Requirements Fulfilled

MCCR shall perform inspection in a minimum rate (average) of 1.33 minutes per square meter	Mag Control Inspection Speed	This is equal to 0.042 m/s, for a 0.3 m scanning width. All the tests so far were done at higher speeds.
MCCR shall distinguish between internal and external pitting.	Pitting position	-
MCCR shall detect pitting at plates with minimum diameter of 10mm.	Minimal pitting diameter detection	Pitting size is only possible for pitting higher than 15 mm on far side. Pitting near side sizing needs to be better understood or supplemented using UT WT.
MCCR shall detect pitting at plates with minimum wall loss of 20%.	Minimal pitting depth detection	-
MCCR shall detect pitting corrosion.	Pitting position	Covered by the test cases showed before

Requirements Fulfilled (cont)

MCCR shall detect crack with different orientation	Crack Orientation	For cracks whose orientation is parallel to the sides of the plate, maybe it is possible to identify.
MCCR shall detect defects under uneven coating layers.	-	Tested During the conceptual phase

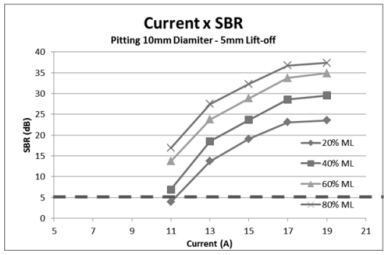
Minimal Pitting Depth at Welding Areas

Perpendicular Direction	The defect signal was superimposed with the weld signal
Transversal direction	Shows different pitting depths for a fixed gain of 34 dB for a defect found before the T-joint weld. It is possible to detect and differentiate pitting with 20% depth or more.
Parallel Direction (Along the weld)	The weld signal has not significant influences in the pitting signal

Minimal Pitting Diameter at Welding Areas

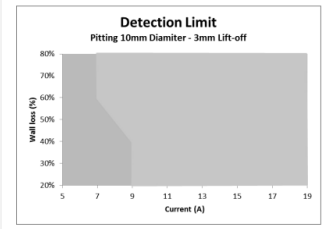
Perpendicular directions	The defect signal was superimposed with the weld signal
Transversal directions	Different pitting diameters for a fixed gain of 34 dB for a defect found before the T-joint weld
Parallel Direction (Along the weld)	The weld signal has not significant influences in the pitting signal

Minimal Pitting Diameter Detection



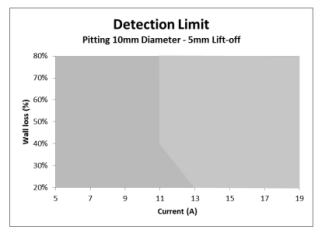
SBR evaluation for a 10 mm diameter pitting in different magnetization levels

Minimal Pitting Depth Detection (Case 01)



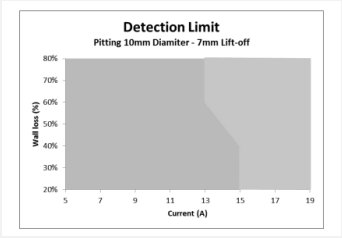
To check if the Mag Control can detect a pitting with 20% of thickness loss. Detection Limit Diagram for a 10 mm Pitting diameter using 3 mm of lift off.

Minimal Pitting Depth Detection (Case 02)



To check if the Mag Control can detect a pitting with 20% of thickness loss. Detection Limit Diagram for a 10 mm Pitting diameter using 5 mm of lift off.

Minimal Pitting Depth Detection (Case 03)



To check if the MAG Control can detect a pitting with 20% of thickness loss. Detection Limit Diagram for a 10 mm Pitting diameter using 7 mm of lift off.

Requirements Fulfilled with Restrictions

MCCR shall detect pitting at welding areas with minimum diameter of 10mm.	Minimal pitting diameter detection at welding areas	It is still an issue to distinguish the signal of the welding and the signal of the pitting on perpendicular direction. Only possible if the inspection is performed along the weld bead.

Requirements Fulfilled with Restrictions (cont)

MCCR shall detect pitting at welding areas with minimum wall loss of 20%.	Minimal pitting depth detection at welding areas	It is still an issue to distinguish the signal of the welding and the signal of the pitting on perpendicular direction. Only possible if the inspection is performed along the weld bead.
MCCR shall distinguish between internal and external cracks.	Crack Position	This requirement may be set as done. Although, cracks sometimes may be mistaken with pitting. It is necessary better understand the crack detection mechanism.

Requirements Fulfilled with Restrictions (cont)

MCCR shall detect cracks with minimum 4 mm depth.	Minimal crack depth detection	Detectable only when the crack is perpendicular to scanner movement. For cracks parallel to the scanner movement, a 4mm crack is difficult to detect.
MCCR shall detect cracks with minimum 60 mm length.	Minimal crack length detection	Detectable when the crack is perpendicular to scanner movement. Detectable for cracks parallel to the scanner movement and depth more than 40% of plate thickness. Vertical cracks were not tested yet. Even tough, it is unlikely to detect those cracks.

Requirements Fulfilled with Restrictions (cont)

MCCR shall categorize crack depth qualitatively [shallow (<25%), middle (>=25%, <=50%), deep (>50%)].	Crack depth differentiation	Only possible to distinguish for cracks at far side and orientation perpendicular to the scanner movement. Some of the tests indicate that MEC may not be able to distinguish the depth of the cracks when they are on the near side or at the same orientation than the scanner movement.

Requirements Fulfilled with Restrictions (cont)

MCCR shall size pitting corrosion.	-	For far side it is clear to size. However, the pitting sizing on near side is not clear for thick plates. Restriction for size pitting smaller than 20mm diameter
MCCR shall detect cracks.	-	The crack detection is strongly dependent of the crack orientation

Requirements Do Not Fullfill

MCCR shall detect pitting at plates with 80% Probability (PoD).	This requirements is an item pass criteria for the other tests cases	Test not completed. There is no PoD curve yet. The high value of SBR suggest the we will have a high POD value (more than 80%)

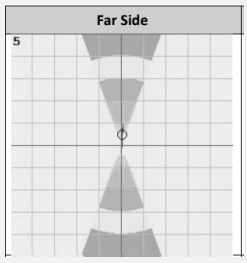
Requirements Do Not Fullfill (cont)

MCCR shall size depth of pitting with an accuracy of at least +/- 10% (at 80% certainty).	N/A	The accuracy was not calculated yet. Although, initially, the sizing of depth is not proportional and the error may be high.
MCCR shall detect cracks with 80% probability (PoD).	This requirements is an item pass criteria for the other tests cases	This requirements is an item pass criteria for the other tests cases

Pitting Position

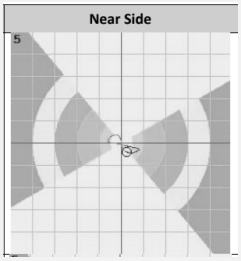
The Mag Control technique is able to distinguish between near side and far side defects according to the angle of the impedance signals.

Far Side Signal (Pitting and Crack Failure)



Oscillate along the vertical axis.

Near Side Signal (Pitting and Crack Failure)



Oscillate mostly horizontally.

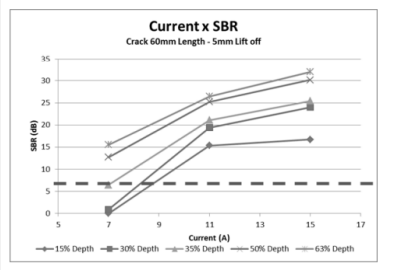
Minimal Crack Depth Detection

Perpendicular direction	The SBR analysis for different cracks depth when the scanning was performed perpendicular to crack orientation. For electrical currents higher than 11 amperes the SBR values found was more than 6 dB. Therefore, these conditions exhibit high detectability.
Tranversal direction	the detection of a crack of 4 mm depth on the far side is clear when the crack is transversal to the MEC movement.
Parallel direction	For that are cracks parallel to the scan was not possible to detect a 4 mm crack.

Minimal Crack legth Detection

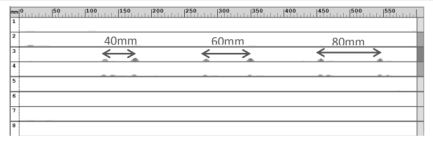
Perpendicular direction	Mag Control is able to detect cracks of 40 mm, 60 mm, and 80 mm length, whether far side or near side.
Tranversal direction	Mag Control is able to detect cracks of 40 mm, 60 mm, and 80 mm length, whether far side or near side.
Parallel direction	Mag Control is able to detect cracks of 40 mm, 60 mm, and 80 mm length, whether far side or near side.

Minimal Crack Depth Detection



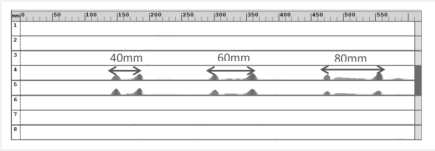
SBR evaluation for different crack depth using different magnetization levels (by electrical current application).

Minimal Crack Length Detection (Far Side)



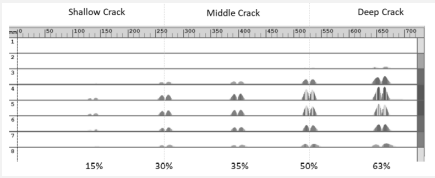
Mag Control scan parallels to the cracks of 40, 60 and 80 mm length on far side.

Minimal Crack Length Detection (Near Side)



Mag Control scan parallels to the cracks of 40, 60 and 80m length on near side

Crack Depth Differentiation (Far Side)



It is possible to distinguish between not only in 3, but also in 5 different levels of crack severity, according to their depths. Regarding the calibration, the shallow defects (<25%) would be represented in grey, the middle ones (≥25% and ≤50%), in green and blue, and the deep ones (>50%), in yellow and red.

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