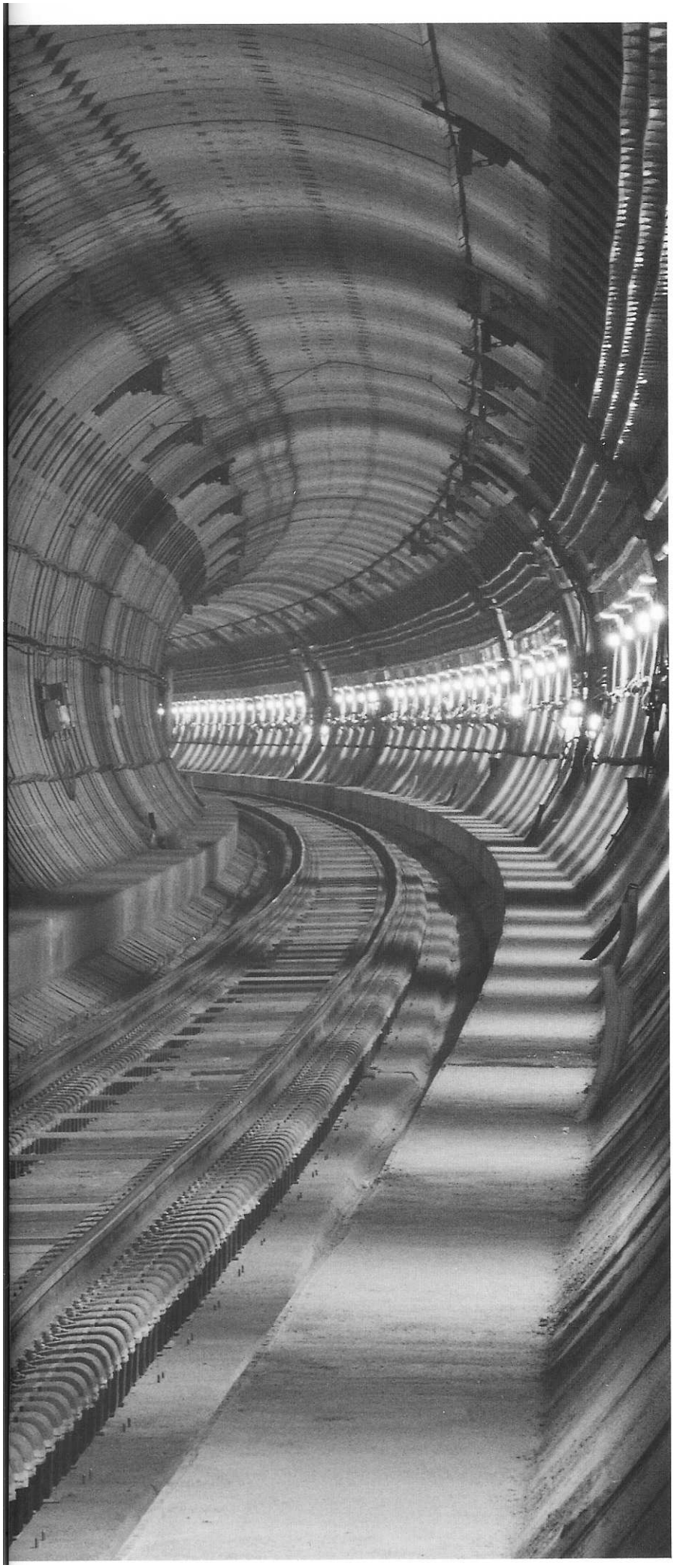
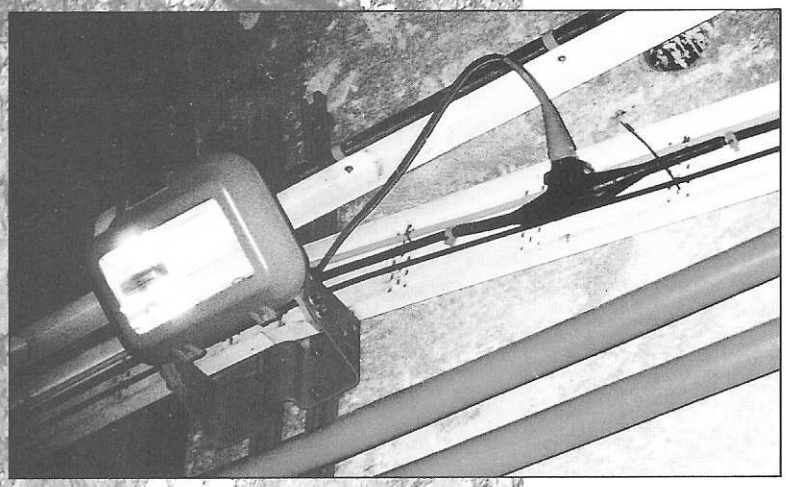


BICC FlexoProducts

Test Programme for Channel Tunnel Products



BICC FLEXO PRODUCTS provided cable and luminaire lead systems to the Channel Tunnel for both Construction and Permanent Installation Phases.

The system designed for permanent installation was subject to extensive testing to prove its suitability for the onerous environmental conditions, with particular regard to the presence of moisture and the sudden variations in pressure.

This brochure outlines the specification requirements which had to be achieved and the tests evolved to provide proof of conformance.

Flexo

PURPOSE OF TESTS:

1) To provide evidence that the materials used would meet the smoke and fume emission requirements.

2) To determine whether the plug would remain electrically connected if the assembly was subject to the air speeds described in the aerodynamic data sheet.

3) To demonstrate that the plug and socket connection is able to withstand the environmental conditions specified.

SYSTEM REQUIREMENTS

1) LOW SMOKE AND FUME

PROPERTY	PERFORMANCE
Acidity or toxicity of gases IEC 754-1.	% not greater than 0.5%.
Smoke Emission (BS6724 Appendix F).	Pass 3m. cube test.
Temperature Index (LUL SE 569).	°C Greater than or equal to 260.
Oxygen Index BS2782.	Greater than or equal to 30.
Fire retardance to IEC 332 Part 3.	Pass Category C.
Corrosion VDE 0472.	pH Greater than 4.0.

2) ENVIRONMENTAL

Air Speeds

Maximum of 100 mt/s in any direction with a 3 minute cycle.

Air Pressure

Extreme ± 30 KPa.

Changes in Air Pressure ± 10 KPa in 10 seconds.

± 30 KPa in 10 minutes.

± 20 KPa in 2 minutes.

TEST HOUSES UTILISED

Fire Tests

Warrington Fire & Material Centre – London.

Air Speed

Hydraulics Research Limited – Wallingford.

* Due to no facility being identified which could provide the required conditions in air a test in water was accepted.
A speed through water of 3.5 mt/second was calculated as being equivalent to 100 mt/second in air.

Environmental

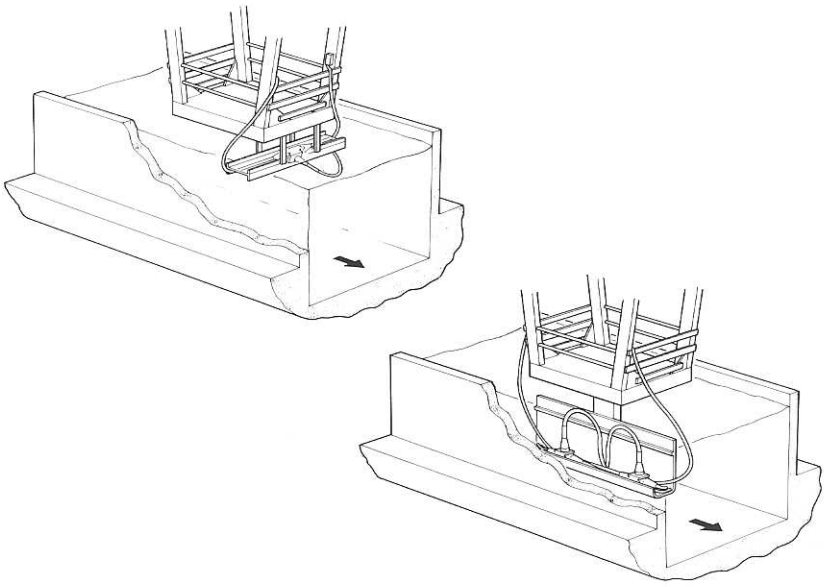
British Rail Research Structures Laboratory – Derby.

BRIEF DESCRIPTION OF TESTS

Fire Tests

Samples of the cable complete with moulded outlet and luminaire plug lead were subject to a range of fire tests which confirmed their performance to the specification requirements. Reports listed below can be supplied if required:-

L10411	FLAME PROPAGATION TEST.
L10412	SMOKE EMISSION TEST.
L10401	DETERMINATION OF THE OXYGEN INDEX OF MATERIALS. BS2782: METHOD 141D: 1978.
L10402	DETERMINATION OF THE FLAMMABILITY TEMPERATURE INDEX OF MATERIALS. BS6853: 1987 APPENDIX A.
L10403 = =	TESTS ON GASES EVOLVED DURING COMBUSTION. DETERMINATION OF THE AMOUNT HALOGEN ACID EVOLVED DURING COMBUSTION.
L10404	CORROSIVITY OF COMBUSTION GASES. VDE 047 PART 812:1983.



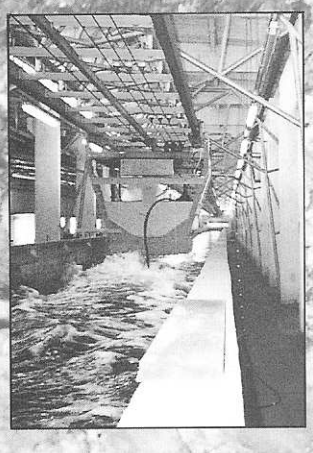
Air Speed

The use of the water instead of air provided a more stringent test for the product.

The test was conducted by mounting a moulded unit beneath a vehicle which then towed the unit through the water.

The purpose of this test programme was to determine whether the plug would remain electrically connected if the assembly was subjected to the air speeds described in the Aerodynamic Data Sheet.

At the request of TML the insulation resistance was monitored at every stage throughout the test programme.

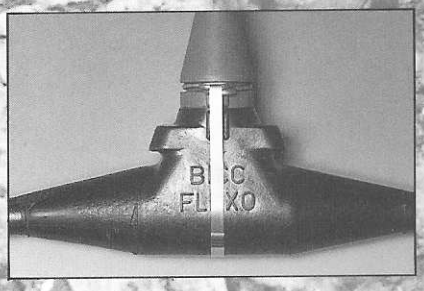


The tests concluded:

- The plugs remained electrically connected throughout the test. The maximum movement observed being 0.35mm. with the plug lead unsupported. (Electrical continuity would cease if the plug moved beyond 10mm.).

- IR failures occurred at speeds greater than 2.0 M/S in water i.e. at air speeds above 60mt/s IR failures always occurred at the end of a run when the trolley was subject to maximum deceleration.

As a result of these tests an installation procedure was drawn up and a mechanical locking device produced to hold the plug/socket firmly together in areas where air speed was expected to exceed 60mt/s.



ENVIRONMENTAL

The tests were in three main parts.

(a) Repeated insertion/withdrawal tests to demonstrate that the plug retention force provided by the plug/socket design did not deteriorate with use.

(b) Pressure variation testing under conditions of high humidity to demonstrate that the plug cannot work loose from the socket or that moisture is not driven into the socket past the sealing ring.

(c) Pressure variation testing in a dust atmosphere to demonstrate that dust cannot be pressure-driven past the plug/socket sealing ring.

At appropriate stages before, during and after testing, insulation measurements were carried out.

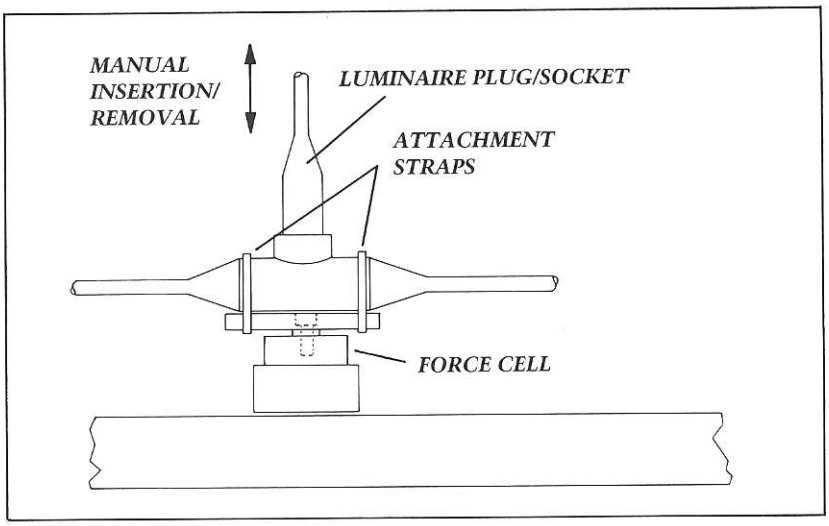
Test Method

Insertion/withdrawal force and durability

These tests were carried out by mounting a cable/socket assembly onto a force cell of 4.45kN (1000 lbf) capacity, itself fastened to a mounting plate.

Testing consisted of manual insertion and withdrawal of the luminaire plug. A continuous analogue record of force was taken during the tests.

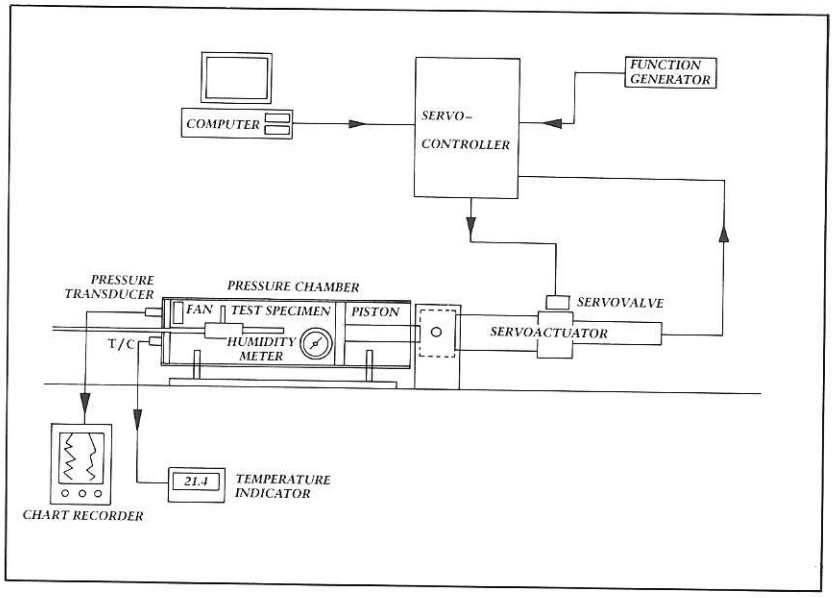
Durability testing consisted of repeated insertion/withdrawal to check for reduction of the specified forces. The specified number of insertions was exceeded.



Pressure Testing

In order to subject a plug/socket assembly to the specified pressure variations, a test chamber was manufactured. This consisted of a perspex tube, closed at one end and with a moveable piston at the other. The piston was connected to a servohydraulic actuator. The actuator position command signal was generated by a computer programme. The correct settings for piston deflection were established on a dummy test specimen before testing commenced.

The chamber was designed to measure pressure, temperature and humidity. It was provided with a safety valve to prevent excessive pressure under fault conditions. The chamber was fitted with a water spray port for the humidity tests, and a circulation fan for the dust tests.

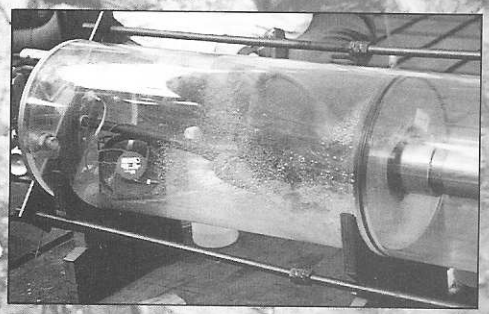


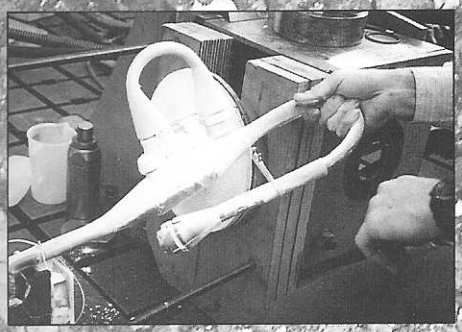
The test specimen was arranged so that the tail of the 3 phase cable was brought outside the chamber through a sealed gland, so that the insulation measurements could be carried out.

The luminaire tail inside the chamber was looped back on itself and secured with a cable tie. Care was taken to ensure that no part of the tail or plug was in contact with the chamber wall, it was free to move under the influence of pressure variations.

Humidity Testing

The test humidity condition was achieved by intermittent water spray into the chamber. Humidity was monitored by an analogue humidity indicator placed in the chamber. This was checked against a sling psychrometer and was accurate to about 5%.
The presence of free water in the chamber under equilibrium conditions was a further indication that close to 100% humidity was achieved.





Dust Testing

The dust used was standard talc. The specified quantity was 2 kG/cu.m. of test chamber volume. This was doubled for the tests carried out. A circulation fan inside the chamber was used to keep the dust in suspension. This was aided by mechanical agitation of the test chamber in order to prevent aggregation of the dust on the chamber lower surfaces.

Results

With the exception of high insertion forces, the plug/socket assemblies meet the requirements of the specification.

This design and manufacturing challenge is proof of the ability of our design and manufacturing facilities to provide a quality product to suit varied and demanding requirements.

Quality

All units manufactured are fully tested prior to despatch which guarantees the products quality.

FLEXO PRODUCTS quality system is approved to Defence Standard 05-24 and we are working towards approval to BS5750 Part 1 during 1992.

BICC Flexo Products

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BFP 92/14

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