Baker Hughes

6-30" MAGNESCAN Product Specification

High Resolution (HR): 6 – 30"
Super High Resolution (SHR)/Super High Resolution Plus (SHR+): 6 – 30"

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Revision History							
Rev.	Workflow #	Amendment Detail	Author	Approver	Approver	Approver	Effective Date
Current Revision							
2.0	Alfresco	"AXISS Axial Strain Measurement Detection and Accuracy" Table 30 added for AXISS Analytical Absolute Calibration product.	John Templey Mohamed ElSeify	Geoffrey Hurd	John Elliott	Anthony Tindall	01 Dec 2020
1.2	209539861	Minor edits	Emma Cribbs	Steve Farnie	John Elliott	Ben Scott	27 Jul 2020
Three Previous Revisions							
1.1	206917479	Minor edits following initial release	Emma Cribbs	Steve Farnie	John Elliott	Ben Scott	7 May 2020
1.0	206257851	Initial Release	Emma Cribbs	Steve Farnie	John Elliott	Ben Scott	9 Apr 2020

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General Tool Specifications

Table 1: Tool/ Sensor Information

	MFL 3.0	MFL 4.0
Primary Sensor Type	Axial MFL	Tri-Axial MFL
• Direction and polarity of magnetic field	Axial (Front: NORTH Rear: SOUTH)	Axial (Front: NORTH Rear: SOUTH)
• Minimum magnetic field strength at inner surface	Tool Specific	Tool Specific
• Type of magnet contact	Brush	Brush
• Circumferential center to center distance	Tool Specific	Tool Specific
• Axial sample interval	3.3mm	2mm
IDOD Sensor Type	Coil	Eddy Current
• Circumferential center to center distance	Tool Specific	Tool Specific
• Axial sample interval	3.3mm	2mm
Caliper sensor type[1]	Mechanical	Mechanical
• Circumferential center to center distance	Tool Specific	Tool Specific
• Axial sample interval	3.3mm	2mm
Mapping sensor type[1]	IMU	IMU
• Axial sample interval	100Hz	100Hz
Battery type	Tool Specific	Tool Specific
ATEX, IECEx, HAZLOC Compliant	ATEX Compliant	ATEX Compliant
Bi-directional Design	No	No
Active Speed Control	Tool Specific	Tool Specific

[1] *If available/ used on specific tool.*

All Specifications presented herein are derived assuming optimal inspection conditions as per Table 2 below. The pipe must also be sufficiently clean so as not to induce sensor lift-off or poor tool dynamics.

Table 2: Operating Conditions

	Imperial	Metric
Tool Speed Range for full performance specification	0.3 – 16.4 ft/s	0.1 – 5.0 m/s
Temperature range	–4° to 158°F	–20° to 70°C
Maximum pressure[2]	3190 psi	220 bar
Minimum pressure in gas pipelines	Tool Specific	
Maximum wall thickness	Tool Specific	
Acceptable Pipeline Product	Carbon steel pipelines for natural gas, oil, and refined products (other products may be acceptable)	

[2] *Maximum pressure for MFL3 6" to 22", and MFL4 6" to 10" is 150 bar (2176 psi).*

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MFL

Classification of Metal Loss Features

Table 3: Definition of Ranges of Geometrical Parameters for Each Classification of Metal Loss Features

Anomaly Dimension Classification	Definition	Reference point for the POD[3] in terms of L x W
General	{[W ≥ 3A] and [L ≥ 3A]}	4A x 4A
Pitting	{([1A ≤ W < 6A] and [1A ≤ L < 6A] and [0.5 < L/W < 2]) and not ([W ≥ 3A] and [L ≥ 3A])}	2A x 2A
Axial grooving	{[1A ≤ W < 3A] and [L/W ≥ 2]}	4A x 2A
Circumferential grooving	{[L/W ≤ 0.5] and [1A ≤ L < 3A]}	2A x 4A
Pinhole	{[0 < W < 1A] and [0 < L < 1A}	½A x ½A
Axial Slotting	{[0 < W < 1A] and [L ≥ 1A]}	2A x ½A
Circumferential slotting	{[W ≥ 1A] and [0 < L < 1A]}	½A x 2A
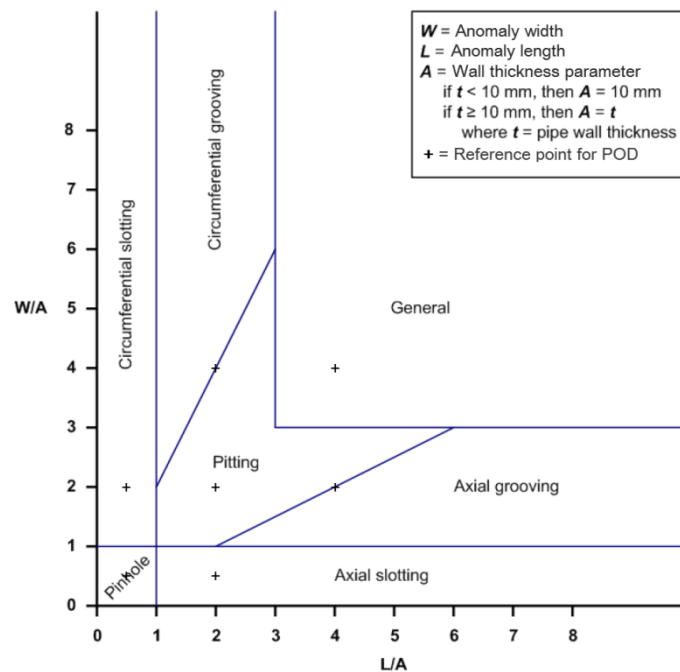
[3] POD = Probability of Detection (probability that a feature will be detected by an inspection tool).

Metal Loss Detection and Sizing Accuracy – High Res Spec (HR)
Body of Long Seam Pipe

Table 4: Detection and Manual Sizing Accuracy for Metal-Loss Anomalies in Body of Long Seam Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting

Minimum Dimensions for sizing accuracy[4]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	0.05t	0.08t	0.08t	0.05t	–	–	–
Depth sizing accuracy at 80% certainty	± 0.1t	± 0.1t	−0.15t +0.1t	−0.1t +0.15t	–	–	–
Width sizing accuracy at 80% certainty	± 0.8-in. ± 20 mm	± 0.8-in. ± 20 mm	± 0.8-in. ± 20 mm	± 0.8-in. ± 20 mm	–	–	–
Length sizing accuracy at 80% certainty	± 0.6-in. ± 15 mm	± 0.4-in. ± 10 mm	± 0.8-in. ±20 mm	± 0.8-in. ± 20 mm	–	–	–
Standard Reporting Threshold[5]				0.10t			

[4] For detection, dimensions are at the reference point as described in Table 3.
[5] Lower thresholds available.

Weld or Heat Affected Zone (HAZ) of Long Seam Pipe

The table below shows the cumulative change in standard performance specifications from the performance specification in body of long seam (as given in Table 4).

Table 5: Detection and Sizing Accuracy for Metal-Loss Anomalies in Weld or Heat Affected Zone (HAZ) [6] of Long Seam Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum Dimensions for sizing accuracy[7]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	Additional 0.04t	Additional 0.05t	Additional 0.05t	Additional 0.04t	–	–	–
Depth sizing accuracy at 80% certainty	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	–	–	–
Width sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	–	–	–
Length sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	–	–	–

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Length of weld affected area, upstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	–	–	–
Length of weld affected area, downstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	–	–	–

[6] *NOTE: Due to the unpredictable nature of welds in a pipeline, the MFL sensors dynamic ride characteristics while traversing a weld may affect detection and sizing. Typically this effect is limited to within ± 1.0-in. / 25mm of the weld.*

[7] *For detection, dimensions are at the reference point as described in Table 3.*

Body of Seamless Pipe

Table 6: Detection and Manual Sizing Accuracy for Metal-Loss Anomalies in Body of Seamless Pipe[8]

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum Dimensions for sizing accuracy[9]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	0.09t	0.13t	0.13t	0.09t	–	–	–
Depth sizing accuracy at 80% certainty	± 0.1t	± 0.1t	−0.15t +0.1t	−0.1t +0.15t	–	–	–
Width sizing accuracy at 80% certainty	± 0.8-in. ± 20 mm	± 0.8-in. ± 20 mm	± 0.8-in. ± 20 mm	± 0.8-in. ± 20 mm	–	–	–
Length sizing accuracy at 80% certainty	± 0.6-in. ± 15 mm	± 0.6-in. ± 15 mm	± 0.8-in. ± 20 mm	± 0.8-in. ± 20 mm	–	–	–
Standard Reporting Threshold[10]				0.1t			

[8] NOTE: Seamless pipe conditions which, due to the manufacturing process vary from location to location. As such, these specifications may be impacted by the level of noise observed in each section of seamless pipe. For low noise sections the results will not differ significantly from that of long seam pipe; however, in high noise sections the detection and sizing specification may increase.

[9] For detection, dimensions are at the reference point as described in Table 3.
[10] Lower thresholds available.

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Weld or Heat Affected Zone (HAZ) of Seamless Pipe

The table below shows the cumulative change in standard performance specifications from the performance specification in body of long seam (as given in Table 6).

Table 7: Detection and Sizing Accuracy for Metal-Loss Anomalies in Weld or Heat Affected Zone (HAZ) [11] of Seamless Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum Dimensions for sizing accuracy[12]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	Additional 0.09t	Additional 0.11t	Additional 0.11t	Additional 0.09t	-	-	-
Depth sizing accuracy at 80% certainty	Additional ± 0.05t	Additional ± 0.05t	Additional ± 0.05t	Additional ± 0.05t	-	-	-
Width sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	-	-	-
Length sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	-	-	-
Length of weld affected area, upstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	-	-	-
Length of weld affected area, downstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	-	-	-

[11]*NOTE: Due to the unpredictable nature of welds in a pipeline, the MFL sensors dynamic ride characteristics while traversing a weld may affect detection and sizing. Typically this effect is limited to within ± 1.0-in. / 25mm of the weld.*

[12] *For detection, dimensions are at the reference point as described in Table 3.*

Metal Loss Detection and Sizing Accuracy – Super High Res Spec (SHR)
Body of Long Seam Pipe

Table 8: Detection and Manual Sizing Accuracy for Metal-Loss Anomalies in Body of Long Seam Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum Dimensions for sizing accuracy[13]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	0.05t	0.08t	0.08t	0.05t	–	–	–
Depth sizing accuracy at 80% certainty	± 0.08t	± 0.08t	−0.13t +0.08t	−0.08t +0.13t	–	–	–
Depth sizing accuracy at 90% certainty	± 0.1t	± 0.1t	−0.15t +0.10t	−0.10t +0.15t	–	–	–
Width sizing accuracy at 80% certainty	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	–	–	–
Length sizing accuracy at 80% certainty	± 0.3-in. ± 7 mm	± 0.2-in. ± 4 mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	–	–	–
Standard Reporting Threshold[14]				0.10t			

[13] For detection, dimensions are at the reference point as described in Table 3.
[14] Lower thresholds available.

Weld or Heat Affected Zone (HAZ) of Long Seam Pipe

The table below shows the cumulative change in standard performance specifications from the performance specification in body of long seam (as given in Table 8).

Table 9: Detection and Sizing Accuracy for Metal-Loss Anomalies in Weld or Heat Affected Zone (HAZ) [15] of Long Seam Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum Dimensions for sizing accuracy[16]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	Additional 0.04t	Additional 0.05t	Additional 0.05t	Additional 0.04t	–	–	–

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Depth sizing accuracy at 80% certainty	Additional ±0.04t	Additional ±0.04t	Additional −0.03t +0.04t	Additional −0.04t +0.03t	−	−	−
Depth sizing accuracy at 90% certainty	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	−	−	−
Width sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	−	−	−
Length sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.3-in. ± 8 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	−	−	−
Length of weld affected area, upstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	−	−	−
Length of weld affected area, downstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	−	−	−

[15] NOTE: Due to the unpredictable nature of welds in a pipeline, the MFL sensors dynamic ride characteristics while traversing a weld may affect detection and sizing. Typically this effect is limited to within ± 1.0-in. / 25mm of the weld.

[16] For detection, dimensions are at the reference point as described in Table 3.

Body of Seamless Pipe

Table 10: Detection and Manual Sizing Accuracy for Metal-Loss Anomalies in Body of Seamless Pipe[17]

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum Dimensions for sizing accuracy[18]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	0.09t	0.13t	0.13t	0.09t	−	−	−
Depth sizing accuracy at 80% certainty	± 0.08t	± 0.08t	−0.13t +0.08t	−0.08t +0.13t	−	−	−
Depth sizing accuracy at 90% certainty	± 0.10t	± 0.10t	−0.15t +0.10t	−0.10t +0.15t	−	−	−
Width sizing accuracy at 80% certainty	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	−	−	−
Length sizing accuracy at 80% certainty	± 0.3-in. ± 7 mm	± 0.3-in. ± 7mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	−	−	−

Standard Reporting Threshold[19]	0.10t

[17] NOTE: Seamless pipe conditions which, due to the manufacturing process vary from location to location. As such, these specifications may be impacted by the level of noise observed in each section of seamless pipe. For low noise sections the results will not differ significantly from that of long seam pipe; however, in high noise sections the detection and sizing specification may increase.

[18] For detection, dimensions are at the reference point as described in Table 3.
[19] Lower thresholds available.

Weld or Heat Affected Zone (HAZ) of Seamless Pipe

The table below shows the cumulative change in standard performance specifications from the performance specification in body of long seam (as given in Table 10).

Table 11: Detection and Sizing Accuracy for Metal-Loss Anomalies in Weld or Heat Affected Zone (HAZ) [20] of Seamless Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole	Axial Slotting	Circ. Slotting
Minimum Dimensions for sizing accuracy[21]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	Additional 0.04t	Additional 0.05t	Additional 0.05t	Additional 0.04t	–	–	–
Depth sizing accuracy at 80% certainty	Additional ±0.04t	Additional ±0.04t	Additional −0.03t +0.04t	Additional −0.04t +0.03t	–	–	–
Depth sizing accuracy at 90% certainty	Additional ± 0.05t	Additional ± 0.05t	Additional ± 0.05t	Additional ± 0.05t	–	–	–
Width sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	–	–	–
Length sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	–	–	–
Length of weld affected area, upstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	–	–	–
Length of weld affected area, downstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	–	–	–

[20]NOTE: Due to the unpredictable nature of welds in a pipeline, the MFL sensors dynamic ride characteristics while traversing a weld may affect detection and sizing. Typically this effect is limited to within ± 1.0-in. / 25mm of the weld.

[21] For detection, dimensions are at the reference point as described in Table 3.

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Metal Loss Detection and Sizing Accuracy – Super High Res Plus Spec (SHR+)
Body of Long Seam Pipe

Table 12: Detection and Manual Sizing Accuracy for Metal-Loss Anomalies in Body of Long Seam Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole[22]	Axial Slotting[23]	Circ. Slotting[23]
Minimum Dimensions for sizing accuracy[24]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	0.05t	0.08t	0.08t	0.05t	0.15t	0.15t	0.05t
Depth sizing accuracy at 80% certainty	± 0.08t	± 0.08t	−0.13t +0.08t	−0.08t +0.13t	−0.13t +0.08t	−0.18t +0.08t	−0.08t +0.13t
Depth sizing accuracy at 90% certainty	± 0.1t	± 0.1t	−0.15t +0.1t	−0.1t +0.15t	−0.15t +0.1t	−0.2t +0.1t	−0.1t +0.15t
Width sizing accuracy at 80% certainty	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.3-in. ± 7 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm
Length sizing accuracy at 80% certainty	± 0.3-in. ± 7 mm	± 0.2-in. ± 4mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	± 0.2-in. ± 4mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm
Standard Reporting Threshold[25]				0.10t			

[22] Minimum width for sizing = 5mm. Depth spec valid for depths <=50%t. Depths spec for >50%t is 90% within −20/+10 (80% within −18/+8) in pipe body.
[23] Minimum width for sizing = 5mm.
[24] For detection, dimensions are at the reference point as described in Table 3.
[25] Lower thresholds available.

Weld or Heat Affected Zone (HAZ) of Long Seam Pipe

The table below shows the cumulative change in standard performance specifications from the performance specification in body of long seam (as given in Table 12).

Table 13: Detection and Sizing Accuracy for Metal-Loss Anomalies in Weld or Heat Affected Zone (HAZ) [26] of Long Seam Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole[27]	Axial Slotting[28]	Circ. Slotting[28]
Minimum Dimensions for sizing accuracy[29]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	Additional 0.04t	Additional 0.05t	Additional 0.05t	Additional 0.04t	Additional 0.05t	Additional 0.05t	Additional 0.04t

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Depth sizing accuracy at 80% certainty	Additional ±0.04t	Additional ±0.04t	Additional −0.03t +0.04t	Additional −0.04t +0.03t	Additional −0.05t +0.04t	Additional −0.04t +0.05t	Additional −0.04t +0.03t
Depth sizing accuracy at 90% certainty	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t
Width sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.4-in. ± 9 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm
Length sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.3-in. ± 8 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.3-in. ± 8 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm
Length of weld affected area, upstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm
Length of weld affected area, downstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm

[26] NOTE: Due to the unpredictable nature of welds in a pipeline, the MFL sensors dynamic ride characteristics while traversing a weld may affect detection and sizing. Typically this effect is limited to within ± 1.0-in. / 25mm of the weld.
[27] Minimum width for sizing = 5mm. Depth spec valid for depths <=50%t. Depths spec for >50%t is 90% within −25/+15 (80% within −23/+15) in vicinity of a weld/HAZ.
[28] Minimum width for sizing = 5mm.
[29] For detection, dimensions are at the reference point as described in Table 3.

Body of Seamless Pipe

Table 14: Detection and Manual Sizing Accuracy for Metal-Loss Anomalies in Body of Seamless Pipe[30]

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole[31]	Axial Slotting[32]	Circ. Slotting[32]
Minimum Dimensions for sizing accuracy[33]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	0.09t	0.13t	0.13t	0.09t	0.2t to 0.4t	0.2t to 0.4t	0.09t
Depth sizing accuracy at 80% certainty	± 0.08t	± 0.08t	−0.13t +0.08t	−0.08t +0.13t	−0.13t +0.08t	−0.18t +0.08t	−0.08t +0.13t
Depth sizing accuracy at 90% certainty	± 0.10t	± 0.10t	−0.15t +0.10t	−0.10t +0.15t	−0.15t +0.10t	−0.20t +0.10t	−0.10t +0.15t
Width sizing accuracy at 80% certainty	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm	± 0.5-in. ± 12 mm
Length sizing accuracy at 80% certainty	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm	± 0.3-in. ± 7 mm

[30] NOTE: Seamless pipe conditions which, due to the manufacturing process vary from location to location. As such, these specifications may be impacted by the level of noise observed in each section of seamless pipe. For low noise sections the results will not differ significantly from that of long seam pipe; however, in high noise sections the detection and sizing specification may increase.

[31] Minimum width for sizing = 5mm. Depth spec valid for depths <=50%t. Depths spec for >50%t is 90% within -20/+10 (80% within -18/+8) in pipe body.

[32] Minimum width for sizing = 5mm.

[33] For detection, dimensions are at the reference point as described in Table 3.

[34] Lower thresholds available.

Weld or Heat Affected Zone (HAZ) of Seamless Pipe

The table below shows the cumulative change in standard performance specifications from the performance specification in body of long seam (as given in Table 14).

Table 15: Detection and Sizing Accuracy for Metal-Loss Anomalies in Weld or Heat Affected Zone (HAZ) [35] of Seamless Pipe

	General	Pitting	Axial Grooving	Circ. Grooving	Pinhole[36]	Axial Slotting[3][7]	Circ. Slotting[3][7]
Minimum Dimensions for sizing accuracy[38]	W>3A L>3A	W>A L>A	W>A L>2A	W>2A L>A	W>0.5A L>0.5A	W>0.5A L>A	W>A L>0.5A
Depth at POD=90%	Additional 0.04t	Additional 0.05t	Additional 0.05t	Additional 0.04t	Additional 0.05t	Additional 0.05t	Additional 0.04t
Depth sizing accuracy at 80% certainty	Additional ±0.04t	Additional ±0.04t	Additional -0.03t +0.04t	Additional -0.04t +0.03t	Additional -0.05t +0.04t	Additional -0.04t +0.05t	Additional -0.04t +0.03t
Depth sizing accuracy at 90% certainty	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t	Additional ±0.05t
Width sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm	Additional ± 0.2-in. ± 4 mm
Length sizing accuracy at 80% certainty	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm	Additional ± 0.2-in. ± 5 mm
Length of weld affected area, upstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm
Length of weld affected area, downstream	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm	1.0-in. 25 mm

[35]NOTE: Due to the unpredictable nature of welds in a pipeline, the MFL sensors dynamic ride characteristics while traversing a weld may affect detection and sizing. Typically this effect is limited to within ± 1.0-in. / 25mm of the weld.

[36]Minimum width for sizing = 5mm. Depth spec valid for depths <=50%t. Depths spec for >50%t is 90% within -25/+15 (80% within -23/+15) in vicinity of a weld/HAZ.

[37] Minimum width for sizing = 5mm

[38] For detection, dimensions are at the reference point as described in Table 3.

Tool Over-Speed

In certain operational situations the MAGNESCAN inspection tools may operate beyond the recommended velocity range. If this occurs, there may be a change to the detection and sizing performance specifications is required. Revised detection and sizing specifications are tool specific and will be provided on request or as part of the inspection report.

Faulty Channels

In the situation where a sensor head is no longer functioning or is recording abnormal data there is an impact on the data on and near these faulty channels. Revised detection and sizing specification are tool specific and will be provided on request or as part of the inspection report.

90° Bends

The table below shows the minimum bend radius to achieve the normal specification in body of long seam (as given in Table 4).

Table 16: Detection and Sizing Accuracy in 90° Bends

	Minimum bend radius to achieve specification
Detection of metal loss anomalies	Minimum bend passing capability of the tool
Sizing accuracy for metal loss anomalies	Minimum bend passing capability of the tool

Crack Detection and Sizing Accuracy

Table 17: Detection and Sizing Accuracy for Crack or Crack-like Anomalies

	Axial Crack	Circumferential Crack	Spiral Crack
Depth at POD = 90% of crack with L=25 mm	n/a	n/a	n/a
Minimum crack opening (mm)	n/a	n/a	n/a
Depth sizing accuracy at 80% certainty	n/a	n/a	n/a
Length sizing accuracy at 80% certainty	n/a	n/a	n/a
Orientation limits (in degrees) for detectability	n/a	n/a	n/a

90° Bends
The table below shows the minimum bend radius to achieve the normal specification

Table 18: Detection and Sizing Accuracy in 90° Bends

	Minimum bend radius to achieve specification
Detection of crack like anomalies	n/a
Sizing accuracy of crack-like anomalies	n/a

Girth Weld & Spiral Weld Crack Detection and Sizing Accuracy

Table 19: Detection and Sizing Accuracy for Circumferential Cracks in the vicinity of GW and Spiral Weld Cracks

	Circumferential GW/Spiral Weld Crack
Depth at POD = 90% of GW crack with circ.width>1.97in./50mm	0.5t
Depth at POD = 90% of GW crack with circ.width>3.15in./80mm	0.3t
Minimum crack opening	0.1-in. / 0.25mm
Depth sizing accuracy at 80% certainty	±0.25t
Circ. Width sizing Accuracy at 80% certainty	± 0.98-in. / 25mm

MFL Deformation Detection and Sizing Accuracy[39]

Table 20: Detection and Sizing Accuracy for Dents

	Dent	Ovality
Depth at POD = 90%	>0.5%OD	n/a
Depth sizing accuracy at 80% certainty	n/a	n/a
Width sizing accuracy at 80% certainty	n/a	n/a
Length sizing accuracy at 80% certainty	n/a	n/a

[39] *This table refers to tools without mechanical calipers. For tools with mechanical calipers* see Table 21.

Geometry

This section applies when an inspection tool has been run with standard or high resolution (HR)calipers.

Standard calipers are provided with the CalScan platform, either as standalone or in combination with MagneScan (MFL3) or TranScan – subject to availability.

HR calipers are provided with the MagneScan (MFL4) platform

Sizing Methodology for Accuracy Reporting
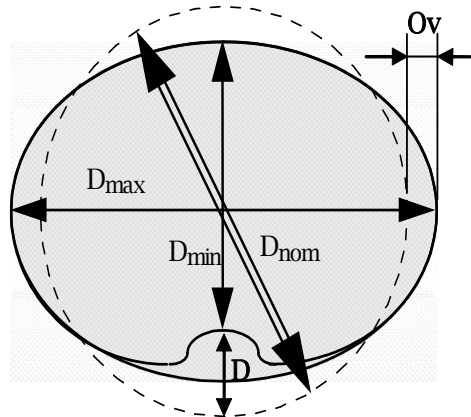
Various deformation definitions are available, however the below definitions are used for this specification.

$$\text{Dent Depth} = D_{nom} - D_{min} - O_v$$
$$\text{Ovality Depth} = D_{nom} - D_{min} - O_v$$
$$\text{Inward Wrinkle Depth} = D_{nom} - D_{min} - O_v$$

Where:

O_V	= pipe ovality = $(D_{Max} - D_{Nom})/2$
D_{Nom}	= inner nominal pipe diameter
D_{Min}	= inner pipe diameter at the feature
D_{Max}	= inner pipe diameter 90° from the feature
OD	= pipe diameter

The anomaly length is calculated as the axial distance over which the feature depth exceeds 50% of its peak value. Similarly, the width is the circumferential distance over which the dent depth exceeds 50% of the peak value.

Outward Wrinkle Depth = Maximum Peak to Trough Height
(within a single clock position, ie sensor)

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Standard Caliper Deformation Detection and Sizing Accuracy

Table 21: Detection and Sizing Accuracy for Dents & Buckles

Diameter / Tool	Depth at POD=90%	Standard Reporting Threshold[40]	ID Red. <10%		ID Red. >10%	
			Depth sizing accuracy at 80% certainty	Minimum Dent Width	Depth sizing accuracy at 80% certainty	Minimum Dent Width
10–12in.	1.2% OD	2.0% OD	±0.7%	2.0–in. 51 mm	±0.9%	5.2–in. 132 mm
14–22in.	0.8% OD	2.0% OD	±0.5%	2.6–in. 66 mm	±0.7%	1.8–in. 46 mm
24–30in.	0.6% OD	2.0% OD	±0.4%	4.6–in. 117 mm	±0.6%	4.0–in. 102 mm

[40] *Lower thresholds available.*

Table 22: Detection and Sizing Accuracy for Ovalities

Diameter / Tool	Depth at POD=90%	Standard Reporting Threshold[41]	Depth sizing accuracy @80% certainty		
			ID Red. <5%	ID Red. 5–10%	ID Red. >10%
10–12in.	1.0% OD	5.0% OD	±0.8%	±1.2%	±1.6%
14–22in.	0.8% OD	5.0% OD	±0.5%	±1.1%	±1.4%
24–30in.	0.6% OD	5.0% OD	±0.4%	±0.9%	±1.2%

[41] *Lower thresholds available.*

HR Caliper Deformation Detection and Sizing Accuracy

Table 23: Detection and Sizing Accuracy for Dents & Buckles

Diameter / Tool	Depth at POD=90%	Standard Reporting Threshold[42]	ID Red. <6%		ID Red. > 6%	
			Depth sizing accuracy at 80% certainty	Minimum Dent Width	Depth sizing accuracy at 80% certainty	Minimum Dent Width
6–in.	2.0% OD	2.0% OD	±1.3%	1.0–in. 25 mm	±1.6%	1.0–in. 25 mm
8–in.	2.0% OD	2.0% OD	±0.9%	1.0–in. 25 mm	±1.1%	1.0–in. 25 mm
10–in.	1.0% OD	2.0% OD	±0.9%	0.8–in. 20 mm	±1.1%	0.3–in. 20 mm
12–in.	1.0% OD	2.0% OD	±0.9%	0.8–in. 20 mm	±1.1%	0.3–in. 8 mm

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14-in.	1.0% OD	2.0% OD	±0.9%	0.8-in. 20 mm	±1.1%	0.3-in. 8 mm
16 to 22-in.	0.7% OD	2.0% OD	±0.44%	0.7-in. 18 mm	±0.6%	All
24 to 30-in.	0.6% OD	2.0% OD	±0.36%	0.7-in. 18 mm	±0.44%	All

[42] *Lower thresholds available.*

Table 24: Detection and Sizing Accuracy for Ovalities

Diameter / Tool	Depth at POD=90%	Standard Reporting Threshold[43]	Depth sizing accuracy at 80% certainty
6-in.	1.2% OD	5.0% OD	±1.4%
8-in.	1.0% OD	5.0% OD	±1.4%
10-in.	1.0% OD	5.0% OD	±1.4%
12-in.	0.8% OD	5.0% OD	±1.2%
14-in.	0.7% OD	5.0% OD	±1.2%
16 to 22-in.	0.6% OD	5.0% OD	±0.7%
24 to 30-in.	0.6% OD	5.0% OD	±0.7%

[43] *Lower thresholds available.*

90° Bends
The table below shows the minimum bend radius to achieve the normal specification

Table 25: Detection and Sizing Accuracy in 90° Bends

	Minimum bend radius to achieve specification
Detection of deformation anomalies	Minimum bend passing capability of the tool
Sizing accuracy of deformation anomalies	Minimum bend passing capability of the tool

Location

Table 26: Location Accuracy

	Accuracy (m) at 90% Certainty
Distance from pig trap valve (Axial location)	±1.0%
Distance to reference girth weld (feature-to-weld distance)	±3.9 -in. / ±100 mm
Circumferential position without IMU (Clock position)	±15°

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Mapping (Coordinates)

This section applies when an inspection tool has been run with Baker Hughes standard IMU (Inertial Measurement Unit) configuration. In some cases, trade compliance issues may require an alternative IMU be used and separate specification can be provided.

Table 27: Standard IMU Accuracy

Accelerometer accuracy (Bias repeatability)	300 µg to 3.0 milli-g, 1σ
Gyroscope accuracy (Bias repeatability)	1°/hr to 3°/hr, 1σ

Table 28: Horizontal and Vertical Accuracy of Pipeline Coordinates

Marker spacing interval	Location accuracy (x, y, z)	Certainty
0.62 mi / 1 km	± 3.3 ft / ± 1.00 m – using Marker magnets	90%
1.86 mi / 3 km or less	± 4.9 ft / ± 1.50 m – using Above Ground Markers	90%
1.86 mi / 3 km or greater	Marker spacing divided by 2000	90%

Unless Baker Hughes is specifically contracted to provide this service, the client will be required to conduct an above-ground pipeline mapping survey before an XYZ mapping inspection can take place. This must be performed in accordance with Baker Hughes' procedure for line marking (document ref: GLOBAL-E-W077, GPS Survey).

Bending

This section applies when an inspection tool has been run with an IMU (Inertial Measurement Unit) and inspection is subject to bending strain assessment. The specification below is only applicable to non-manufactured bends.

Table 29: Bend Detection and Accuracy

Bend at POD=90%	1.5° and 100D [44]
Bend Angle Accuracy at 80% certainty	± 0.1°
Bend Radius Accuracy at 80% certainty	± 0.04% strain

[44] *Lower detectable but generally considered a bending strain rather than a field bend.*

Axial Strain

This section applies when an inspection tool has been run with AXISS™ sensors (Axial Strain measurement)

Table 30: AXISS Axial Strain Measurement Detection and Accuracy

Axial Strain	MicroStrain	Percent
Axial Strain at POD=90%	200µε	0.02%
Axial Strain Accuracy at 80% Certainty When samples provided	±100µε	±0.01%
Axial Strain Accuracy at 80% Certainty When using Analytical Calibration Model	±(100µε + 15% of reported strain)	±(0.01% + 15% of reported strain)

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Temperature and Pressure

Table 31: Temperature and Pressure Accuracy

Temperature Accuracy	±2.7°F / ±1.5°C
Pressure Accuracy	± 0.10%

Probability of Identification (POI)

Probability of Identification (POI) is the likelihood of an anomaly or a feature, once detected, is classified correctly. Detection will depend on a number of factors including, but not limited to, dimensions (length, width), shape, feature interaction, pipe parameters and operating conditions.

Table 32: Probability of Identification

Feature	Yes POI > 90%	No POI < 50%	Maybe 50% ≤ POI ≤ 90%
Internal/ Non-Internal (External and Mid Wall) Discrimination	X		
External/ Mid Wall Discrimination		X	
Additional Metal/ Material:			
• Debris, magnetic	X		
• Debris, non-magnetic	X		
• Touching metal to metal	X		
Anode	X		
Anomaly			
• Arc strike			X
• Artificial defect	X		
• Buckle	X[45]		X[46]
• Corrosion	X		
• Corrosion cluster	X		
• Corrosion related to corrosion resistant alloy (CRA)		X	
• Crack (axially oriented)		X	
• Crack (circumferentially oriented)			X
• Crack cluster		X	
• Dent (dent-kinked)	X		
• Dent (dent-plain)	X		
Feature	Yes POI > 90%	No POI < 50%	Maybe 50% ≤ POI ≤ 90%
• Dent with metal loss (dent – smooth, dent – complex)	X		
• Gouge			X
• Gouge cluster			X
• Grinding			X
• Girth weld crack			X

Feature	Yes POI > 90%	No POI < 50%	Maybe 50% ≤ POI ≤ 90%
• Girth weld anomaly			X
• HIC		X	
• Longitudinal weld crack		X	
• Longitudinal weld anomaly		X	
• Mill anomaly (metal loss)	X		
• Mill anomaly (blister)		X	
• Mill anomaly (grinding)			X
• Mill anomaly (lamination)			X
• Mill anomaly (lap)			X
• Mill anomaly (non–metallic)			X
• Mill anomaly (roll mark)			X
• Mill anomaly (silver)			X
• Mill anomaly (cluster)	X		
• Ovality	X[45]	X[46]	
• Ripple/ wrinkle	X[45]		X[46]
• Roof topping		X[46]	X[45]
• SCC		X	
• Spalling		X	
• Spiral weld crack			X

Feature	Yes POI > 90%	No POI < 50%	Maybe 50% ≤ POI ≤ 90%
• Spiral weld anomaly	X		
Eccentric pipeline casing	X		
Change in wall thickness	X		
CP connection/ anode	X		
External support	X		
Ground anchor	X		
Off take	X		
Pipeline fixture	X		
Reference magnet	X		
Repair:			
• Welded sleeve	X		
• Composite sleeve		X	

Feature			
• Weld deposit			X
• Patch	X		
• Coating		X	
• Crack arrestor		X	
Tee	X		
Valve	X		
Weld:			
• Bend	X		
• Change in diameter	X		
• Change in wall thickness (pipe/pipe connection)	X		
• Adjacent tapering			X
• Longitudinal seam	X		

Feature	Yes POI > 90%	No POI < 50%	Maybe 50% ≤ POI ≤ 90%
• Spiral seam	X		
• Seamless	X		

[45] *Including high resolution calipers.*
[46] *Not including high resolution calipers.*