



PROJECT DELIVERABLE REPORT

INTEL-LINE

Work Package 5

Deliverable 5.1

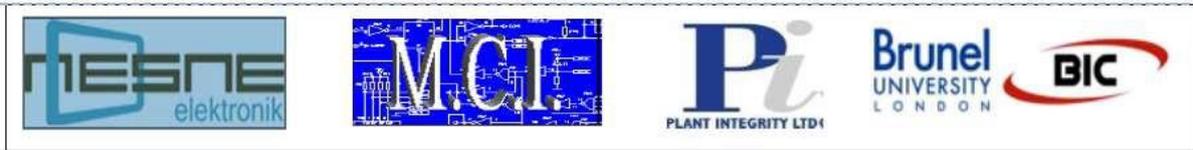
Intel-line System Certification

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1. Introduction

This report describes the activities carried out during the Intel-line project and all the documentation compiled in order to proceed with the European CE marking.

Members of the consortium conducted some of these activities while suppliers and companies external to the project conducted the rest. These activities are further detailed in the following sections.

2. High voltage testing

The high voltage testing was carried out early this year by the Offshore Renewable Energy Catapult (OREC) located in Blyth, UK. This was required to demonstrate that the entire system can withstand the conditions for which it has been designed for. More detailed information on this test is provided in D4.1.

2.1 Risk assessment

Although tests were carried by an external company, a risk assessment was prepared as part of the documentation required for CE marking. An example is shown in Figure 1.

Description of Task:		High Voltage Testing up to 400 KV for the IntelLine Project							
Name of COSHH MSDS where applicable:									
Significant Hazard and Adverse Effects	Person/ Equipment at Risk	Existing control measures	RISK RATING			Additional Action required (by whom & when)	REVISED RISK		
			C	L	Total		C	L	Total
Awareness of site specific hazards	Operator(s)	+ Operators will wear Personal Protective Equipment (PPE) specific to the task and mandatory site requirements.	4	2	8	Pre job site-specific safety induction/s and tool box talk to ensure operators are familiar with on-site requirements and emergency procedures. Tool box talk to be given by Offshore Renewable Energy Catapult staff.	4	1	4
Manual Handling	Operator(s)	+ Make full and proper use of aids for lifting and carrying. Two man lifts if required with heavy equipment. + Ensure personnel wear PPE appropriate to lifting task. Report any problems or concerns associated with manual handling operations to site contact.	3	1	3				
Slip/Trip and Falls	Operator(s) Other personnel in the vicinity	+ Beware of obstacles. + Remove loose objects from the work area if necessary. + Do not leave tools and equipment unsecured where they may fall or act as a trip hazard. + Ensure that work area is in a tidy state before leaving location.	3	3	9	Toolbox Talk at start of each shift with all relevant personnel. Dynamic risk assessments during inspection.	3	1	3
Injuries such as cuts due to Intel-Line system installation to cable	Operator(s) Other personnel in the vicinity	+ The system will be mounted to the cable and operated by qualified personnel only (Gergo Majo, Nikos Parasgoupolos and Kara Jolley).	1	2	2				
Risk of injuries due to cable transportation	Operator(s) Other personnel in the vicinity	The Aluminium Conductor Steel Reinforced cable has been secured with multiple cable ties. Two people at least will need to hold the cable down while a third person cuts the ties.	4	2	8	OREC staff will help with this task to ensure that the cable is released safely.	4	1	4
ENVIRONMENTAL SECTION									
Please put environmental data in this section such as spillages (including spill kits), discharge down drains, bunding and disposal methods.									
Notes									
Total Risk Rating Key:	1-4 LOW				No further action but ensure controls are maintained.				
	5-9 LOW - MEDIUM				Look to improve at next review.				
	10-16 MEDIUM				Look to improve within specified timescale.				
	17 - 25 HIGH				Stop activity, seek advice and make immediate improvements.				

Figure 1: Intel-line risk assessment for high voltage testing

2.2 Description of equipment

As previously described, the Intel-line system mainly consists of a collar populated with transducers, electronic boards (Lora and PR-PE), an energy harvesting regulator all enclosed in an encapsulation. Two types of system were subjected to four separate high voltage values: a mock-up (prototype) version of Intel-line and the full complete wireless version, manufactured as per the latest designs and system specifications (Figure 2).

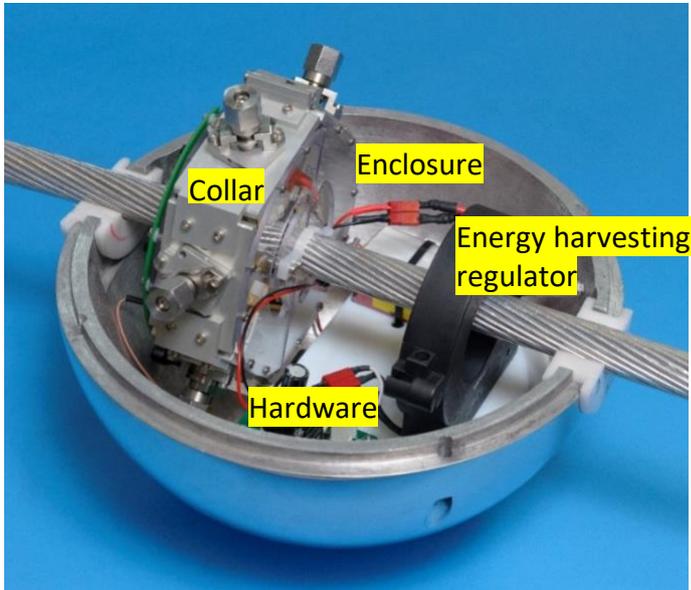


Figure 2: Full complete wireless Intel-line system

2.3 High Voltage test requirements

The test requirements were set following the BS EN standard 60060-1:2010:

- Tests were set at four high voltage values: 30kV, 138kV, 220kV and 400kV.
- Each high voltage test was to last 60 seconds as recommended in section 6.2.1.2 (Tolerances) of 60060-1:2010.

2.4 Test set-up

The experimental set-up was designed by the Intel-line consortium and executed by OREC as shown in Figure 3.

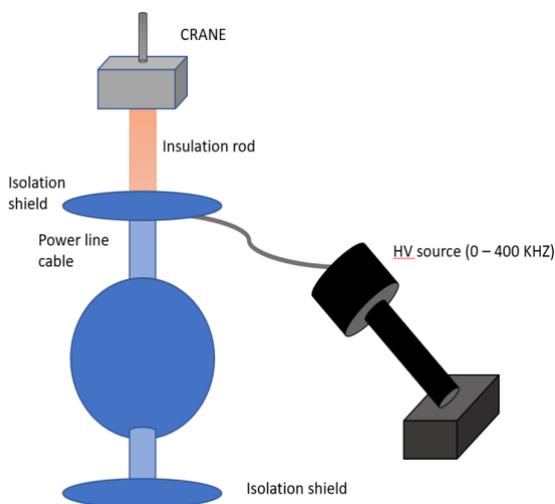


Figure 3 Test set up



2.5 HV Results

Tests were successful as shown in Figure 4. The criteria for "Pass Test Result" was record and display of ultrasonic signals before, during and after high voltage application. These signals are illustrated in Figure 5.

Test 1, Withstand/PD Test: Test Sphere 1
Background PD = 57pC

Voltage Level (kV)	PD (pC)	Test Result	Notes
30	62	Pass	LED flashing after test
138	90	Pass	LED flashing after test
220	1500	Pass	LED flashing after test
400	15000	Pass	LED flashing after test

Test 2, Withstand/PD Test: Test Sphere 2
Background PD = 57pC

Voltage Level (kV)	PD (pC)	Test Result	Notes
30	60	Pass	Comms working
138	62	Pass	Comms working
166	304	Pass	Comms working
220	8000	Pass	Comms working
355	135000	Fail	Comms failed
208	20000	Pass	Comms working
400	150000	Pass	Comms working

Figure 4 High voltage test results

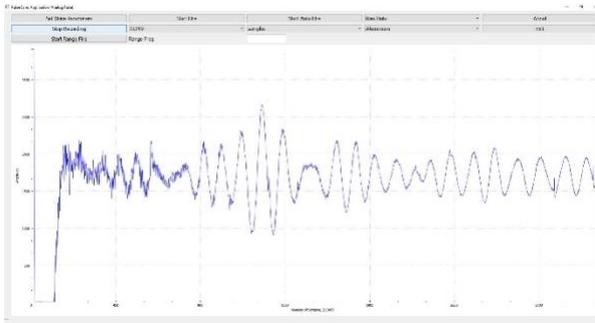


Figure 5 Pass test result for high voltage testing

In addition to report provided by OREC, an additional test record sheet was created for the project is part of the documentation compiled for the system certification. This record is listed in the Appendix A of this report

3. Lightning impulses tests

The risk assessment, equipment and test set up remain were the same as for the high voltage test. The "Pass test result" criteria were also the same as described in the section 2.5 but the test requirements were different.

3.1 Test requirement

Lightning impulse tests were conducted following Procedure A of section 7.3.1.1 (Withstand voltage test) from the BS EN standard 60060-1:2010, i.e. three lightning impulse tests were carried out at ± 600 kV and ± 1200 kV voltage levels using the 1.2uS/50uS impulses standard.

3.2 LI Results

The Intel-line system successfully passed the lightning impulses tests as shown in Figure 6 and Figure 7. The final report provided by OREC will be used to proceed with the certification, along with the Intel-line record sheet published in Appendix B.

Test 3, LI Test: Test Sphere 1

Number/Polarity	Peak Voltage (MV)	T1 (uS)	T2 (uS)	Test Result	Notes
1, Positive	1.187	1.16	52.2	Pass	LED flashing after test
2, Positive	1.196	1.17	52.8	Pass	LED flashing after test
3, Positive	1.201	1.18	52.8	Pass	LED flashing after test
1, Negative	1.192	1.11	51.8	Pass	LED flashing after test
2, Negative	1.206	1.12	52.5	Pass	LED flashing after test
3, Negative	1.206	1.12	52.5	Pass	LED flashing after test

Test 3, LI Test: Test Sphere 2

Number/Polarity	Peak Voltage (MV)	T1 (uS)	T2 (uS)	Test Result	Notes
1, Positive	1.185	1.14	52.2	Pass	Comms working
2, Positive	1.204	1.18	52.8	Pass	Comms working
3, Positive	1.204	1.18	52.8	Pass	Comms working
1, Negative	1.21	1.12	52.4	Pass	Comms working
2, Negative	1.205	1.13	52.4	Pass	Comms working
3, Negative	1.202	1.13	52.5	Pass*	Comms working

* Note: After the 3rd negative impulse communication was lost with the test sphere but was regained after the system was reset.

Figure 6 Lightning impulses test results

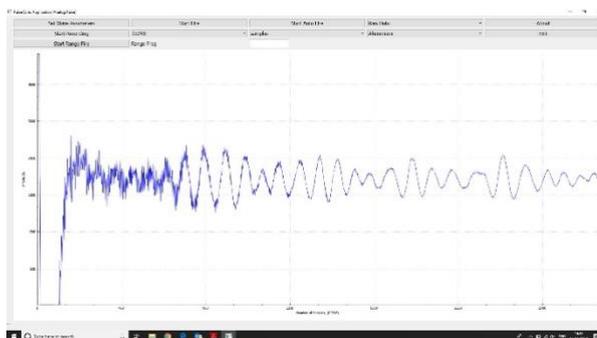


Figure 7 Pass test result for lightning impulses test

4. Corona discharge

Corona discharge was also investigated. Figure 8 shows how the system encapsulation was free of corona discharge during the HV test, while there was some discharge in the power line cable and both top and bottom shields.



Figure 8 Corona discharge results

5. High Current Testing

High current tests were carried out on the Intel-line system. The system successfully passed the tests in accordance with the following criteria:

- Check the high level AC (50Hz) magnetic field produced by the AC current (1500Amps rms) does not interfere with the Ultrasonic transmission / reception and Lora system
- Check that the high level AC (50Hz) magnetic field produced by the AC current (1500Amps rms) does not produce heating due to induction in the ultrasonic
- Check that the high level AC (50Hz) magnetic field produced by the AC current (1500Amps rms) does not produce heating due to induction in the cast aluminium enclosure.

6. Certificates of conformity

6.1 Transducers

The Intel-line transducers are manufactured by a company called EddyFi. Each batch of transducers is delivered with a copy of the certificate of conformity (Figure 9), which lists the required tolerance range for signal amplitudes (mV) and capacitance range (pF). This certificate will also be part of the documentation pack prepared for the certification process.

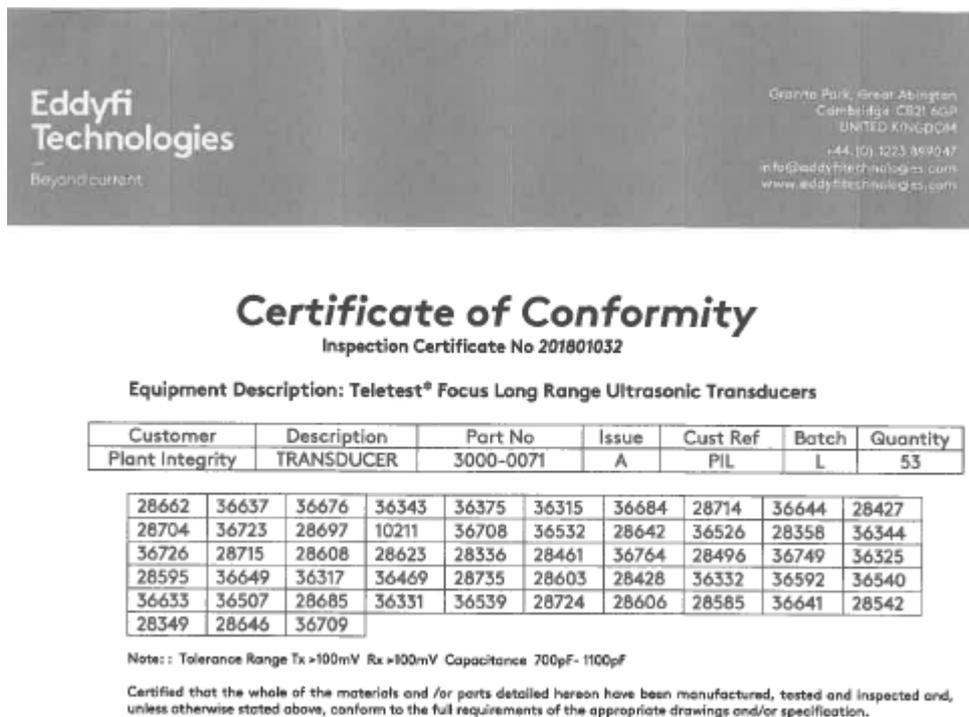


Figure 9 Certificate of conformity for Intel-line transducers

6.2 Hardware

The electronic board (Lora, PR-PE) and energy harvesting regulator are made of more than 100 components. Each of these has their own certificate of compliance available on demand. These certificates will also be part of the documentation pack for the certification process. These items are further described in the deliverable 3.2.

7. EMC testing

The ElectroMagnetic Compatibility (EMC) testing demonstrates that a piece of equipment will not cause electromagnetic disturbances and will keep operating successfully near other electromagnetic equipment. The Intel-line system is currently being subjected to the pre-requisites of this test at Plat Integrity facilities, which results will confirm the likelihood of the system passing the tests.

8. Conclusion

The consortium carried out a series of tests toward the certification process of the Intel-line system. The consortium started a documentation pack which will support the CE marking process. These documents are:

- Test results/reports from manufacturers and testing facilities
- Certificates of conformity from suppliers
- The drawing designs for the Intel-line system
- Bill of Materials drawings
- Intel-line test record sheet

Following the EMC results, the consortium will be in a better position to proceed with European CE marking.

APPENDIX A

Test Title:	Intel-Line High voltage / Current (Surge) Test.		
Intel-Line unit No:	Manufacturer:		
	Equipment ID:		
Job/Project No:	Test No:	Rev No:	
	Test Engineer:		
Date of Test:			
Document No.:	Client Rep:		
Author:	Approval (if required):		
Description of Tests:			
Tests to confirm that the Intel-Line system remains fully functional when subjected to High voltage and High current surge levels			
Safety:			
WARNING – Refer to Task Risk Assessment before commencing work.			
Test Method 1: High voltage Corona partial discharge test 400kV			
<ol style="list-style-type: none"> 1. This test is carried out on a complete Intel-Line system mounted on the short length of the correct cable (Bear) using correct cable seals / sealing compounds. 2. The system is to be fitted into a high voltage test setup and the system is used in communications with a PC/laptop to monitor correct operation during the tests. 3. The cable that the Intel-Line system is connected to the output of a high voltage generator. A photograph of the outside of the enclosure is taken to indicate possible high Corona fields. 4. The levels of Corona discharge should be recorded at the different voltage levels together with the status of the working Intel-Line system via the wireless (LORA link) 5. If the unit fails during the test, remove the system from the cable and inspect the internal PCBs for any over voltage indicators or failed components. 			
Acceptance Criteria:			
The Intel-Line system should remain fully functional up to 400kV with minimal CORONA discharge			
Record of Test:			
Model / Type	s/n:
Starting Voltage	Zero	Ambient test temperature	°C
Max Test Voltage	400kV	Intel-Line remains fully functional	YES / NO*
Max Voltage at system failure	kV	Intel-Line remains fully functional	YES / NO*
Note: <ul style="list-style-type: none"> • Delete as appropriate • Note maximum voltage reached and where / what monitored 			

I confirm that Type Test T01 has been completed satisfactorily.

Test Engineer:		Date:		Signature:
Witness:		Date:		Signature:

APPENDIX B

Test Title:	Lightning impulses Test.		
Intel-Line unit No:	Manufacturer:		
	Equipment ID:		
Job/Project No:	Test No:	Rev No:	
	Test Engineer:		
Date of Test:	Client Rep:		
Document No.:	Approval (if required):		
Author:			

Description of Tests:

Tests to confirm that the Intel-Line system remains fully functional when subjected to High voltage and High current surge levels

Safety:

WARNING – Refer to Task Risk Assessment before commencing work.

Test Method 2:
High voltage surge discharge test to enclosure (Lightning impulse) 1200 kV peak (1.2/50us)

- This test is carried out on a complete Intel-Line system mounted on the short length of the correct cable (Bear) using correct cable seals / sealing compounds.
- The system is to be fitted into a high voltage test setup and the system is used in communications with a PC/laptop via LORA to monitor correct operation during the tests.
- The lightning impulses should be recorded at the different levels together with the status of the working Intel-Line system via the wireless (LORA link)
- If the unit fails during the test remove the system from the cable and inspect the internal PCBs for any over voltage indicators or failed components.

Acceptance Criteria:

The Intel-Line system should remain fully functional up 1200 kV. It is acceptable for the system to reset as long as it automatically restarts after the discharge

Record of Test:

Model / Type		s/n:	
Starting Voltage	Zero	Ambient test temperature	°C
Max LI	1200kV	Intel-Line remains fully functional	YES / NO*
Max Voltage at system failure	kV	Intel-Line remains fully functional	YES / NO*

Note:

- Delete as appropriate
- Note maximum peak voltage reached and where / what monitored

I confirm that Type Test T02 has been completed satisfactorily.

Test Engineer:

Date:

Signature:

Witness:

Date:

Signature: