



PFP Specialists

Technical Report
Summary of Fire Test Data for Bolt Cap Protection Systems

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Report No.



PFPS-TR-2015-2

Issue

01

Date of Issue

11th June 2020

Document History			
Issue	Date	Prepared by	Comments
01	2020-06-11	Allan Jowsey PhD CEng MEng FIFireE PMSFPE MASCE Director  	First issue

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EXECUTIVE SUMMARY

There is no dedicated fire resistance test standard for bolted connections or their components. As such, product certification is not possible.

In the absence of a fire test standard however, a manufacturer will choose to undertake ad-hoc testing to the principles of a recognised test standard. This can permit an indicative assessment report which demonstrates the capability of the product and can be used with the project team's stakeholders to consider its acceptance and use.

Typhoon have made their fire test reports and associated summaries available to PFPS. Accounting for both cellulosic and hydrocarbon fire test exposures of up to 180 minutes, these documents comprise a mix of: -

- Fire test reports (indicative and preliminary testing) issued by recognised test houses
- Comparative assessment reports issued by recognised test houses
- Technical notes of internal testing written by intumescent coating manufacturers
- Technical notes of internal testing written by Typhoon

The Typhoon bolt caps have demonstrated resilience for up to 180 minutes in cellulosic type fires and 180 minutes in hydrocarbon pool fire/jet fires, in temperatures of up to 1200°C. They have demonstrated an ability to keep the temperature of bolts and nuts below 550°C /538°C for cellulosic fires for fire durations of up to 180 minutes, and 538°C for UL hydrocarbon fires of durations up to 180 minutes, when used in conjunction with an appropriate steelwork protection system.

This document does not make any statement on the fire performance of the bolt caps but simply presents facts relating to documents provided by Typhoon. It is expected that on project-specific enquiries, Typhoon would make their relevant test data or reports available to the project stakeholders as required.

The purpose of this document is to provide assurance to potential end-clients of Typhoon or other project stakeholders that in the absence of a dedicated fire test standard for bolted connections, Typhoon have undertaken a range of ad-hoc testing which may be considered as an acceptable alternative.

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1 INTRODUCTION

Typhoon Performance Products Ltd. (Typhoon) produce a bolt cap protection system for the construction industry that provides protection from the effects of fire to bolts and nuts associated with bolted connections.

PFPS Specialists Ltd. (PFPS) have been requested by Typhoon to provide a summary of the fire testing that has been undertaken on their bolt caps within the context of there being no recognised global fire test standard for bolted connections.

The purpose of this document is to provide assurance to potential end-clients of Typhoon or other project stakeholders that in the absence of a dedicated fire test standard for bolted connections, Typhoon have undertaken range of ad-hoc testing which may be considered as an acceptable alternative.

This document does not make any statement on the fire performance of the bolt caps but simply presents facts relating to documents provided by Typhoon. It is expected that on project-specific enquiries, Typhoon would make their relevant test data or reports available to the project stakeholders as required.

2 REGULATORY OVERVIEW

Regulations associated with the fire resistance of steel structures around the world vary greatly. Fundamentally, a building code or design code will typically dictate the fire resistance period that the steel structure should withstand. This is described as a duration of time with respect to a degree of fire exposure. A complementary critical or limiting temperature that the steel should not exceed is defined by the project's structural engineer or is taken as an assumed and typically conservative value.

It is to note that building codes or design codes provide practical guidance on potential ways to achieve compliance with the requirements of the regulations. They often note that there may be other ways to comply with the requirements via some other acceptable means or method.

2.1 Demonstrating passive fire protection performance via certification

Manufacturers of passive fire protection material will test their products to characterise performance and to ascertain thicknesses of material to meet steelwork specifications. Typically, a selection of beam and column sizes are used, and the resulting matrix of specimens leads to an assessment of data to enable tabulated thicknesses relevant to massivity of steel and limiting steel temperature.

Product certification is based on testing and assessment to an appropriate test standard (e.g. ISO 834 [1], BS 476 [2], UL 263 [3], UL 1709 [4], etc.) by a recognised test house or accredited certification body such as a classification society or notified body.

There is no dedicated fire test standard or assessment protocol for bolted connections, let alone for components of connections, i.e. a bolt cap. As such, bolt cap certification for fire resistance is not possible.

2.2 Alternative means of demonstrating performance

Many building codes and design codes will request materials used on a project demonstrate compliance in accordance with a recognised fire test standard. However, they also make allowances for alternative solutions which meet the intent of the fire test standard. The acceptance of such an approach is therefore subject to confirmation by the project design team, approving authorities or other stakeholders as appropriate.

An example of an alternative means of demonstrating performance is given in Figure 1, which is an extract from the International Building Code (IBC) [5], which is commonly used in North America.

104.11 Alternative materials, design and methods of construction

and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety. Where the alternative material, design or method of construction is not approved, the building official shall respond in writing, stating the reasons why the alternative was not approved.

104.11.1 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

104.11.2 Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the building official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the building official for the period required for retention of public records.

Figure 1: Example extract from the International Building Code (IBC) [5] on alternative means of demonstrating performance

Within the UK and Europe, guidance on the use of products is given typically in terms of performance classifications in relation to British or European standards. Products are required to demonstrate they can meet the relevant performance classification. One such method to do this involves assessment by applying relevant test evidence, in lieu of carrying out a test. Products for the protection of steelwork are then classified for fire resistance to EN 13501-2 [6] and are

deemed acceptable for use in industry, having demonstrated they meet the relevant performance classification.

A classification report, however, requires a classification standard and a definition of appropriate classification. While these exist for common steel beams and columns, they do not exist for a bolt cap. As such, for bolt caps, it is impossible to obtain a classification report due to the absence of classification standard for them.

Where no dedicated standard exists, manufacturers will undertake ad-hoc fire testing to produce an indicative assessment report. Such testing will often be done in accordance with the intent of the principles of a recognised fire test standard. A corresponding indicative assessment report will then be produced, which although does not constitute product certification, it can be used to provide confidence in the performance of a product.

3 FIRE TESTING OF BOLT CAPS

Typhoon have made their fire test reports and associated summaries available to PFPS. These are a series of ad-hoc fire tests that align with the intent of common fire test standards. They include a mix of tests undertaken by recognised test houses, internal tests undertaken by manufacturers of passive fire protection materials and technical notes by Typhoon.

Typhoon have confirmed to PFPS that they are at liberty to provide, without restriction, the test reports that are specifically issued to named sponsors not limited to Typhoon.

PFPS have summarised the content of the fire tests as shown below. Due to commercial sensitivity, not all details associated with each report are reproduced in full, however, the key aspects of each are presented to provide confidence to the reader of the extent of fire testing that has been undertaken on bolt caps.

The size of bolts varies across the tests, ranging from M16 to M30 metric sizes and $\frac{3}{4}$ " to $1\frac{3}{4}$ " imperial sizes.

3.1 Documents issued by recognised test houses or classification societies

3.1.1 Cellulosic

Issuing body:	BRE
Document type:	Test report
Document reference:	P112832-1000 Issue 1
Issued:	5 th May 2018
Fire exposure:	BS 476-20
Duration:	90 minutes
Comments:	This test comprised three composite steel T-shaped assemblies, each comprising two I-section steel beams joined to the top of a steel I-section column via bolts. The structural sections were painted with an intumescent coating.

Issuing body:	UL
Document type:	Test report (preliminary investigation)
Document reference:	File number: R7471, Project number: 4786307192(A)
Issued:	12 th February 2014
Fire exposure:	UL 1479 / UL 263
Duration:	180 minutes
Comments:	This was a preliminary investigation report of a small-scale fire test of ¼" steel plate protected with an intumescent coating and with bolt caps protecting bolts passing through the plate.

Issuing body:	Warringtonfire Australia
Document type:	Assessment report (comparative - based on another test report)
Document reference:	FAS190046 R1.0
Issued:	13 th September 2019 (expires 30 th September 2024)
Fire exposure:	AS 1530.4
Duration:	120 minutes
Comments:	This is a comparative assessment report which concludes that bolt caps are likely to achieve fire resistance performance of up to 120 minutes if tested in accordance with AS 1530.4:2014 test conditions.

Issuing body:	Northwest Composite Centre / The National Composites Certification and Evaluation Facility
Document type:	Technical note
Document reference:	NCCEF F1
Issued:	February 2009
Fire exposure:	BS 476-20
Duration:	120 minutes
Comments:	This document summarises a small-scale fire test of steel plate protected with an intumescent coating and with bolt caps protecting bolts passing through the plate.

Issued by:	Typhoon Performance Products
Document type:	Technical note
Document reference:	Test note – TP N – SWBC90/2012, Project #: 12-088-126
Issued:	26 th June 2012
Fire exposure:	BS 476-20
Duration:	90 minutes
Comments:	This technical note by Typhoon summarises a small-scale fire test of steel plate protected with an intumescent coating and with bolt caps protecting bolts passing through the plate.

3.1.2 Hydrocarbon

Issuing body:	UL
Document type:	Test report (preliminary investigation)
Document reference:	File number: R9607, Project number: 4788165431
Issued:	30 th April 2019
Fire exposure:	UL 1709
Duration:	180 minutes
Comments:	This was a preliminary investigation report of a small-scale fire test of 10mm steel plate protected with an intumescent coating and with bolt caps protecting bolts passing through the plate.

Issuing body:	Lloyd's Register
Document type:	Certificate of Fire Approval (manufacturer-specific)
Document reference:	SAS F150202 / M2
Issued:	25 th May 2018 (expires 22 nd July 2020)
Fire exposure:	BS 476-20 Appendix D / ISO 22899-1:2007
Duration:	120 minutes
Comments:	This is a Certificate of Fire Approval for structural steel sections protected with International Paint's Chartek 7E for hydrocarbon fires incorporating jet fire exposures, up to 120 minutes. Page 3 of the certificate is a Design Appraisal Document which states <i>"Additional jet fire testing was performed to demonstrate that 'Chartek Boltcaps' may be used for the protection of bolt heads and nuts without adversely affecting the fire performance of the 'Chartek 7E' system."</i>

Issued by:	Manufacturer of intumescent coating
Document type:	Technical note
Document reference:	TN/F/CT/489_Rev.0
Issued:	13 th May 2019
Fire exposure:	UL 1709
Duration:	Test was terminated after 229 minutes
Comments:	This document is a summary of an in-house test which showed that the temperatures of the bolts remained no greater than 538°C for at least 180 minutes.

Issued by:	Typhoon
Document type:	Technical note
Document reference:	TPPL/D/JD/2509 Rev 0
Issued:	25 th September 2018
Fire exposure:	UL 1709
Duration:	180 minutes
Comments:	This Typhoon document is a summary of an in-house test at an intumescent coating manufacturer which tested flat panels of different thicknesses formed from the bolt cap material. These panels were used to encapsulate steel columns.

4 SUMMARY

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5 REFERENCES

- [1] ISO 834-1: 1999, Fire-resistance tests - Elements of building construction. General requirements. International Standards Organisation
- [2] BS 476-20: 1987, Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles). BSI
- [3] UL 263 Fire Tests of Building Construction and Materials.
- [4] UL 1709 5th Edition, February 24, 2017. UL Standard for Safety Rapid Rise Fire Tests of Protection Materials for Structural Steel.
- [5] 2018 International Building Code (IBC). Fourth printing: Jan 2020. The International Code Council, Inc. 2018.
- [6] EN 13501-2:2016 Fire classification of construction products and building elements. Classification using data from fire resistance tests, excluding ventilation services. CEN. 2016.