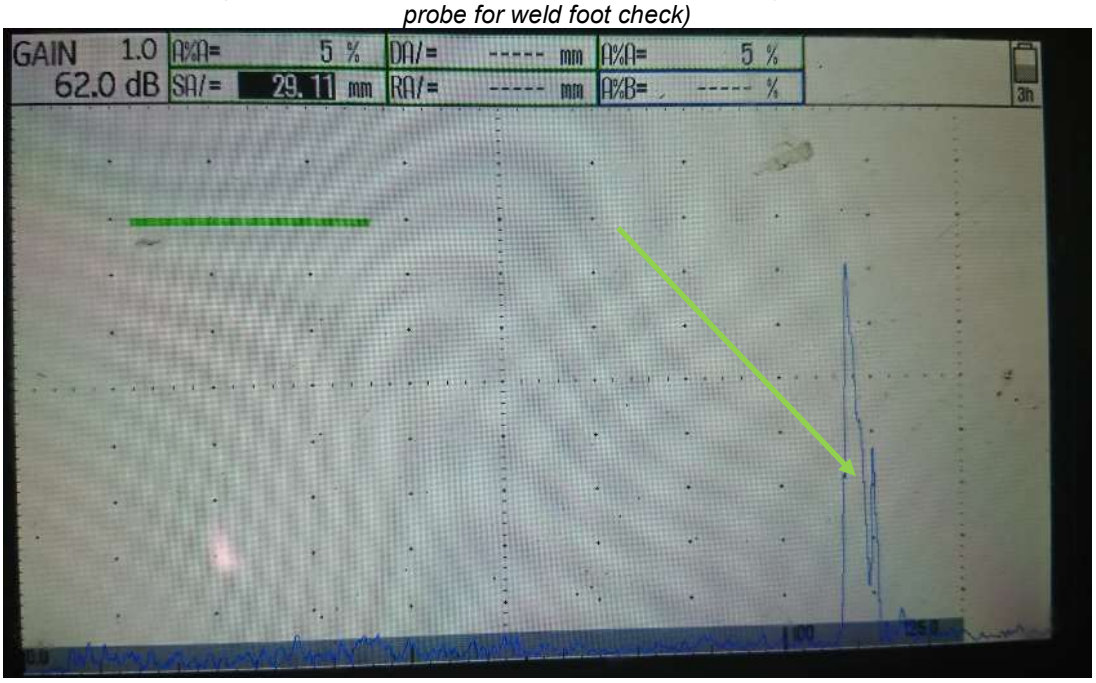

Figure 8 – A return signal from the above function check, corresponds with the opposite rail foot edge, ~110mm in 53kg rail, return signal a little weak in this photo, increase to say 80% FSH

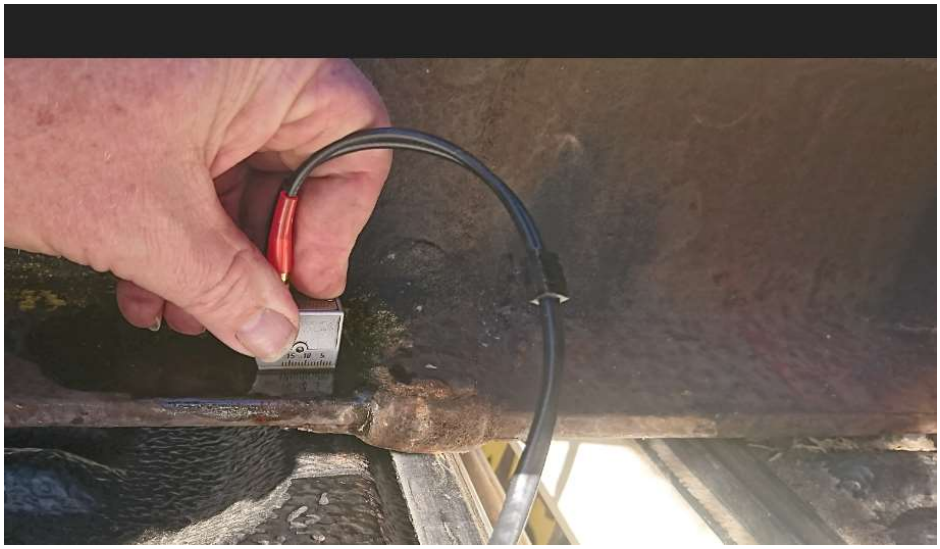

Figure 9 – Photo of correct orientation mini 70 toward weld

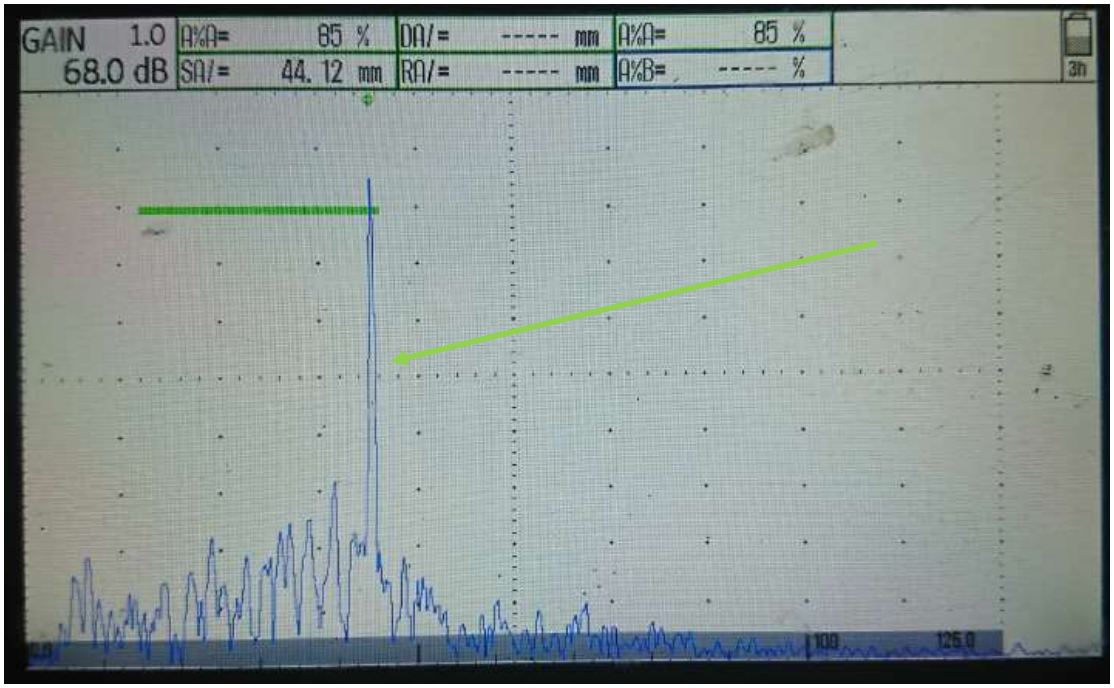

Figure 10 – An example signal showing possible defect in weld foot, any significant signal in the 30-50mm range should be reviewed.

Authorised for issue

Michael Wright

Principal Track & Civil Engineer

Appendix 1 Starting Settings Register

John Holland COUNTRY REGIONAL NETWORK

Ultrasonic Machine Starting Settings Register

Form USM 1
From CCT 18-12

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Annual Calibration Date:		**Settings check date:**	
Team:		**Serial number:**	
Operator:	Name	Signature	

Probe	Part No.	Probe Delay	Frequency	Dual *On/Off*	Velocity	Starting Range [2]	Starting gain (scanning)	Staring gain (evaluation)	Measured probe angle [1]	Angle tolerance
Hand held probe start settings										
0	SEB 2 0 E		2	On	5900					0° ±2°
35	WB 35-2		2	Off	3200					38° ±2°
70	WB 70-2		2	Off	3200					70° ±2°
0	MB4F		4	Off	5900					0° ±2°
70	VS 70-04		4	On	3200					70° ±2°
Pogo stick start settings										
0	SEB 2 0 E		2	On	5900					0° ±2°
35	WB 35-2		2	Off	3200					38° ±2°
70	WB 70-2		2	Off	3200					70° ±2°
Spare start settings										
Weekly detailed calibration/setting check – Date and initial when complete										

Comments

1. Zero probe angle is determined by visual assessment
2. Show most common range for mini probes