TEST REPORT

No. : 42958

Client	**Electrical Safety Council** 1 – 10 Canterbury Court 1 – 3 Brixton Road London SW9 6DE
Client Contact	Mr Steve Curtler
Item/s tested	A selection of consumer unit main switches See the following pages of this report for details
Tested to	Investigation looking at the effect on the terminals of consumer unit main switches when the meter tails are disturbed using reference standard **BS EN 60947-1: 2007 + A1: 2011**
Date sample received	30th August 2011
Test Period	9th September to 5th October 2011
Date of Issue	7th October 2011
Tests carried out at	20 ± 5 º C
Testing Officer	*Giuseppe Capanna*
Verified by	*Bunmi Phillips*

Form No: QF102-5
Issue No: 2
Issue Date: 12.01.09

Report No:	**42958**
Client:	**Electrical Safety Council**

THIS REPORT APPLIES ONLY TO THE PARTICULAR SAMPLE UNIT(S) TESTED AND TO THE SPECIFIC TESTS CARRIED OUT AS DETAILED IN THIS REPORT.

Background

There is concern that when electricity meters are changed and meter tails are disturbed, the tightness of single screw terminal connections at the main isolator switches of consumer units can be adversely affected. There is also anecdotal evidence that when newly-made connections are revisited some time later, it is often possible to re-tighten them using the same torque as originally applied.
There are also concerns that seven-strand conductors are not particularly suitable for use with the type of terminal commonly found in some consumer unit main switches, the connections have a tendency to come loose if the cable is disturbed. At least one Meter Operator has now specified a more flexible cable that has 19 strands to provide a more reliable means of connection. This more flexible type of conductor is also commonly used for meter tails in other parts of Europe.

Objective

To assess the mechanical strength (tightness) of meter tail screw terminal connections typically found in consumer unit main switches following;

a) a period of time (24 hours) after initial termination of meter tails,

b) simulated disturbance of meter tails – to a degree foreseeable during a meter change, and

c) different cable end preparation – as dressed when insulation removed, and applying a tighter twist to, and flattening of, conductor strands.

Sample selection:

Three consumer units of different design incorporating mains switches with screw terminals of different type rated at 100 Amps, and designed to accommodate meter tails up to 25 mm^2 (samples 1-3)

Three consumer units of different design incorporating mains switches with screw terminals of different type rated at 60- 80 Amps, and designed to accommodate meter tails up to 25 mm^2 (samples 4-6)

Insulated and sheathed meter tails;

a) 16 mm^2 class 2, 7-stranded to BS 6004

b) 25 mm^2 class 2, 7-stranded to BS 6004

c) 25 mm^2 flexible class 5, 19-stranded to BS 6004

Test criteria

1. Each design of consumer unit to be tested with all classes and sizes of meter tail stated above in ‘Sample selection’.
2. Meter tails terminated into a mains switch are to be tightened to the manufacturers stated torque, or as tabulated in table 4 of BS EN 60947-1: 2007 + A1: 2011 where not available.
3. No additional support to be applied to the tails – other than that which may be provided by the cable entry point of the consumer unit enclosure.

Report No:	**42958**
Client:	**Electrical Safety Council**

Details of tests

Tails are to be re-terminated into the consumer main switch terminal prior to each test.

Test 1
Leave termination to settle for 24 hours. Apply procedures A and B below

Test 2
To simulate foreseeable movement of tails, the test procedure outlined in clause 8.2.4.3 'Testing for damage to and accidental loosening of conductors (flexion test)' of BS EN 60947-1: 2007 + A1: 2011 should be followed. The tail end should then be bent through 180 degrees (to form a loop) as if being prepared for termination into a meter. The loop should then be twisted through 45 degrees away from the mounting surface and returned to its original position. Apply procedures A and B below.

Test 3
Apply a tighter twist to the strands (two full twists by hand with pliers by hand in the direction of the manufactured twist of the strands) on the tails before termination. Apply test procedures A and B below.

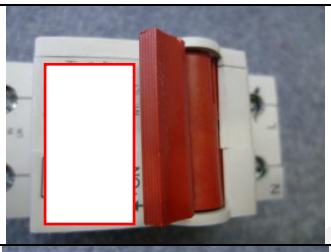
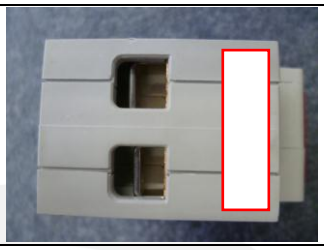
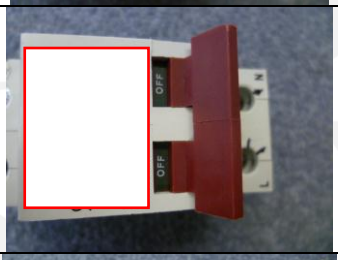
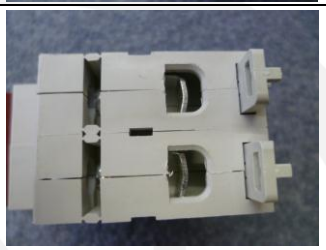
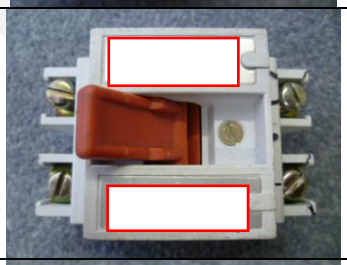
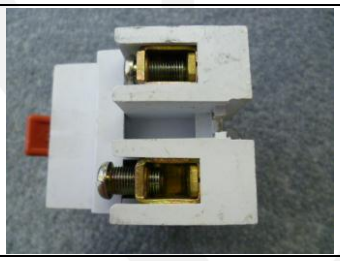
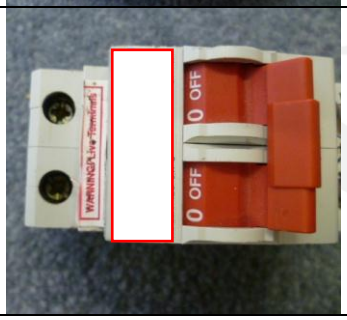
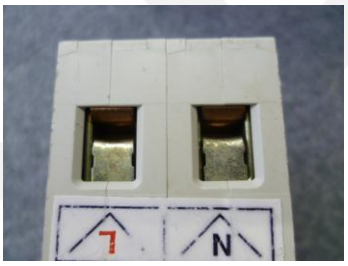
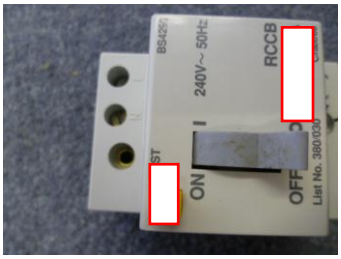
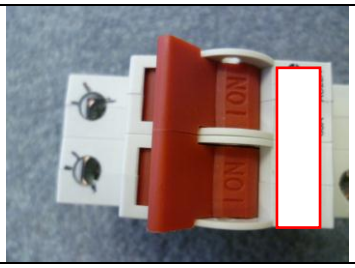
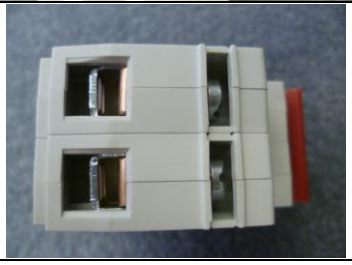
Test 4
The strands of the conductor shall be flattened (with pliers by hand) such that there is minimum displacement of the strands during tightening of the termination to the specified torque. Apply procedures A and B below.

Procedure A
The 'Pull-out test' given in clause 8.2.4.4 of BS EN 60947-1: 2007 + A1: 2011 shall be applied to the tails. Record the pull force taken to move and /or pull out the cable (where lower than Table 5).

Procedure B
Measure and record the movement, if any, of the terminal screw to reach the specified torque.

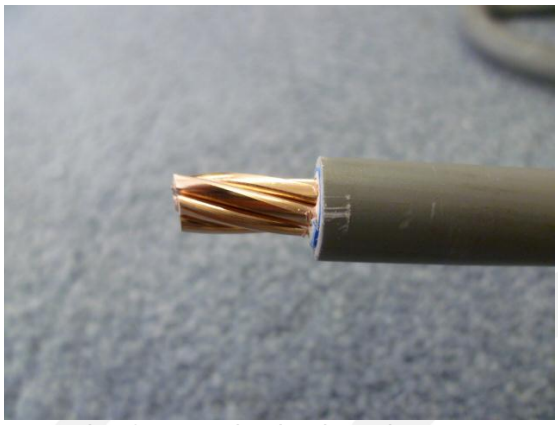
Report No:	**42958**
Client:	**Electrical Safety Council**

Sample Identification and applied torque values

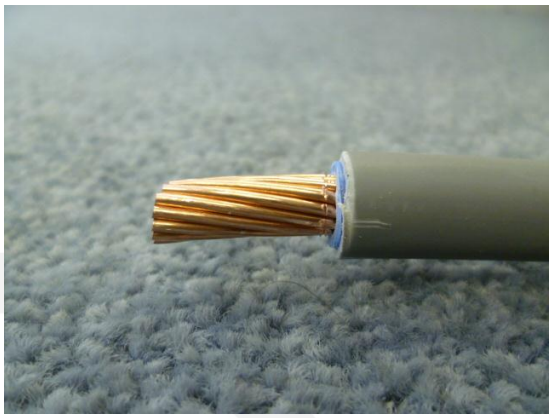
	Sample tested	Terminal type	Torque applied	Source of torque value
1			3Nm	Manufacturer Instructions
2			2.5Nm	BS EN 60947-1: 2007 + A1: 2011 table 4
3			3.5Nm	BS EN 60947-1: 2007 + A1: 2011 table 4
4			1.6Nm	Manufacturer Instructions
5			2.5Nm	BS EN 60947-1: 2007 + A1: 2011 table 4
6			2.3Nm	Manufacturer Instructions

Report No:	**42958**
Client:	**Electrical Safety Council**

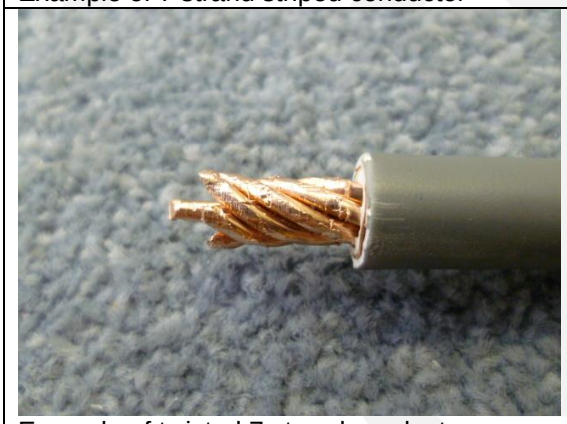
Photographs



Example of 7 strand striped conductor

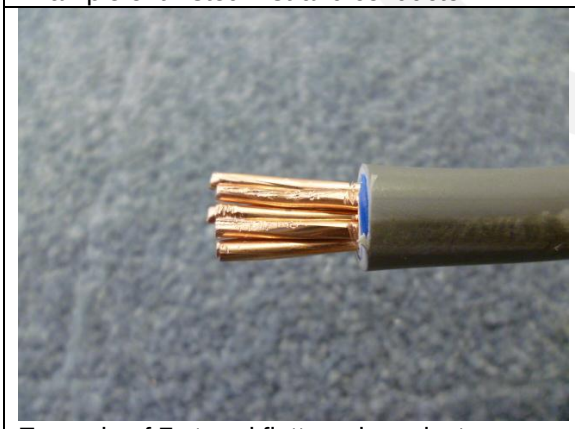


Example of 19 strand striped conductor

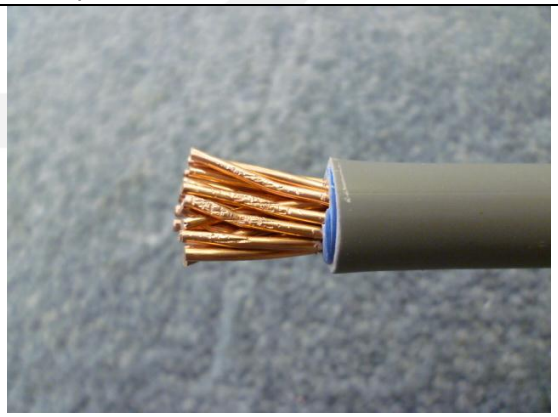


Example of twisted 7 strand conductor

Example of twisted 19 strand conductor



Example of 7 strand flattened conductor



Example of 19 strand flattened conductor

Report No:	**42958**
Client:	**Electrical Safety Council**

Results of tests

Test No 1					
Leave termination to settle for 24 hours. Apply procedures A and B					
Sample tested	**Pull Force applied**	**Meter Tail Type**	**Torque Applied**	**Conductor Movement**	**Screw Movement**
1	135N	25 mm^2 7-stranded	3Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	3Nm	<1mm	5°
	135N	25 mm^2 19-stranded	3Nm	<1mm	<1°
2	135N	25 mm^2 7-stranded	2.5Nm	Pulled out of Terminal	–
	100N	16 mm^2 7-stranded	2.5Nm	Pulled out of Terminal	–
	135N	25 mm^2 19-stranded	2.5Nm	<1mm	45°
3	135N	25 mm^2 7-stranded	3.5Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	3.5Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	3.5Nm	<1mm	<1°
4	135N	25 mm^2 7-stranded	1.6Nm	<1mm	30°
	100N	16 mm^2 7-stranded	1.6Nm	<1mm	30°
	135N	25 mm^2 19-stranded	1.6Nm	<1mm	5°
5	135N	25 mm^2 7-stranded	2.5Nm	<1mm	45°
	100N	16 mm^2 7-stranded	2.5Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	2.5Nm	<1mm	<1°
6	135N	25 mm^2 7-stranded	2.3Nm	<1mm	5°
	100N	16 mm^2 7-stranded	2.3Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	2.3Nm	Pulled out of Terminal	–

Report No:	42958
Client:	Electrical Safety Council

Test No 2

To simulate foreseeable movement of tails, the test procedure outlined in clause 8.2.4.3 'Testing for damage to and accidental loosening of conductors (flexion test)' of BS EN 60947-1: 2007 + A1: 2011 should be followed. The tail end should then be bent through 180 degrees (to form a loop) as if being prepared for termination into a meter. The loop should then be twisted through 45 degrees away from the mounting surface and returned to its original position. Apply procedures A and B

Sample tested	Pull Force applied	Meter Tail Type	Torque Applied	Conductor Movement	Screw Movement
1	135N	25 mm^2 7-stranded	3Nm	<1mm	15°
	100N	16 mm^2 7-stranded	3Nm	<1mm	15°
	135N	25 mm^2 19-stranded	3Nm	<1mm	30°
2	135N	25 mm^2 7-stranded	2.5Nm	Pulled out of Terminal	–
	100N	16 mm^2 7-stranded	2.5Nm	Pulled out of Terminal	–
	135N	25 mm^2 19-stranded	2.5Nm	Pulled out of Terminal	–
3	135N	25 mm^2 7-stranded	3.5Nm	<1mm	45°
	100N	16 mm^2 7-stranded	3.5Nm	1.8mm	30°
	135N	25 mm^2 19-stranded	3.5Nm	<1mm	<1°
4	135N	25 mm^2 7-stranded	1.6Nm	Pulled out of Terminal	–
	100N	16 mm^2 7-stranded	1.6Nm	Pulled out of Terminal	–
	135N	25 mm^2 19-stranded	1.6Nm	<1mm	45°
5	135N	25 mm^2 7-stranded	2.5Nm	<1mm	30°
	100N	16 mm^2 7-stranded	2.5Nm	<1mm	5°
	135N	25 mm^2 19-stranded	2.5Nm	<1mm	5°
6	135N	25 mm^2 7-stranded	2.3Nm	<1mm	30°
	100N	16 mm^2 7-stranded	2.3Nm	Pulled out of Terminal	–
	135N	25 mm^2 19-stranded	2.3Nm	Pulled out of Terminal	–

Report No:	**42958**
Client:	**Electrical Safety Council**

Test No 3

Apply a tighter twist to the strands (two full twists by hand with pliers by hand in the direction of the manufactured twist of the strands) on the tails before termination. Apply test procedures A and B

Sample tested	Pull Force applied	Meter Tail Type	Torque Applied	Conductor Movement	Screw Movement
1	135N	25 mm^2 7-stranded	3Nm	<1mm	15°
	100N	16 mm^2 7-stranded	3Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	3Nm	<1mm	15°
2	135N	25 mm^2 7-stranded	2.5Nm	<1mm	15°
	100N	16 mm^2 7-stranded	2.5Nm	<1mm	5°
	135N	25 mm^2 19-stranded	2.5Nm	<1mm	30°
3	135N	25 mm^2 7-stranded	3.5Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	3.5Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	3.5Nm	<1mm	<1°
4	135N	25 mm^2 7-stranded	1.6Nm	<1mm	15°
	100N	16 mm^2 7-stranded	1.6Nm	<1mm	5°
	135N	25 mm^2 19-stranded	1.6Nm	Pulled out of Terminal	–
5	135N	25 mm^2 7-stranded	–	Conductor would not fit in terminal	–
	100N	16 mm^2 7-stranded	2.5Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	–	Conductor would not fit in terminal	–
6	135N	25 mm^2 7-stranded	2.3Nm	<1mm	15°
	100N	16 mm^2 7-stranded	2.3Nm	<1mm	5°
	135N	25 mm^2 19-stranded	2.3Nm	<1mm	30°

Report No:	42958
Client:	Electrical Safety Council

Test No 4

The strands of the conductor shall be flattened (with pliers by hand) such that there is minimum displacement of the strands during tightening of the termination to the specified toque. Apply procedures A and B

Sample tested	Pull Force applied	Meter Tail Type	Torque Applied	Conductor Movement	Screw Movement
1	135N	25 mm^2 7-stranded	3Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	3Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	3Nm	<1mm	>1°<5°
2	135N	25 mm^2 7-stranded	2.5Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	2.5Nm	<1mm	>1°<5°
	135N	25 mm^2 19-stranded	2.5Nm	<1mm	<1°
3	135N	25 mm^2 7-stranded	3.5Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	3.5Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	3.5Nm	<1mm	<1°
4	135N	25 mm^2 7-stranded	1.6Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	1.6Nm	Pulled out of Terminal	–
	135N	25 mm^2 19-stranded	–	Conductor would not fit in terminal	–
5	135N	25 mm^2 7-stranded	–	Conductor would not fit in terminal	–
	100N	16 mm^2 7-stranded	2.5Nm	<1mm	<1°
	135N	25 mm^2 19-stranded	–	Conductor would not fit in terminal	–
6	135N	25 mm^2 7-stranded	2.3Nm	<1mm	<1°
	100N	16 mm^2 7-stranded	2.3Nm	<1mm	>1°<5°
	135N	25 mm^2 19-stranded	2.3Nm	<1mm	>1°<5°

Conclusions and observations

From the test results above it appears that disturbing the terminals of the main switch does cause a loosening of the terminal screw to a greater or lesser extent, possibly due to the individual conductor strands changing position relative to each other within the terminal space.

Flattening of the conductors appeared to improve the security of the conductor in the terminal, although there was the additional risk that terminals originally designed for 25mm^2 conductors would no longer accept this size of cable after the conductors had been prepared in this way.

Twisting the conductors lead to variable results along with the additional risk that terminals originally designed for 25mm^2 conductors would no longer accept this size of cable after the conductors had been prepared in this way.

It also appears that the older style of pillar terminal where the contact pressure is applied directly by the end of the screw were less prone to the conductor pulling out of the terminal following the tests.

Recommendations

It is recommended from the results obtained above; that the terminals at both ends of the meter tails are checked for tightness if the conductors are disturbed as in the case of a meter change.

********** END OF TEST REPORT **********