

WATER REGULATIONS ADVISORY SCHEME (WRAS).

**TESTING OF NON-METALLIC MATERIALS FOR USE WITH DRINKING
WATER (BS 6920 : 2000)**

TEST REPORT

Product : PC Leakinject UNI 6816 E Resin & Catalyst
Report Reference : M103025 & M103263/B
Page 1 of 9 Pages.

Tradecc NV
Terbekehofdreef 50-52
B-2610 Wilrijk
BELGIUM

Report Date : 23rd April 2003
Reissued with Supplementary Data : 1st April 2004

Executive Summary - this product has met the requirements of the Water Regulations Advisory Scheme (WRAS) Tests of Effect on Water Quality/BS 6920:2000 Cold Water Use.

NOTES.

1. The results given in this report relate only to the items tested, and not necessarily to the bulk from which they were taken.
2. This test work was undertaken in the UKAS accredited Spencer House laboratory of Thames Water Utilities Ltd., UKAS registration number 0677, unless otherwise stated.
3. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.
4. This test report shall not be reproduced, except in full, without our prior written approval.



THE WATER QUALITY CENTRE ("WQC").

Terms and Conditions : Materials Testing.

1. These terms and conditions apply to services provided by the Water Quality Centre of Thames Water Utilities Limited (WQC) to its Clients for goods and materials testing (Services). Unless agreed in writing these Terms and Conditions shall apply to the exclusion of any others. WQC shall perform the services with all reasonable skill and care.
2. **Disclosure.** The provision of Services by WQC is undertaken on the basis that full and adequate disclosure is made by the Client to WQC of all information and documentation which may affect such testing, including, without limitation, the purpose or purposes for which the goods or materials supplied to WQC for testing are to be used. Such information and documentation and the results of all tests undertaken will be treated as confidential and will not be made available to third parties (including staff of the Thames Water Group and its agents) without the Clients written instructions.
 - (i) The Client will indemnify WQC against any third party claims for any loss or injury arising out of any use or application of any such goods or materials not disclosed to the WQC, **and**
 - (ii) WQC shall not be liable for any loss or damage arising out of undisclosed use *or application* by the Client.
3. **Testing.** (i) WQC will carry out such work as it considers appropriate or as agreed between WQC and the Client, and WQC shall be entitled to test any samples/goods to destruction.
 - (ii) WQC further reserves the right to carry out tests in any of its' UKAS accredited laboratories.
 - (iii) WQC will use established methods for testing and analysis where these are available but makes no warranty as to the accuracy or fitness for purpose of such results. Where novel test methods have to be developed and validated WQC shall not be liable for any resulting losses or damage, howsoever caused; including but not limited to, loss of profit, business revenue or goodwill.
 - (iv) If agreed by WQC, the Client or any agreed third party may be present when work is carried out.
4. **Test Samples.** Any report issued by WQC will relate only to the goods or materials in respect of which work has been done and not the bulk from which the samples tested have been selected.
5. **Reports.** WQC reports are provided in confidence. No right is given or implied to use the name of Thames Water; of any of the companies in the Thames Water Plc group; or of the Water Quality Centre in any promotion or other publication relating to any sample tested or the bulk from which it is taken. Copyright in all written statements, opinions, reports, certificates and other information given by the WQC in the course of test and analytical services will remain the property of Thames Water Utilities Limited; and must not be made public (except as required by law), edited or amended in whole or in part without prior written consent.

Test reports shall not be reproduced, except in full, without our prior written consent.
6. **Sample Disposal.** Unless otherwise agreed in writing, all goods and materials received for testing will be disposed of by WQC after completion of the work. If agreed in writing, WQC will, at the Clients expense and risk, return untested samples to the Client by a method considered to be appropriate by the WQC.
7. **Termination.** WQC reserves the right to terminate testing/analysis of samples for reasons of laboratory safety and/or instrumental integrity, and to charge the Client for all work undertaken.
8. **Payments.** All payments for samples shall be paid in advance. No result or report shall be supplied by WQC until such time as payment in full has been received. On submission of invoice all payments unless otherwise agreed in writing shall be made within 14 days of the date of the invoice. For customers outside UK payment shall be made within 30 days of the date of the invoice. Customers outside UK are responsible for costs of currency conversion and other associated charges. WQC reserves the right to withhold reports or to suspend or discontinue the provision of services at any time and at its discretion. The WQC accepts no responsibility for the consequences of withholding reports or suspending or discontinuing work in such circumstances.
9. **Liability.** The Client accepts:-
 - (i) that it is reasonable for WQC to exclude all guarantees and warranties express or implied and all liabilities including all conditions, and warranties whatsoever that would be implied or imposed by statute, law or otherwise howsoever are excluded to the fullest extent permitted by law.
 - (ii) that in no circumstances shall WQC be liable for any loss or damage, including but not limited to, loss of profits, business revenue or goodwill; or for any special, indirect or consequential loss or damage, or in respect of any claim made against the Client by a third party. Save that nothing under this Agreement shall limit or exclude liability of either party in respect of death, personal injuries or fraudulent misrepresentation.;
 - (iii) that WQC shall bear no duty of care or contractual liability to the Client in providing the Services in respect of uses and/or applications not disclosed by the Client to WQC.
 - (iv) The liability of WQC, if any, shall be limited to the sum of the Contract Price plus 25% thereof.
10. **General.** (i) Neither party may assign this agreement without the express written permission of the other. (ii) A person who is not a party to this agreement has no rights under the Contract (Rights of Third Parties) Act 1999 to enforce any term of this agreement. (iii) This agreement sets out the entire agreement between the parties and supersedes all prior agreements and understandings relating to its subject matter.
11. **Jurisdiction.** This Agreement shall be interpreted in accordance with the Laws of England and Wales and any dispute arising under it shall be submitted to the non- exclusive jurisdiction of the courts in England and Wales.

**TESTING OF NON-METALLIC MATERIALS FOR USE WITH DRINKING WATER.
WATER REGULATIONS ADVISORY SCHEME TESTS OF EFFECT ON WATER
QUALITY (BS 6920).**

0. INTRODUCTION.

The samples of the product referred to in this report have been tested in accordance with the methods of the Water Regulations Advisory Scheme (WRAS) Tests of Effect on Water Quality/BS 6920-2:2000 "Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water : Methods of Test".

1. TEST SAMPLES.

General composition of product	Polyurethane Foam	
Trade name/designation	PC Leakinject UNI 6816 E Resin & Catalyst	
Material manufacturer	not supplied	
Date of preparation	(1) 25 th February 2003 & 1st April 2003 (2) 9 th December 2003	
Production batch numbers	not supplied	
Samples prepared by	WQC Staff	
Submitting organisation	Tradec NV	
Date of receipt of test samples	(1) 20 th February 2003 (2) 1 st December 2003	
Method of packaging	Product Containers	
Condition on receipt	Satisfactory	
Laboratory storage before test	Ambient temperature (21±4)°C	
Description	test article	Sample cured within steel tube.
	shape dimensions	Square 20mm x 20mm x 3mm
Appearance of article	colour	Yellow
	surface finish	Textured
	opacity	Opaque
Surface area of one article (mm ²)	(1) 1040 (2) ~1000	
Number of articles to give a surface area of 1000mm ²	1	
Calibration mark of the test vessel/container in litres	1	
Extraction temperature used for tests 2, 3, 5 & 6	(23±2)°C	

1.1 SITE APPLIED PRODUCTS.

Typical uses of the product	Crack injection/concrete repair
Method of test sample preparation	Resin & catalyst were hand mixed before adding water. Liquid was then poured into steel tube and capped off at both ends. The fully cured product was removed from the tube and cut to size.
Mix ratio (g : g)	Original & Supplementary (1) test sample Resin : Catalyst : Water 600g : 36g : 40g Supplementary (2) test sample Resin Catalyst : Water 300g : 6g : 45g
Location of sample preparation	Spencer House
Final curing (time and temperature)	6 hours at 7°C

2. ODOUR & FLAVOUR OF WATER TEST.

Temperature of extraction : (23±2)°C

Date test started : 25.02.03.

The extracts detailed below were compared with the procedural blank test waters by a panel of 3 testers. The following results were obtained for the test extracts.

Extract	Test water	Test	Descriptors	Threshold dilutions
First	Chlorine free	Odour	Fruity/Fruity/Fruity	
		Flavour	--	--
	Chlorinated	Odour	Fruity/Fruity/Fruity	
		Flavour	--	--
Final	Chlorine free	Odour	None/Fruity/Fruity	
		Flavour	--	--
	Chlorinated	Odour	None/Fruity/Fruity	
		Flavour	--	--

COMMENT. On the basis of these results the samples of this product have been found **NOT to conform** with the requirements of BS 6920-1 : Clause 4 when extracted at 23°C.

SUPPLEMENTARY TESTING (1) - samples taken from the previous batch received 20/02/03 were submitted for Odour & Flavour of Water re-testing using identical curing conditions.

2. SUPPLEMENTARY(1) ODOUR & FLAVOUR OF WATER TEST.

Temperature of extraction : (23±2)°C

Date test started : 01.04.03.

The extracts detailed below were compared with the procedural blank test waters by a panel of 3 testers. The following results were obtained for the test extracts.

Extract	Test water	Test	Descriptors	Threshold dilutions
First	Chlorine free	Odour	Chemical(sweet)/Sweet/Fruity	
		Flavour	—	--
	Chlorinated	Odour	Chemical(sweet)/Sweet/Fruity	
		Flavour	—	--
Final	Chlorine free	Odour	Fruity/Fruity/Fruity	
		Flavour	—	--
	Chlorinated	Odour	Fruity/Fruity/Fruity	
		Flavour	—	--

COMMENT. On the basis of these results the samples of this product have been found **NOT to conform** with the requirements of BS 6920-1 : Clause 4 when extracted at 23°C.

SUPPLEMENTARY TESTING (2) - Fresh samples were submitted for Odour & Flavour of Water re-testing using identical curing conditions.

2. SUPPLEMENTARY (2) ODOUR & FLAVOUR OF WATER TEST.

Temperature of extraction : (23±2)°C

Date test started : 09.12.03

The extracts detailed below were compared with the procedural blank test waters by a panel of 3 testers. The following results were obtained for the test extracts.

Extract	Test water	Test	Descriptors	Threshold dilutions
First	Chlorine free	Odour	None	
		Flavour	None	<1
	Chlorinated	Odour	Chemical/Chemical/Chemical	
		Flavour	--	--
Final	Chlorine free	Odour	--	
		Flavour	--	--
	Chlorinated	Odour	None	
		Flavour	None	<1

COMMENT. On the basis of these results the samples of this product have been found *to conform* with the requirements of BS 6920-1 : Clause 4 when extracted at 23°C.

3. APPEARANCE OF WATER.

Temperature of extraction : (23±2)°C

Date test started : 25.02.03.

	Colour (Hazen Units)*		Turbidity (Formazine Nephelometric Units)*	
	First Extract	Final Extract	First Extract	Final Extract
	Test sample extract	<1.0	--	<0.25
Reagent blank	<1.0	--	<0.25	--
Test sample effect	<1.0	--	<0.25	--

[* - method code 321]

COMMENT. On the basis of these results the sample of this product has been found *to conform* with the requirements of BS 6920-1 : Clause 5 when extracted at 23°C.

4. GROWTH OF AQUATIC MICROORGANISMS.

Temperature of test : (30±2)°C

Date test started : 25.02.03.

Container	Mean Dissolved Oxygen Difference (MDOD) in mg/L
Test product (weeks 5 to 7)	1.4
Negative reference (glass) (weeks 5 to 7)	0.5
Positive reference (wax) (weeks 5 to 7)	7.9
Special positive reference	n/a
Negative control - Mean dissolved oxygen concentration (weeks 5 to 7)	8.1

COMMENT. On the basis of these results the sample of this product has been found *to conform* with the requirements of BS 6920-1 : Clause 6.

At the end of this test the test pieces showed no changes in colour and appearance.

5. THE EXTRACTION OF SUBSTANCES THAT MAY BE OF CONCERN TO PUBLIC HEALTH.

Temperature of extraction : (23±2)°C

Date test started : 25.02.03.

The extracts from the product and the blank were used to prepare culture media for use with a monkey kidney cell line (VERO ATCC CCL 81) - [method code 256].

Attribute	Test sample extract	Reagent blank	Zinc sulfate solution
Cell morphology (Microscopy)	Satisfactory	Satisfactory	Cell death
Culture medium (colour)	Normal	Normal	Abnormal (alkaline)
Monolayer confluence (approx %)	100%	100%	0%

COMMENT. On the basis of these test results the extract of this product has been found to give a non-cytotoxic response, and therefore it has been found *to conform* with the requirements of BS 6920-1 : Clause 7 when extracted at 23°C.

6. EXTRACTION OF METALS.

Temperature of extraction : (23±2)°C

Date test started : 25.02.03.

The results obtained for the first extract are given below -

Element	Unit	MAC	Reporting limit	Sample 1	Sample 2	Reagent blank
Aluminium	Al $\mu\text{g/L}$	200	14.0	<14.0	<14.0	<14.0
Antimony	Sb $\mu\text{g/L}$	10	0.8	<0.8	<0.8	<0.8
Arsenic	As $\mu\text{g/L}$	50	0.8	<0.8	<0.8	<0.8
Barium	Ba $\mu\text{g/L}$	1000	3.0	<3.0	<3.0	<3.0
Cadmium	Cd $\mu\text{g/L}$	5	0.5	<0.5	<0.5	<0.5
Chromium	Cr $\mu\text{g/L}$	50	5.0	<5.0	<5.0	<5.0
Iron	Fe $\mu\text{g/L}$	200	12.0	<12.0	<12.0	<12.0
Lead	Pb $\mu\text{g/L}$	50	0.5	<0.5	<0.5	<0.5
Manganese	Mn $\mu\text{g/L}$	50	3.0	<3.0	<3.0	<3.0
Mercury	Hg $\mu\text{g/L}$	1	0.05	<0.05	<0.05	<0.05
Nickel	Ni $\mu\text{g/L}$	50	2.0	<2.0	<2.0	<2.0
Selenium	Se $\mu\text{g/L}$	10	0.5	<0.5	<0.5	<0.5
Silver	Ag $\mu\text{g/L}$	10	1.0	<1.0	<1.0	<1.0

Extract Analytical.

The analysis of the extracts for these metals was undertaken in the Millharbour Laboratories of Thames Water, UKAS registration number 1258.

Mercury, arsenic, selenium, antimony, silver and lead - inductively coupled plasma mass spectrometry [method code 407].

Aluminium, barium, cadmium, chromium, iron, manganese and nickel - inductively coupled plasma optical emission spectrometry [method code 385].

Analytical Control Data - these two techniques are in continuous use for analysis of drinking water metals; all of these techniques are fully validated to the requirements of "A Manual on Analytical Quality Control for the Water Industry" (NS 30) and the requirements laid down by the Drinking Water Inspectorate. Each technique has a comprehensive AQC protocol including control solutions and spike recovery testing with each batch of samples for analysis; full details available upon request.

COMMENT. On the basis of these results the samples of this product have been found **to conform** with the requirements of BS 6920-1 : Clause 8 when extracted at 23°C.

CONCLUSIONS.

The samples of this product meet the test criteria of BS 6920-1:2000 ("Specification") and thus DO conform with the requirements of the Water Regulations Advisory Scheme (WRAS) Tests of Effect on Water Quality, for use with cold water.

NOTE : materials and products intended for use by a public water supply company in the preparation or conveyance of water may need to satisfy more comprehensive toxicological requirements as set specified by the Drinking Water Inspectorate. These additional requirements are necessary to ensure legal compliance with Regulation 25 of the Water Supply (Water Quality) Regulations 1989.

NOTES -

1. The results specified in this report relate to the samples submitted for evaluation and not necessarily to the bulk from which they were taken. Any changes in the nature or source of ingredients and the process of manufacture or application could affect the suitability of the product for use in contact with drinking water.
2. We would draw to your attention that reports issued by the accredited test laboratories do not of themselves constitute approval by the Water Regulations Advisory Scheme (WRAS) or the test laboratory. Only a letter from the Scheme, citing a Directory Reference Number, can be regarded as indicating approval.

Note for the Water Regulations Advisory Scheme (WRAS) : the 1st extract Odour & Flavour of Water test extract foamed when shaken (original & supplementary (1) samples only).



Anthony Maddox
Materials Consultant

WATER REGULATIONS ADVISORY SCHEME (WRAS) TESTS OF EFFECT ON WATER QUALITY : TEST CRITERIA (BS 6920:2000).

The following test criteria are used to determine whether your product(s) complies with the requirements of the Water Regulations Advisory Scheme (WRAS) Tests of Effect on Water Quality.

1. ODOUR & FLAVOUR OF WATER. (BS 6920-1 : Clause 4)

Off-odours and off-flavours of water are the most usual causes of customer complaints about water quality. On test the material is exposed, under controlled conditions (surface area to volume (S/V) test ratio, duration, temperature) to the test water (with and without free-chlorine); it is subsequently diluted twice on a 1 to 1 basis and assessed by a test panel.

The test sample leachates must be free from odour and, after dilution, free from flavour in the first 1:1 dilutions of them. If, after 7 sequential leaching periods, any odour is detected in the sample leachates or any flavour detected in the first dilution of these leachates by any of the three panellists, then the product fails to meet this test criterion *unless* two further sets of test samples are assessed and no odour is reported in the leachates and no flavour is reported in the first dilutions of the final (i.e. seventh) leachates from these additional test samples.

Materials meeting these test criteria do not usually give rise to off-odours and off-flavours in-service.

2. APPEARANCE OF WATER. (BS 6920-1 : Clause 5)

Any increase in the colour and turbidity of the final (i.e. seventh) leachate from the sample of the product must not be greater than 5 Hazen units and 0.5 FNU respectively. If any colour or turbidity is detected in the final extract, then the product fails to meet the test criteria *unless* two further samples are tested and the mean of the colour and turbidity measurements of the final extracts of *all* of the samples meet the test criteria.

Materials meeting these test criteria do not usually give rise to in-service changes in the appearance of water.

3. GROWTH OF AQUATIC MICROORGANISMS. (BS 6920-1 : Clause 6)

The original methods were based on microbiological counting techniques and the test took a longer time period and cost considerably more (in real terms) than the present test. In an attempt to improve the performance of the test, including duration, other techniques were evaluated for assessing materials for the supports of biofilms and overall growth in water. Work using dissolved oxygen depletion measurements as a surrogate measure of microbial growth in water showed improved reproducibility and repeatability compared with bacterial counts. The mean dissolved oxygen difference (MDOD) value obtained for the product is a surrogate measure of its ability to support the growth of microorganisms - as the growth of the organisms increases oxygen is removed from the test system; thus the greater the loss of dissolved oxygen caused by the product, the greater the MDOD value. This work was subsequently published (Colbourne and Brown, 1979) and incorporated into BS 6920 : Section 2.4:1988.

The mean dissolved oxygen difference between the water in contact with the sample of the product and the negative control system must be less than 2.4 mg/l; two further test samples of products giving a value in the range 1.7 to 2.9 mg/L are tested and the mean of the three readings used to show conformity with the test requirement $s < 2.4$ mg/l).

The pass/fail criterion was set after consideration of results obtained from materials using microbial counts and evaluation of materials associated with biofilm development and/or microbial deterioration in water quality in-service.

4. THE EXTRACTION OF SUBSTANCES.... (CYTOTOXICITY TEST) (BS 6920-1 : Clause 7)

If the first aqueous extract from the sample of the product is free from toxicity to the test cell line, it can be regarded as suitable for use in contact with potable water in relation to this particular test. If any toxicity is detected in this extract, then the product fails to meet the test criteria *unless* two further samples are tested and found to be free from any toxic response.

A failure in this test is indicative only of a possible public health issue and NOT necessarily of a real concern.

5. THE EXTRACTION OF METALS. (BS 6920-1 : Clause 8)

Any metal present in the final duplicate extracts obtained from the samples of the product must be at levels less than Maximum Admissible Levels (MACs) based on both the first and subsequent EU Drinking Water Directives. If the MACs of any metal is exceeded in either of the final extracts from the samples of the product then the product fails to meet this test criterion *unless* three further samples of the product are tested and the levels of the specified metals in the extracts from all of these additional samples do not exceed the MACs.

Materials meeting these test criteria do not usually give rise to significant in-service changes in the concentrations of metals in water.