EI Research report

Fire resistance testing of sealant materials and system components for secondary containment construction/expansion joints

energy institute

RESEARCH REPORT: FIRE RESISTANCE TESTING OF SEALANT MATERIALS AND SYSTEM COMPONENTS FOR SECONDARY CONTAINMENT CONSTRUCTION/EXPANSION JOINTS

First edition

November 2019

Published by
Energy Institute, London
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Registered charity number 1097899

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The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies:

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Uniper
Valero
Vattenfall
Vitol Energy
Woodside
World Fuel Services

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ISBN 978 1 78725 071 0

Published by the Energy Institute

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ACKNOWLEDGEMENTS

The multi-phase project described in this research report was commissioned by EI's Containment Systems Working Group (CSWG), which is a working group of the EI's Process Safety Committee. Development work was contracted initially to Resource Protection International (RPI), which was acquired by Falck Fire Consulting. Final work was carried out by ENRg Consultants. Paul Watkins was the main researcher throughout the project phases; Dr Barbara Chisholm supported the project. IKM Consulting Ltd. designed the test modules. Initial testing (Phase 1) was undertaken at Centro Jovellanos (Asturias, Spain), whereas subsequent testing (Phases 2–3) was carried out at Falck Fire Services (Esbjerg, Denmark).

CSWG members provided technical direction to the project. Its members during the project were:

Katy Baker	Arcadis
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Dave Wright	BP
Stephen Clarke	BP
Kerry Sinclair (Secretary)	Energy Institute
Dr Mark Scanlon	Energy Institute
Paul Watkins	ENRg Consultants
David Tarttelin (Vice-Chair)	Environment Agency (EA)
Mark Palmer	Esso Petroleum Company Ltd
Tony Brown	Federation of Petroleum Suppliers (FPS)
Tammy Brantley	GB Oils
Liz Copeland	IKM Consulting
Steven Flynn	Rawell Environmental Ltd
Brian Blagden	Scottish Environment Protection Agency (SEPA)
Dr Irene Anders	Scottish Environment Protection Agency (SEPA)
Leighanne Moir	Scottish Environment Protection Agency (SEPA)
Felix Nelson	Shell
Barrie Salmon	Tank Storage Association (TSA)
John Wormald	Total Lindsey Oil Refinery
Jamie Walker	UKPIA
Ian Goldsworthy (Chair)	Valero

The EI wishes to record its appreciation of the work carried out by the researchers and also its gratitude for the valuable contributions made by CSWG members during the course of the project. In addition, the EI acknowledges those industry end-users that participated in an initial questionnaire regarding the sealant materials and system components that were used at their installations, and what were their experiences in using them.

The EI acknowledges suppliers of commercially available sealant materials and system components that donated samples for testing.

1 INTRODUCTION

Resource Protection International (RPI)[Note] was commissioned by the Energy Institute (EI) to consider the scope of and undertake fire exposure testing on commercially available sealant products or systems used to seal construction/expansion joints in secondary containment for aboveground storage tanks storing petroleum, petroleum products or other fuels. The tests would be independently conducted.

The intention of these tests was to investigate the fire resistance duration of the sealant products and systems used under real-world fire conditions as opposed to standardised furnace testing. The criteria for success were inherent fire resistance of the seal whilst also maintaining the liquid (fuel, water and fire-fighting foam) tightness of the joint.

Periods of fire resistance and integrity were investigated with a view to providing information about the seal to the oil and petrochemical industry end-users about these aspects over and above the information which is available from the PDSs.

It was not intended that the test results should give a product or system any commercial advantage when publishing the results contained in this research report. The primary aim was to furnish potential end users of the products, and the industry, with independently assessed information relating to the fire resistance and integrity of the sealant materials and systems for situations where extended periods of fire resistance are required such as in large, long duration bund fires.

Note:

RPI were acquired by the Falck Group part way through the project and therefore reference will be made to RPI/ Falck research report.

2 TESTS SCOPE

A number of products were considered for testing. Given the financial constraints on the project, product selectivity and prioritisation were considered important from an early stage.

In practice, in the UK and Europe, a well-known polysulfide intumescent product is probably the most widely used sealant for bunds. The most critical joints in the industry are remediation ones where the sealant is used behind a steel cover plate. This was considered to be a type of joint that was most in need of fire exposure testing. However, there are a number of other materials in use, or potentially useable that were proposed for testing. These materials were identified by an end user questionnaire conducted by the EI and RPI at an early stage of this project. A summary sheet detailing the products considered is presented in Annex C, and findings of the end-user questionnaire are provided in Annex D.

Whilst it was considered desirable to have the PSLG recommended new build detail tested as well, however, due to time and budgetary constraints this type of joint was not tested – therefore the scope and results of both dry burn and real-world fire exposure testing carried out and reported here are not applicable to new build joints – only remediation ones. Of course, it could be argued that conceptually a new build joint has little potential for loss of containment, since even if the sealant material loses integrity there is a stainless steel waterstop present. The most suitable product candidates based on the end user initial product questionnaire and subsequent meetings with suppliers were:

- Product A – intumescent polysulfide sealant.
- Product B – phenolic syntactic foam (PSF) sealant.
- Product C – silyl modified polyurethane (SMP) sealant.
- Product D – fire resistant (FR) silicone sealant.
- Product E – FR polyurethane sealant with Product F – intumescent foil backed sponge.

Phase 1 initial tests were set up as fire exposure tests with the aim of establishing how the sealants and joint configurations perform under high temperature. Fire exposure tests involved constructing a single joint in a simple wall module subjected to a heptane fire exposure. Burns were dry, i.e. no liquid (either fuel or water) was present against the seal; fuel used for the burn was contained in a steel pan and therefore the seals were subjected to flaming only throughout the test to ascertain how the materials performed under fire conditions. These tests were envisaged to see how the sealant system behaved and what timescales they could survive. They also were used to screen the sealant systems before proceeding to Phase 2 tests.

The aim of Phase 2 was to carry out fire exposure and liquid retention tests in small bund mock-up modules with a single joint on the fire-exposed side to enable visualisation of the behaviour of sealant systems and contained liquids under fire conditions. Hydrostatic tests were performed, and then the joints were subjected to fire exposure. At the end of the test period, the bunds were subjected to hydrostatic tests again to determine leak tightness.

Phase 3 tests were carried out at the end of the project based on further input from the CSWG and were aimed at ascertaining the resilience of double joints (i.e. where a sealant material is present in both exposed and unexposed faces of the bund) especially to an extended period of the exposure and to simulate addition of firewater to fire exposed joints.