Guidance on selection, installation and management of fire-resistant sealant materials and system components for secondary containment construction/expansion joints

energy institute

GUIDANCE ON SELECTION, INSTALLATION AND MANAGEMENT OF FIRE-RESISTANT SEALANT MATERIALS AND SYSTEM COMPONENTS FOR SECONDARY CONTAINMENT CONSTRUCTION/EXPANSION JOINTS

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FOREWORD

This technical publication has been prepared under the technical direction of the Energy Institute's (EI) Containment Systems Working Group (CSWG) adopting the findings from the *Research report: Fire resistance testing of sealant materials and system components for secondary containment construction/expansion joints* (hereafter *Research report).* It is primarily intended for application in the United Kingdom (UK) since it refers to the Control of Major Accident Hazards (COMAH) Competent Authority (CA) *Policy on containment of bulk hazardous liquids at COMAH establishments* (hereafter. *Containment policy*). However, this technical publication may also be relevant for facilities and markets outside of the UK.

The *Research report* is a comprehensive document detailing the experimental work carried out to investigate the fire resistance duration and liquid retention capabilities/integrity of sealant systems used under real world fire exposure conditions. This accompanying technical publication integrates information from product data sheets (PDS) to provide guidance on installation, inspection, maintenance and life cycle considerations.

The main conclusions relating to these and from the EI fire testing investigations are:

- A variety of fire-resistant (FR) sealant materials are available for use in secondary containment construction/expansion joints. In the EI fire testing programme investigations of remediation type joints were tested (i.e. comprising of backer, sealant, intumescent foil backed sponge strip and Process Safety Leadership Group [PSLG] recommended steel cover plate described in *Final report: Safety and environmental standards for fuel storage sites*, hereafter PSLG *Final report*).
- Some sealant products on the market are not specifically designed for application to vertical and/or horizontal bund wall gaps and this was evidenced during installation of the fire tested joints. Specifiers and end users should select a FR sealant that is conducive to installation as well as one that offers good fire resistance.
- Various sealant materials are damaged by exposure to a hydrocarbon fire without the protection afforded by a steel cover plate, and their liquid retention effectiveness is reduced. However, even with a steel cover plate there will be significant damage to the seal due to long heat exposure and spalling of concrete, such that its integrity may eventually fail, leading to liquid leakage from the secondary containment.
- In general, all sealants exposed to hydrocarbon fires during the EI test work failed within 2–3 hours when the seal was installed on a single side of a bund mock-up module.
- Seals were partially consumed or extensively damaged above the liquid level in the bund module mock-ups, even with steel cover plates installed as additional protection.
- There are implications of adding firewater and/or foam to a bund fire in progress – as the liquid level rises it will encounter the damaged portion of the joint and push any sealant material outwards, increasing the possibility of loss of containment from the bund.
- There are various installation considerations that require thought and the quality of installation is highly likely to affect fire performance.
- The type of backing material used in the joint plays an important role in maintaining integrity of the seal in front. Ceramic fibre (CF) backers appear to be more robust following fire exposure and resistant to the passage of liquid through secondary containment gaps.

- Under fire exposure conditions all the joints fire tested were seen to emit potentially noxious fumes from time to time – fire responders should be aware of this hazard. Additionally, steam ejection can easily weaken or dislodge backing materials on the unexposed side of the joint and eventually push them outwards, reducing integrity of the sealant system.
- Approximately 35–55 % liquid losses from secondary containment were measured for all products, arising from liquid loss along the damaged portion of the joint during post fire exposure hydrostatic testing when left to stand overnight. The lowest levels of liquid loss were not necessarily observed for products that are the most commonly specified and used. Joints tested without a steel cover plate generally failed to retain liquid during the tests. Therefore, the presence of a steel cover plate helped retain liquid in the bund module mock-ups.
- Where sealants are applied to one side of a bund module mock-up gap there is only a 2-hour response window for joint failure should be given in the case of a fire incident. Where sealants are applied to both sides and robust backing materials are used such as CF, 6 hours or more fire resistance may be possible, although this depends on installation quality. After this time, fire response personnel should monitor closely for signs of loss of integrity and loss of containment. Supplier specifications typically quote 5 hours possible with a double seal arrangement.
- Fire authorities should be involved with the planning preparation in the case of an incident. Fire authorities should be made aware of the risks involved when adding fire water to secondary containment where seals are exposed to fire and plan for the consequences, as added firewater can weaken and dislodge seals that are already weakened by the fire. Liquid loss was substantially reduced under fire conditions when firewater was not applied to the bund module mock-up fire. In cases where liquid might be lost due to fire control actions, facility operating companies and fire responders should consider what tertiary containment measures might be necessary.
- Where steel cover plates are utilised for additional protection there is a possibility of re-ignition of the fire with potential large-scale re-establishment if any applied foam blanket is not secure; this is because the cover plate glows red hot during after a fire exposure and can easily reignite hydrocarbon vapours.
- In practice, during most bund fire incidents it is highly likely that atmospheric storage tank (AST) cooling water systems will be operated to limit the consequences of fire exposure and decrease the possibility of fire escalation. This addition of fire water may weaken the fire exposed seal and fire water run-off may be lost from secondary containment. Therefore, fire responders should pre-plan and consider the vulnerability of the bund and any joints/seals to cracking if water/foam is applied. It is likely that fixed or semi fixed foam systems for bund fire-fighting would minimise the volumes of water added to a bund and lessen the chances of bund/seal damage.

It is hoped that the general findings above offer some useful guidance to designers, specifiers, end users and emergency responders when implementing FR sealants within seal systems for secondary containment applications. For further information on the testing see *Research report*.

1 INTRODUCTION, SCOPE AND APPLICATION

Reference – *Research report: Fire resistance testing of sealant materials and system components for secondary containment construction/expansion joints*	
Section(s) and title(s)	**1 Introduction** **2 Test scope**
Description/scope	The introduction and scope of the *Research report* describe the intent of the test work and the scope of the fire resistance testing: – why it was carried out – how it was carried out – what materials were were tested based on the results of EI/stakeholder initial product surveys

1.1 INTRODUCTION

The selection of appropriate sealant materials and system components in secondary containment expansion joints becomes critical in case of a major fire accident. The 2005 Buncefield fuel storage incident demonstrated the consequences of using inadequate sealant materials. Reports following the incident found that the integrity/fire resistance of sealant materials play an important role in preventing the spread of fire beyond the secondary containment bund area.

Based on a series of fire exposure tests (see *Research report*) this technical publication aims to make industry practitioners (e.g. designers and bulk storage facility managers) intelligent customers of the various commercially available bund sealant materials and configurations used to provide fire resistance and leak tightness in secondary containment (i.e. bund) wall construction/expansion joints. In addition, it aims to assist suppliers of sealant materials and system components in understanding the various industry requirements and specifications to help optimise their products.

This guidance adopts findings from the *Research report*. The *Research report* is a comprehensive document detailing the experimental work carried out to investigate the fire resistance duration and liquid retention capabilities/integrity of sealant systems used under real-world fire conditions.

The objective of the tests was to investigate the fire resistance duration of the sealant materials and system components used under real-world fire conditions as opposed to standardised furnace testing. The criteria for success were inherent fire resistance of the test materials whilst also maintaining the water tightness of the joint.

The period of fire resistance and integrity was investigated with a view to providing information about the seal to the oil and petrochemical industry about these aspects over and above the information which is widely available from PDS. It was not the intention that the results of the tests should give any one sealant material and/or system component any commercial advantage by testing and publishing results. The primary aim was to furnish potential end users of the products, and the industry as a whole, with independently assessed information relating to the fire resistance and integrity of the sealants for situations where

extended periods of fire resistance are required – such as in large, long duration secondary containment bund fires.

Designers, specifiers, end users and emergency responders may use the guidance in this publication to select appropriate system(s) and the tables in Section 4 can be studied to identify the required system that aligns to their performance requirements.

1.2 SCOPE

The aim of this technical publication is to present the findings from the *Research report* concisely and with clarity for industry practitioners. Where appropriate, background information and fire exposure test data from the *Research report* is referenced at the start of each chapter. Designers, specifiers and end users should therefore refer to this if more information is required regarding the various sealant materials and system components, test parameters and fire performance.

This technical publication covers various aspects of the materials and their performance specification, including:

– generic types of sealant systems;
– criteria to include in a specification/performance standard;
– importance of surface preparation and installation quality control;
– typical fire resistance durations;
– life cycle of sealant systems;
– liquid retention duration implications, and
– limitations of guidance with comparison to PSLG requirements.

To accompany this technical publication a media pack is available (see Annex D). The pack collates visual information, including videos and photographs, which were taken during fire exposure and hydrostatic testing of the selected sealant materials and system components. It also provides concise information mirroring the guidance in this technical publication for ease of reading and reference for designers, specifiers, end users and product suppliers.

1.3 APPLICATION

The guidance contained in this technical publication is applicable both to new build installations and existing facilities. As the primary application of the guidance relates to construction/expansion joints in secondary containment bund walls it should be considered how such joints are typically sealed depending on the age of the facility, see 2.2 *Constructional Requirements*. The guidance in this technical publication is primarily intended for application in the United Kingdom (UK) since it refers to the COMAH CA *Containment policy* (see section 2) and matters arising from the Buncefield fuel storage fire in 2005. Also, some of the sealant system materials tested as part of the fire resistance testing research are either solely available or widely applied in the UK market and petroleum and bulk fuel storage sector, respectively. As there are specific constructional requirements for secondary containment construction/ expansion joints recommended in the PSLG *Final report* applied at UK facilities, the guidance provided in this technical publication is particularly relevant to the UK situation.

However, this guidance may also be relevant for facilities and markets outside of the UK. At hydrocarbon storage facilities in other locations it is often observed that sealant materials and system components similar to those tested in the *Research report* are in use and whilst the specific constructional requirements applied by the UK's COMAH CA might not be followed, the guiding principles in terms of fire exposure, fire resistance, design and specification are broadly similar and relevant. For example, in some worldwide locations there is only a requirement to provide a sealant material in a secondary containment bund joint without a steel cover plate or waterstop.

Some of the other sealant materials and system components in use may differ in chemistries, composition, specification or application to those tested in the *Research report*. Therefore, whilst some of the principles contained in this guidance might apply, the non-UK reader should exercise caution in applying the guidance to specific joint configurations, check product/sealant system specifications and capabilities, and if necessary conduct additional fire testing to verify performance.

Products referred to are those that were tested, which were available commercially. They are listed in the *Research report*. The products were selected to reflect different product types and chemistries, as described in the *Research report*. Other products and bespoke solutions not tested should be evaluated using the performance criteria set out in section 4. Pipe penetration and link seal products were excluded from the testing.

It should be noted that new build joints -those featuring a steel waterstop- were not tested in the *Research report* because conceptually they should greatly reduce or eliminate the possibility of loss of containment. Some sealant materials have also been tested without steel cover plates.