

# Ultrasonic Metal Welding – Quality Guidelines

## Ultrasonic Wire Splicing

**Correct Splicing:**

- Place the smallest wires on top. The wires must be stacked vertically.
- The wires must not be positioned randomly.

**Incorrect Splicing:**

- No bent strands longer than 1.5 mm.
- No missing strands (indicative of retracted wires).
- No molten wire insulation.
- Scorched or over-welded weld nugget must be released by supervisor.
- Only weld splices where all strands overlap are allowed.
- No unwelded strands. See "Broken strands guideline" below.
- No wire insulation in the weld transition area.
- Looped strands shall be pushed to the wire – clarify with supervisor.
- Broken or cut strands: See "Broken strands guideline" below.

## Ultrasonic Wire Termination

**Correct Termination:**

- Use terminals with a polished surface.
- Follow your internal guidelines on the weldability of the material because of aging and environmental factors.

**Incorrect Termination:**

- No upright single strands at the end of the weld brush that are longer than 2 mm.
- No noticeably projecting strands at the end of the weld brush.
- No collateral damage because of the terminal being welded.
- The weld nugget must not be shortened because of the wire placement under the horn.
- No damage to the wire insulation.
- No wire insulation in the weld.
- No uninsulated wire inside the insulation barrels.
- No broken wire insulation. No wires outside the insulation barrels.
- Scorched or over-welded weld nugget must be released by supervisor.
- No noticeable cracks or gaps in the weld nugget.
- No burr or flash that are higher than 0.5 mm.
- Terminal should extend min. 1.0mm on each side of the nugget.
- No unwelded strands. See "Broken strands guideline" below.
- No wire insulation in weld nugget.
- Looped strands shall be pushed to the wire – clarify with supervisor.
- No deformation of the terminal.
- No weld nugget outside the terminal.
- Broken or cut strands: See "Broken strands guideline" below.

**Correct Termination:**

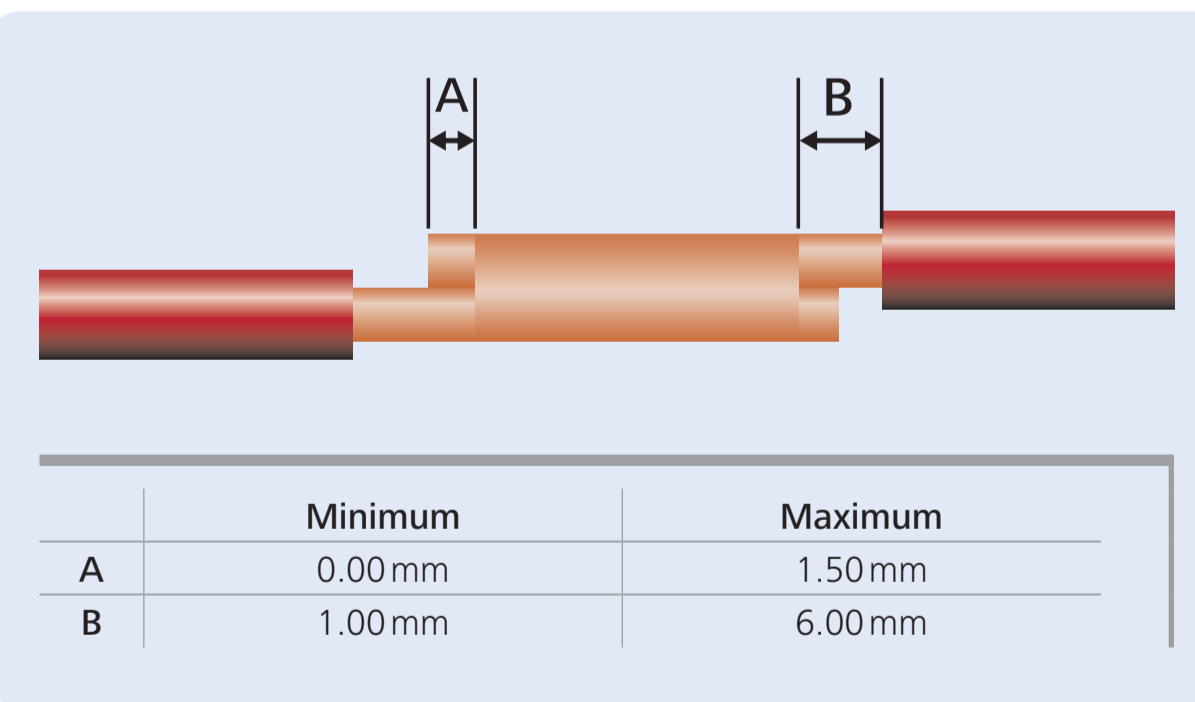
- An ideal weld. Place the smallest wires at the bottom.
- The strands must end between the two lines. If there are no lines, the strands must not disturb the function of the terminal connection.

**Incorrect Termination:**

- No wire insulation in the weld.
- No uninsulated wire inside the insulation barrels.
- No broken wire insulation. No wires outside the insulation barrels.
- No overlap of the insulation barrels.
- No folded back wires.
- No unwelded strands. See "Broken strands guideline" below.
- Only consistent anvil imprints at the bottom of the terminal allowed.
- Do not use wires with cut strands.
- Broken or cut strands: See "Broken strands guideline" below.

### WELD QUALITY GUIDELINE

Critical dimensions of a welded splice nugget



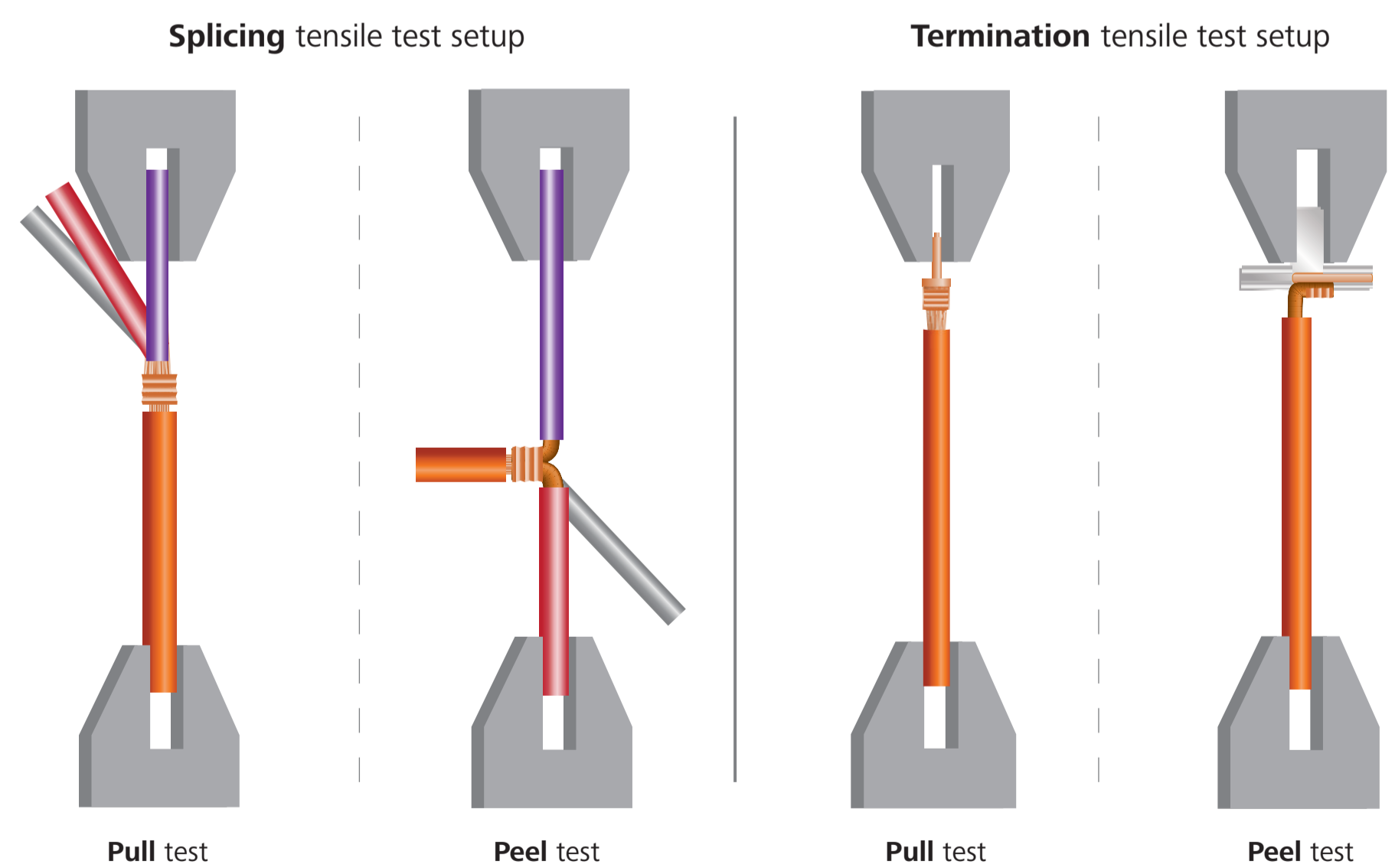
### BROKEN STRANDS GUIDELINE

Maximum allowed broken or missing strands for splicing & termination in production.

Strands of cable	Broken or missing allowed
1 to 7	0
8 to 19	1
20 to 37	2
38 or more	max 5% of total strands in splice

### TENSILE TEST METHODS & VALUES

SPlicing		
Copper Wire		
Wire Size [mm <sup>2</sup> ]	Pull Force [N]	Peel Force [N]
0.13	50	7
0.35	55	10
0.5	80	15
0.75	120	23
1	160	32
1.5	200	40
2	225	45
2.5	250	50
3	350	70
4	375	75
5	400	80
6	425	85
8	500	100
10	750	150
12	1000	185
14	1025	200
16	1050	210
18	1100	215
20	1200	235
25	1350	265
30	1500	290
35	1700	335
40	1850	365
50	2200	440



**Tensile test setup**  
Pull the smallest wire and hold the opposing individual wire/the terminal. For termination tensile tests use a specific fixture to hold the terminal. For multi-wire termination tensile test, it is preferred to pull and peel both the largest and smallest wire, from different samples. Termination peel test may also be carried out in 180 degree. The measured tensile value shall exceed the listed value per table.

**Mechanical strength test capability study**  
Short term:  $C_{95} \geq 1.67$  based on minimum of 50 samples  
Process:  $P_{95} \geq 1.67$  based on minimum of 125 samples  
Long term:  $C_{95} \geq 1.33$  based on minimum of 125 samples out of minimum 25 subgroups with minimum 3 samples each  
Typical values are shown. Other values may be used depending on project requirements.

TERMINATION				
Copper Wire				
Wire Size [mm <sup>2</sup> ]	Pull Force [N]	Peel Force [N]	Aluminum Wire	
			Pull Force [N]	Peel Force [N]
0.22	50	10	-	-
0.35	55	11	-	-
0.50	85	17	50	10
0.75	120	24	85	17
1	170	34	120	24
1.5	225	45	150	30
2	250	50	180	36
2.5	275	55	200	40
3	350	70	240	48
4	375	75	260	52
5	400	80	280	56
6	435	-	300	-
8	500	-	350	-
10	800	-	400	-
12	1000	-	450	-
14	1025	-	500	-
16	1050	-	550	-
18	1100	-	600	-
20	1200	-	650	-
25	1350	-	850	-
30	1500	-	1000	-
35	1700	-	1200	-
40	1850	-	1400	-
50	2200	-	1650	-
60	2200	-	1800	-
70	2400	-	1880	-
95	2650	-	2050	-
110	2800	-	2150	-
120	2900	-	2200	-

### WIRE SPECIFICATIONS

SAE AWG					ISO METRIC						
SAE AWG size	Min. Cross-Section Area [mm <sup>2</sup> ]	Strand count			ISO Metric size	Min. Cross-Section Area [mm <sup>2</sup> ]	ISO 6722-1 Strand count			ISO 19642-1 Strand count	
		Type A	Type B	Type C			Structure A	Structure B	Structure C	Standard	Flexible
26	0.127	7	19		0.13	0.127	7		19	7	19
24	0.205	7	19	41	0.22	0.203	7		19	7	30
22	0.345	7	19	37	0.35	0.317	7	12	19	7	19
20	0.543	7	19	41	0.5	0.465	7/19	16	26	19	37
18	0.779	19		41	0.75	0.698	19	24	38	19	38
					1	0.932	19	32	54	19	54
16	1.18	19		41	1.25	1.16	19	16	50	19	66
					1.5	1.36	19	30	76	19	76
14	1.88	19		105	2	1.83	19	28	105	19	105
					2.5	2.27	37	50	140	37	140
12	2.96	19	65	105	3	2.80	37	44	160	44	160
					4	3.66	37	56	224	56	224
10	4.73	19	105		5	4.38	37	65	250	70	250
					6	5.49	37	84	320	84	189
8	7.50	19	133		8	7.24	98	50	240	116	240
					10	9.47	63	80	320	144	320
6	12.4	37	133	280	12	11.3	154	96	380	174	380
					16	14.9	105	126	512	228	512
4	18.9	61	133	440	20	18.1	247	152	610	276	610
					25	23.2	154	196	790	355	790
					30	26.6	361	224	900	408	903
					35	32.7	551	276	1070	501	1102
					40	36.5	494	308	1200	558	1235
					50	47.8	798	396	1600	717	1600
					60	55.8	741	296	1200	838	1841
00	63.4	1254	1408		70	67.9	1140	360	1427	1019	2147
000	80.4		1760		95	89.7	836	475	1936	1347	3000
0000	104		2224		120	115	1064	608	2450	1726	3724

The above shown strand counts are common industry stranding. Other stranding configurations may be used depending on manufacturer.