Advanced **water mist** fire testing for non-standard **heritage buildings**

Harry Wright, Regional Sales Manager at Siemens GB&I

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Agenda

- Project introduction
- Motivation for **high-pressure water mist**
- Fire test protocol, design standard, and fire testing
- The sprinkler test
- The water mist test
- Conclusions drawn
- The test report

Intension to use high-pressure water mist

As part of a large-scale refurbishment of a historically important heritage building, an active fire suppression system has been chosen to be used to protect the site.

The heritage building consists of a historically important research library, and tourist attraction.

High-pressure water mist technology has been chosen to protect the facility because of the following system advantages:

•Small pipework

•Harmless to occupants

•Conventionally lower water flow and demand

•Reduced water damage in the event of an activation

•Extremely efficient at fighting fire

•Automatic system activation

•Aesthetic design, with less visual impact on historical ceilings

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Project introduction

- Due to the unique size, construction, and fire loading of the heritage library, there isn't a pre-existing fire test protocol that is relevant that suitably matches the building parameters.
- Thus, Siemens were employed to consult, design, and test a suitable system to protect the unique buildings in compliance with **EN 14972-1:2020**, and base a water mist system sizing on actual fire test data relating to the exact hazard.
- The fire testing was completed by a 3rd Party accredited fire research facility called RISE Fire Research AS, in Norway.

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Developing a fire test protocol


BS EN 14972-1:2020

BSI Standards Publication

Fixed firefighting systems — Water mist systems

Part 1: Design, installation, inspection and maintenance

bsi.

Committee member copy: Do not reproduce

4.1.3.1 General

The safe use of a water mist system is limited to applications it has been tested for. Water mist systems shall be tested in accordance with the fire test protocols of the EN 14972 series[1]. For scenarios where test protocols listed in EN 14972 series[1] are not applicable, water mist systems shall be tested in accordance with the guidelines given in Annex A.

BS EN 14972-1:2020
EN 14972-1:2020 (E)

Annex A
(informative)

Guideline for developing representative fire test protocols for water mist systems

A.1 General

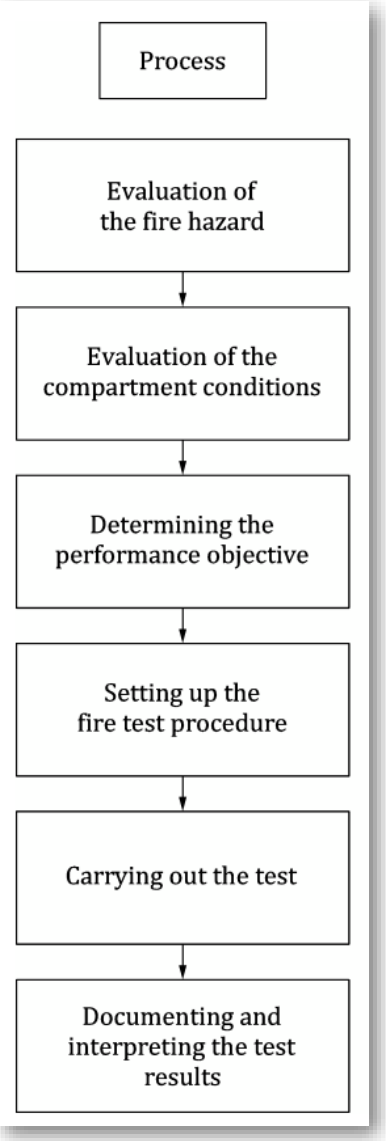
Annex A provides guidelines for defining representative fire test protocols based on a proper fire protection engineering evaluation of the fire hazard, the compartment conditions, and the performance objectives for the system.

The design of a test protocol should be in accordance with the established scientific and engineering principles of fire protection that incorporate widely accepted methods, empirical data, calculations, correlations and computer models, as exemplified by the ISO 16730 series, Fire safety engineering, and as contained in engineering textbooks and technical literature.

The intent of these guidelines is to encourage the development of fire test procedures that:

a) are based on a fire protection engineering evaluation of the fire hazard, the compartment conditions, and the performance objectives for the water mist system;

b) are developed, carried out, and interpreted by qualified personnel.



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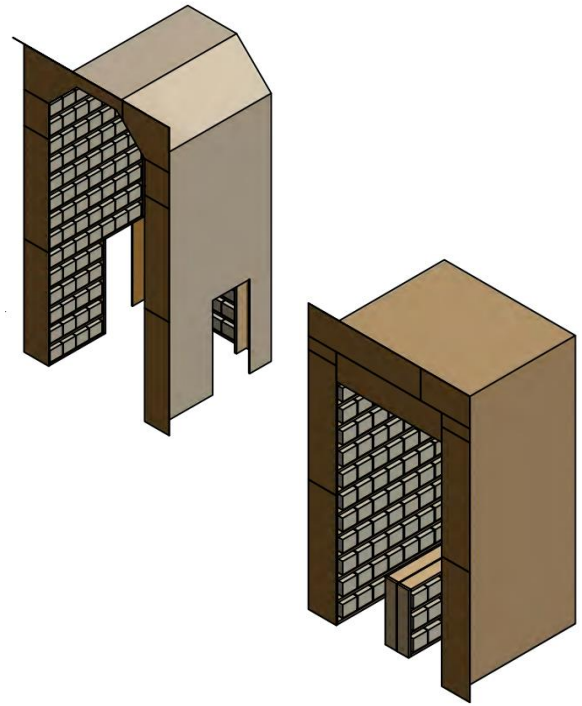
General requirements of the testing

Evaluation of compartments
Exacting measurements were taken of the fire compartments, so replicas could be produced.



The fuel source
The fuel source shall be based on empty double wall cardboard boxes of 310 mm × 230 mm × 250 (L × W × H)
The cardboard boxes shall be placed on shelves in accordance with images shown.

The cardboard boxes used for the fuel source is classified as category III in accordance with **EN 12845 [5].**

Reference sprinkler test
The sprinkler system used in the reference tests shall be in accordance with VdS 3883-5en.

Ignition source
The ignition source is a unit made of fibreboard soaked in heptane in a closed plastic bag as described in EN 14972-3:2021 section 5.3.4

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Test procedure and criteria

Test program

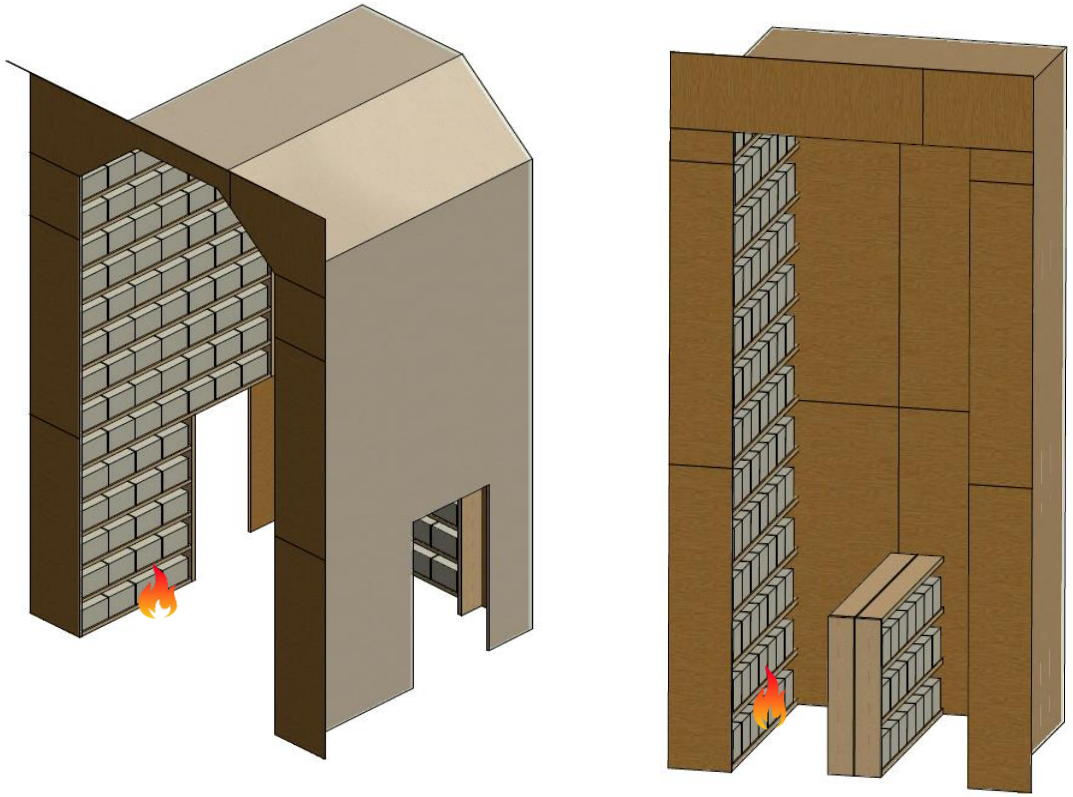
The following fire tests shall be conducted with the nozzles installed in the top of the alcove for both lower and upper level and the test shall be conducted with the minimum operating pressure specified by the manufacturer.

Test procedure

The ignition cube is ignited, and the fire is allowed to burn freely until the sprinkler (reference tests) or water mist nozzles (classification tests) are activated.

The water flow shall in accordance with **VdS 3883-5en [6]** be shut-off 10 minutes after the activation of the sprinkler or water mist nozzle. Any remaining fire should be extinguished manually.

The data sampling is stopped and logged. Pictures of the remaining fuel package are to be taken. Damages to the fuel package shall be measured and recorded.



Pass criteria
The performance of the tested water mist system shall be evaluated against the performance of the reference sprinkler system.

The temperature and damage of each individual water mist test shall be equal or less than the temperature and damage in the respective sprinkler test.

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The fire test
Large scale fire testing – Historical library

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Reference sprinkler test – Lower alcove

Video 1

Ignition.

Video 2

02:42
Nozzle activation.

Video 3

05:30
Fire continues to grow manual extinguishment.

Video 4

12:56
Test is ended manual extinguishment.

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The sprinkler reference test results

Test 1

For Test 2, there were 109 Unharmed boxes, 0 boxes with damage less than 50% and 109 boxes with damage between 50% and 100%. The fire spread to the centre bookshelf. The front plate was only damaged in the area bordering to the shelves on the ignition side. See Figure A 16.

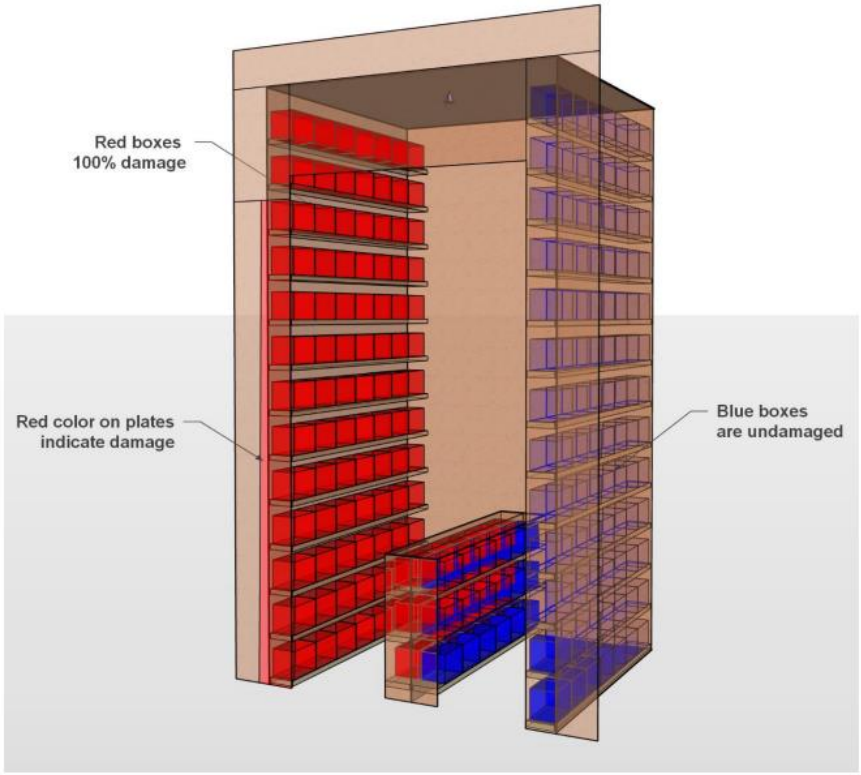

Figure A 8 Recorded damages after test 2. Blue boxes indicate that the cardboard box is undamaged. Yellow boxes indicate less than 50% damaged. Red boxes indicate that the damage is between 50% and 100%

Test 2

For Test 1, there were 86 Unharmed boxes, 3 boxes with damage less than 50% and 71 boxes with damage between 50% and 100%. The front plate was damaged in the area bordering to the shelves on the ignition side, as well as 1/3rd of the top plate above the alcove. See Figure A 16.

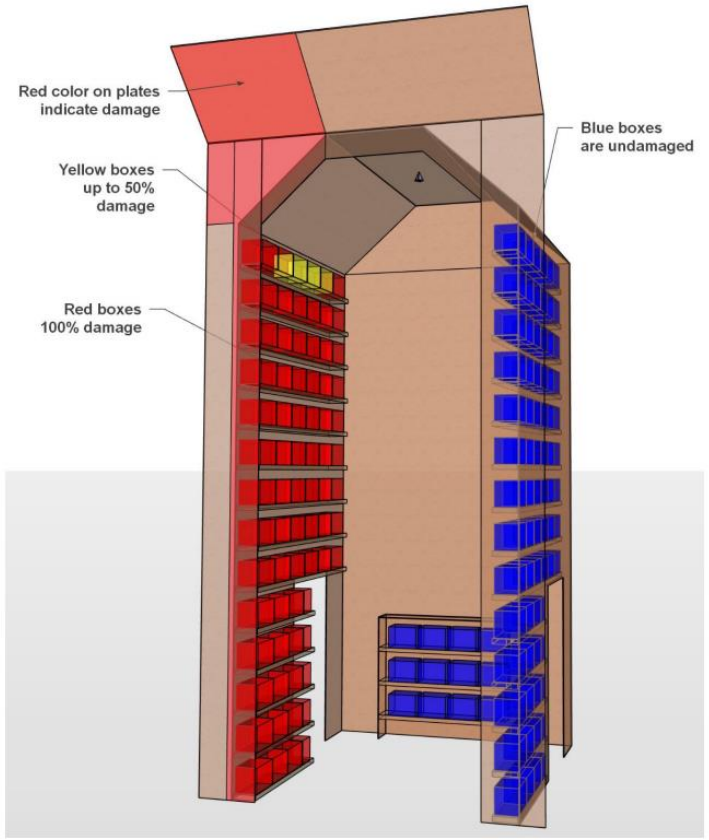

Figure A 4 Recorded damages after test 1. Blue boxes indicate that the cardboard box is undamaged. Yellow boxes indicate less than 50% damaged. Red boxes indicate that the damage is between 50% and 100%

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The Water Mist Test
Witnessing 17th October 2023

Now the reference and benchmark had been outlined by the completed sprinkler test, the water mist system is to be reviewed.

The results of the water mist test need to outperform the sprinkler test and meet our pass/fail criteria.

Ahead of the witnessing, multiple tests were completed. This was done to find the most suitable nozzle, flow, spray angle, mist density, etc.

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Water mist test – Lower alcove

Video 1

Ignition.

Video 2

02:33
Nozzle activation.

Video 3

05:30
Fire is controlled by the water mist.

Video 4

12:38
Test is ended. Water mist has extinguished fire.

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The water mist test results

Test 3

For Test 3, there were 96 Unharmed boxes, 8 boxes with damage less than 50% and 56 boxes with damage between 50% and 100%. The front plate was only damaged in the area bordering to the shelves on the ignition side. See Figure A 16.

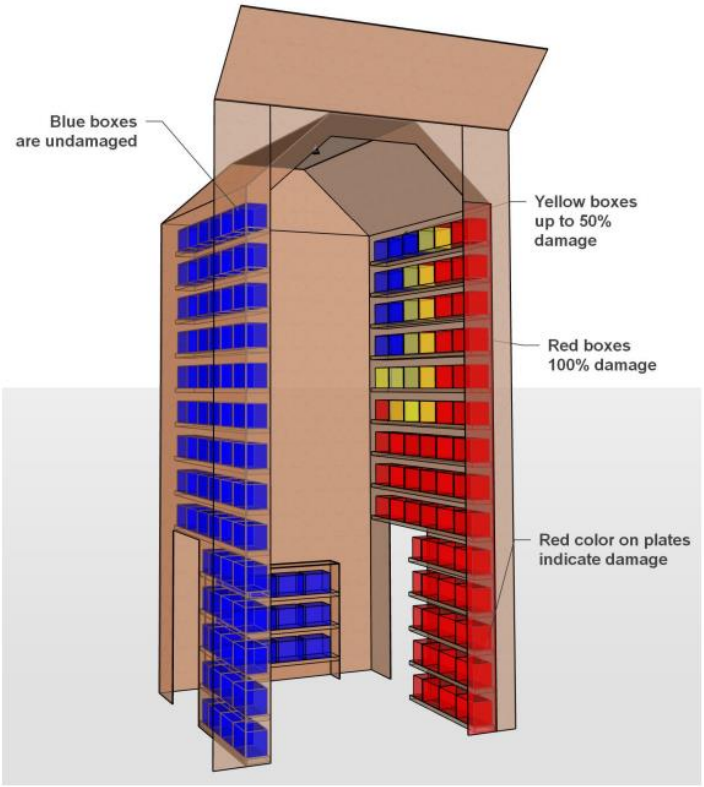

Figure A 12 Recorded damages after test 3. Blue boxes indicate that the cardboard box is undamaged. Yellow boxes indicate less than 50% damaged. Red boxes indicate that the damage is between 50% and 100%

Test 4

For Test 4, there were 174 Unharmed boxes, 8 boxes with damage less than 50% and 36 boxes with damage between 50% and 100%. See Figure A 16.

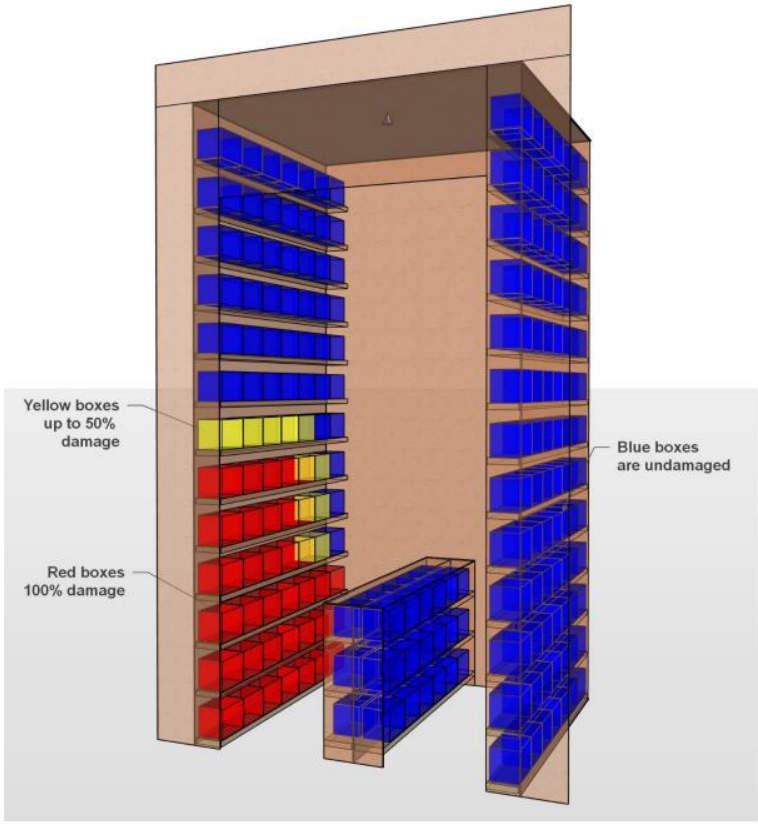

Figure A 16 Recorded damages after test 4. Blue boxes indicate that the cardboard box is undamaged. Yellow boxes indicate less than 50% damaged. Red boxes indicate that the damage is between 50% and 100%

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Conclusions from testing

Pass Criteria

- The performance of the tested water mist system shall be evaluated against the performance of the reference sprinkler system.

- The temperature and damage of each individual water mist test shall be equal or less than the temperature and damage in the respective sprinkler test.

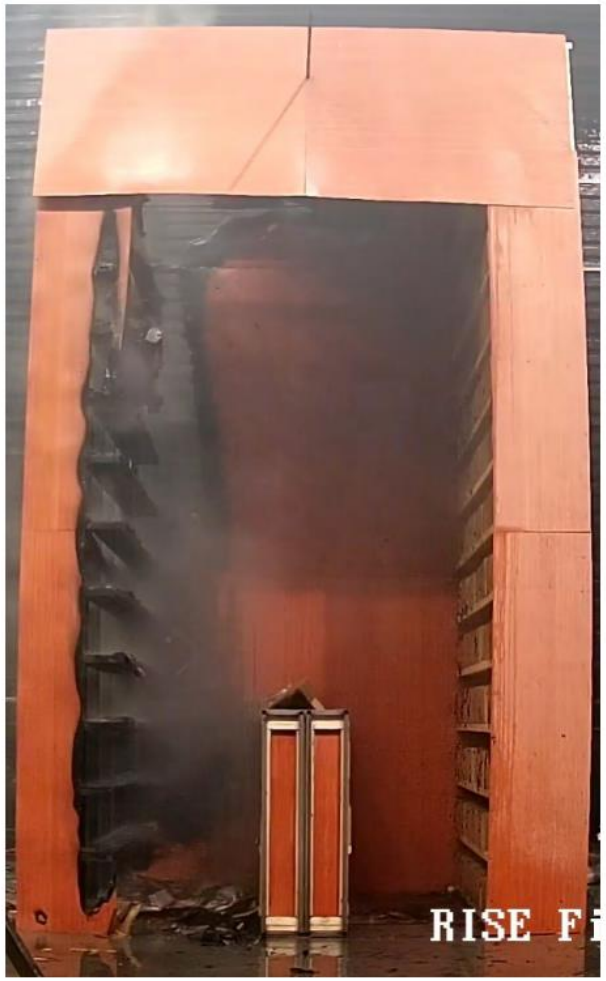

Photo C 10 Image of squared alcove after sprinkler test, Test 2.

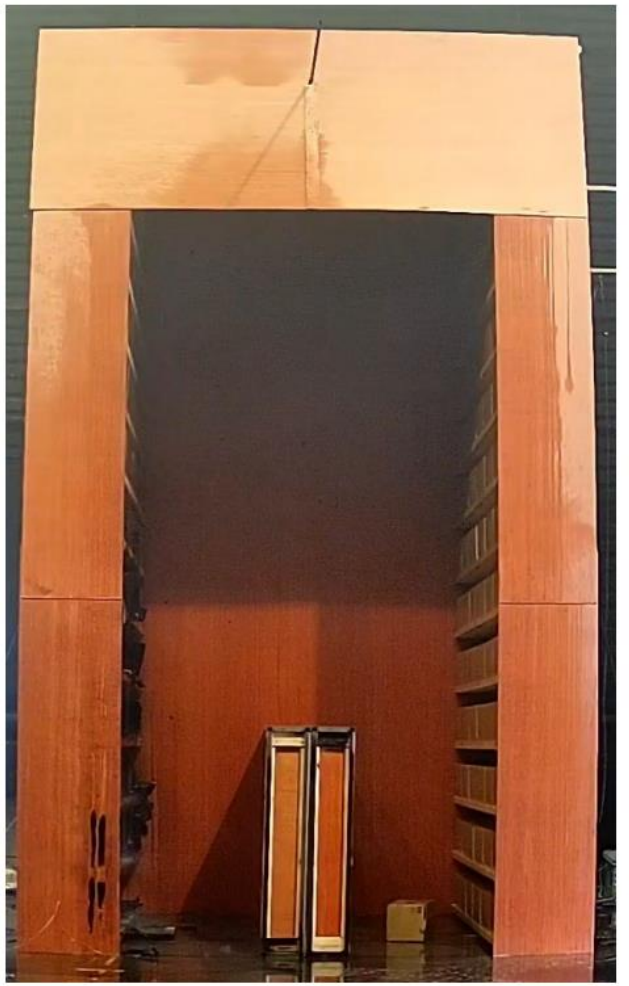

Photo C 11 Images of squared alcove after water mist test, Test 4.

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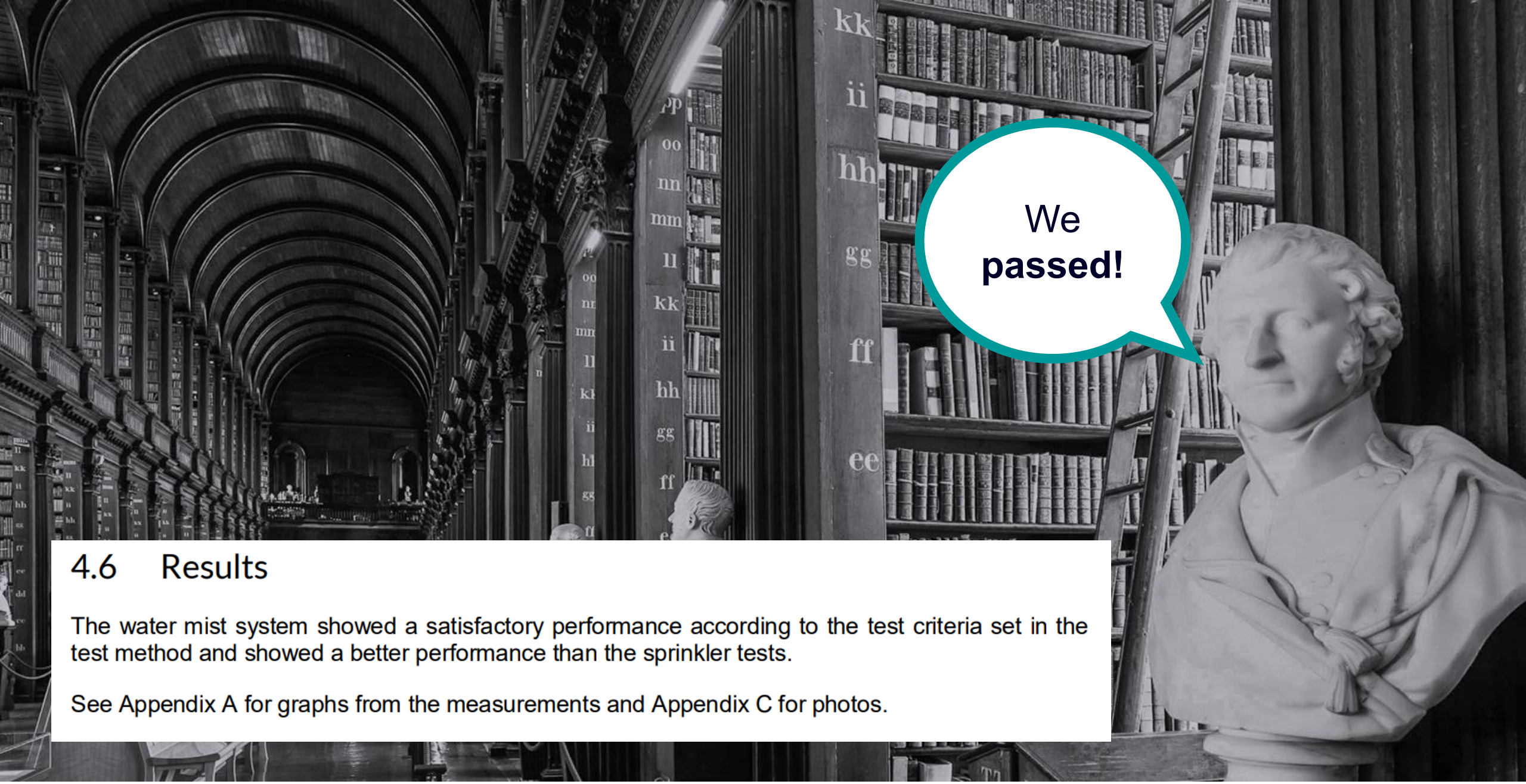


4.6 Results

The water mist system showed a satisfactory performance according to the test criteria set in the test method and showed a better performance than the sprinkler tests.

See Appendix A for graphs from the measurements and Appendix C for photos.

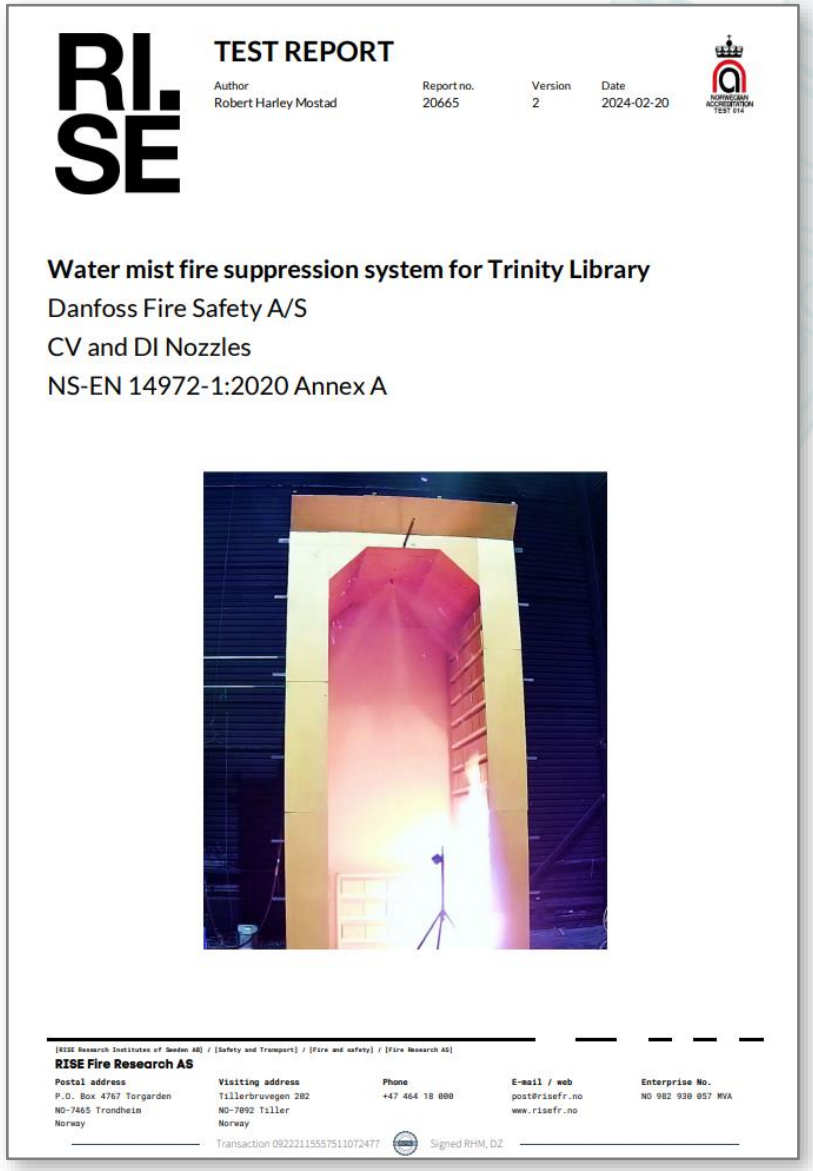
Creation of the fire test report

- To formalise the fire testing, the 3rd Party fire test laboratory RISE Fire Research A/S created our test report.

- This report provides an in-depth overview on the testing that was completed, including test layouts, test images, thermal data, and conclusions.

- This formalises the outcomes of the testing, with unbiased data supported conclusions on the most suitable nozzle to protect the long room.

- This allows us to confidently use the Siemens water mist system, supporting the design intent with data demonstrating its suitability over a conventional sprinkler system.



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TEST REPORT

Author	Report no.	Version	Date
Robert Harley Mostad	20665	2	2024-02-20

Water mist fire suppression system for Trinity Library

Danfoss Fire Safety A/S

CV and DI Nozzles

NS-EN 14972-1:2020 Annex A

[RISE Research Institutes of Sweden AB] / [Safety and Transport] / [Fire and safety] / [Fire Research AS]

RISE Fire Research AS

Postal address	Visiting address	Phone	E-mail / web	Enterprise No.
P.O. Box 4767 Torgarden NO-7465 Trondheim Norway	Tillerbruvegen 202 NO-7892 Tiller Norway	+47 464 18 000	post@risefr.no www.risefr.no	NO 982 930 057 MVA

Transaction 09222115557511072477 Signed RHM, DZ

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Harry Wright,
Regional Sales Manager
+44 7762 025 394
harry.wright@siemens.com