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TEST REPORT

TSL No. R18201

**Fire Hazard Evaluation
of "Drytech I/II" Injection
Grout.**

**Fire Hazard Evaluation of “Fire Hazard Evaluation of “Drytech I/II”
Injection Grout.**



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1. INTRODUCTION

The purpose of this evaluation is to ascertain whether the Injection grout, referenced Drytech I/II poses considerable hazards for its proposed applications across London Underground, based on fire testing of the proposed material, against the London Underground Limited Engineering Standard 1-85: A1: 2008

2. MATERIAL DESCRIPTION

Clear, acrylic injection grout compound, referenced “Drytech I/II”, supplied by Drytech Italia S.r.l

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3. FIRE PERFORMANCE

3.1 SMOKE EMISSION

3.1.1 DATA

The material referenced “Drytech I/II” was tested on 14th May 2008, in accordance with BS6853: 1999 Annex D8.3. – “Fire precautions in the design and construction of passenger carrying trains”.

The results obtained were as follows:

Sample Reference	Test	Ao(abs) m²/g	Average	S.D.
Drytech I/II	Test 1	0.0035		
	Test 2	0.0017	0.0026	0.0009

3.1.2 SUMMERY

The London Underground Limited Engineering Standard 1-085: A1: March 2008 require that smoke emission criterion of Ao(abs) <0.05m²/g be met. The materials referenced “Drytech I/II” meets this requirement and is therefore in conformance.

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3.2 TOXIC FUME EMISSION

3.2.1 DATA

The material referenced “Drytech I/II” was tested for potential toxic fume emission on 22nd and 27th May 2008, by 4-Rail Services Limited – Test Report 4RS-RG-080160-R189726 refers.

The results obtained were as follows:

QUALITATIVE ANALYSIS

Specimen	Elements detected
Drytech I/II	Carbon, Oxygen, Magnesium, Sulphur.

QUANTITATIVE ANALYSIS

Specimen	% Nitrogen	% Carbon	% Sulphur
Drytech I/II	0.71	21.39	0.42

3.2.2 SUMMERY

The Engineering Standard states that “For unrestricted use of a material, covered by Standard 1-95: A1: March 2008, neither it nor its constituents shall have deliberately incorporated by selection, addition or modification any significant amounts of organically bound halogens, nitrogen, sulphur or phosphorus; typical chemical groups proscribed are:-

- C-X (where X = Halogen)
- C-N
- C-P
- C-O-P
- C-S
- C-O-S

Trace levels of such chemical groups are acceptable – the criterion for “trace level” shall be that the summation of the weight for weight percentage of the chemical group divided by the atomic weight for the group shall not exceed 0.015”.

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Thus, applying the ‘Trace level’ criteria i.e.

$$\sum \frac{w/w\% \text{ of Chemical Group}}{\text{Atomic weight of Group}} \leq 0.015$$

The calculated value for the material “Drytech I/II” is 0.0638, based on 0.71% Nitrogen and 0.42% Sulphur content.

Hence, the specimen material under this category fails to meet the London Underground Limited Engineering Standard 1-08: A1: March 2003, due to the presence of nitrogen and sulphur above the required limit.

However, considering that the respective standard calls for keeping the concentrations of any toxic gases below the relevant IDLH levels (Immediately Dangerous to Life or Health), it is therefore possible to calculate the potential toxic hazard presented by this material. Such calculations would need to assume that the *dispersal volume in which the product is installed is 200m³ for Tunnel.*

Following assumptions would also need to be made:

- *The materials referenced “Drytech I/II” is the sole contributor to the fire atmosphere.*
- *All of the Nitrogen (0.71%) and the Sulphur (0.421%) in the material would convert to Hydrogen cyanide and Sulphur dioxide i.e. 100% conversion of nitrogen to hydrogen cyanide and Sulphur to Sulphur Dioxide.*
- *Size of Fire region is 0.5m² for tunnel locations.*
- *Mass of material consumed is 798g (total consumption during ad-hoc test on assembly system).*

Hence, the expected concentrations of hydrogen cyanide and sulphur dioxide are calculated, according to "Users Guide to the LUL Code of Practice - Fire Safety of Materials Used in the Underground - Issue 1; 1994" and the Manual of Good Practice M1042, which gives the following expected concentrations of Hydrogen cyanide and Sulphur dioxide for Tunnel application.

Expected concentration (ppm)	Icosit KC340
HCN	36.5
SO ₂	21.6

The total expected toxicity, T_x is given by the equation:

$$T_{Total} = \sum \frac{C_N}{H_N}$$

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Where, C_N = Concentration of any one toxic species, and
 H_N = IDLH for value for that toxic species.

The calculated values and the requirements are:

Location	Total expected toxicity, T_x	Requirements
TU/EQ/I	0.95	<1.0

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3.3 FLAMMABILITY

3.3.1 DATA

The Drytech I/II was tested for flammability oxygen index on 16th May 2008, in accordance with BS EN ISO 4589-2: 1996: Part 2: Plastics – Determination of burning behaviour by oxygen index. Ambient - temperature test.

The test was performed by QinetiQ and their Test Report HAG135; Dated 16th May 2008 refers.

Sample reference	Result(% LOI)
Drytech I/II	>90

3.3.1 SUMMERY

The requirements of the London Underground Limited Engineering Standard 1-85: A1: March 2008 for the flammability oxygen index is a value of >30%. The Drytech I/II, therefore meet the requirement.

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4. CONCLUSION

Although, the material referenced, Drytech I/II comply with the fire performance requirements of the London Underground Limited Engineering Standard 1-085: A1: March 2008.