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From deviation to certified protection concept

Development, planning and implementation

1 New risks

2 VdS CEA 4001

3 Annex T

4 Proof of effectiveness

5 Conducting fire tests

6 Protection Concept

7 Limits of application

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1 New risks

Technical development is subject to constant change

New technologies:

- **Hyperscale data center**
- **Large-scale energy storage**
- **Electric mobility**
- **New storage systems**
- **…**

Selected example for further presentation:

TL-ASRS → Top Loading - Automatic Storage and Retrieval Systems

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1 New risks

Warehouse technology is subject to a continuous optimizing process

Automation and efficiency are basic requirements of today's warehouse technology

- Use of robots and artificial intelligence

- Optimizing of space utilization

One approach:

TL-ASRS → Top Loading - Automatic Storage and Retrieval Systems

Advantages from a logistics perspective:

- Top loading storage systems do not require aisles for operating equipment or forklift trucks.
  - This results in maximum utilization of storage space volume.
  - The surface area of such systems is theoretically unlimited.

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1 New risks

TL-ASRS = Top Loading - Automatic Storage and Retrieval Systems

Disadvantages from a fire safety perspective:

- No clear strips or aisles without fire load required
- Very high fire load density due to plastic crates containing stored goods
- No access
  - -for employes to combat small fires
  - -for firefighters for firefighting operations
- Extensive clearing required to reach the seat of the fire

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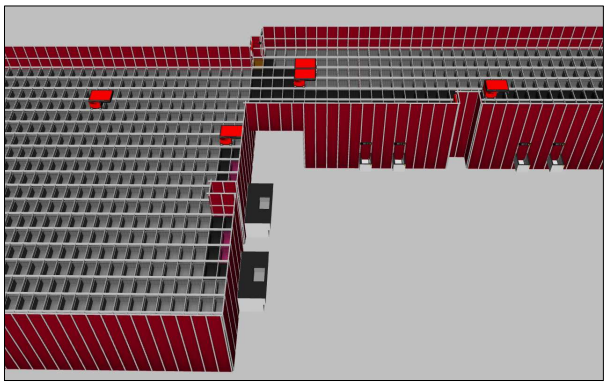
1 New risks

E.g. TL-ASRS Autostore® Lagersystem

- Systems with up to 180.000 bins and more



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2 VdS CEA 4001

Deviations

VdS CEA 4001 specified no design parameters to protect TL-ASRS risks.

The following deviations from VdS CEA 4001, guidelines for sprinkler systems, were identified:

- Exceeding the maximum allowed partial storage areas of 150 m²
- Elimination of 2.4 m wide clear aisles
- Exceeding the maximum allowed storage height of 4.6 m
- Risk cannot be assigned to any of the known storage types

Additional requirement of the client: No use of foam concentrate

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2 VdS CEA 4001

- **Possible solutions when a fire extinguishing system is required:**
  1. Comprehensive application of a planning and installation set of rules that offers a solution:
     - e.g. FM Data Sheet 8-34 Protection for Automatic Storage and Retrieval Systems
     - e.g., extinguishing system with other extinguishing agent, if suitability has been proven
  2. Application of Annex T of VdS CEA 4001
  3. Conducting large scale fire and extinguishing tests as proof of effectiveness

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3 Annex T

Mixing of different planning and installation guidelines is not permitted.

VdS CEA 4001 : 2021-01 (07) Application of Annex T in the case of special risks, if

- no design parameters are described in VdS CEA 4001 and
- in other planning and installation guidelines design parameters are described.

Aim of Annex T:

- Preventing uncontrolled growth and cherry-picking,
- Description of a defined interface.

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3 Annex T

Defined interface to another planning and installation guideline

- Some of the key points to be considered during application:
  - Drafting of a fire extinguishing system concept
  - Review of the fire extinguishing system concept prior to application
  - In addition to VdS CEA 4001, only one other guideline may be used
  - Detailed list of which parameters from which guideline are to be applied
    - Operating time in accordance with the guideline from which the design parameters originate
    - Hydraulic calculation in accordance with VdS CEA 4001
    - …
  - Description of the separation from other areas
  - …

  Note: It is recommended that the application of Annex T be coordinated in advance with the authorities having jurisdiction and the fire insurer.

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4 Proof of effectiveness

Fire and extinguishing tests

Quote from a colleague:

„Learning by burning!“

- Proof of effectiveness is an option when deviating from guidelines or when the effectiveness of a protection concept needs to be proven.
- There is always a test result!

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4 Proof of effectiveness

Why not use computer simulation?

There is currently no validated software that can simulate the interaction of a fire with an activated sprinkler system.

What else needs to be considered?

- Results from effectiveness tests are generally
  - not transferable
  - property of the client

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4 Proof of effectiveness

Fire test concept

The proof of effectiveness shall test the worst-case scenario that can realistically be assumed, i.e., the most unfavorable combination of all parameters determined!

The fire test concept describes the structure and procedure of the proof of effectiveness:

- Test and protection goal(s)
- Test setup
  - Storage system, storage height, storage material, other fire loads, size and scope
- Extinguishing agents and sprinkler system, including sprinkler type and layout
- Ceiling height, spray obstacles, etc.
- Safety margins
- Evaluation and pass criteria
- Number and sequence of tests: As many as necessary, as few as possible
- Repeat tests

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4 Proof of effectiveness

Protection goal

Introduction from DIN EN 12845:
An automatic sprinkler system is designed to detect a fire and extinguish it with water at an early stage or to keep the fire under control so that it can be extinguished by other means.

Introduction from VdS CEA 4001:
An automatic sprinkler system is designed to detect a fire in its early stages and extinguish it or bring it under control so that it can be extinguished by other means. Final extinguishing must be carried out by emergency services (e.g., the fire department). For high-rack storage systems in general and multi-row racking in particular, a concept must be developed for how the seat of the fire can be reached and finally extinguished in the event of a fire.

Protection goal: Enabling final extinguishing

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5 Conducting Proof of Effectiveness

Example: Fire test in a ASRS system

Question: Positioning of sprinklers at the outer edge of the rack ("face" sprinklers)

- Ignition source: MDF-boards soaked in n-heptane
- ASRS with in rack sprinklers
- Plastic bins made of PE
- Sprinkler distance to outer edge: 20 cm
- Distance between sprinkler and bins: 10 cm
- K57, RTI of sprinkler „fast"
- Ignition between two sprinklers

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5 Conducting Proof of Effectiveness

General

Proof of effectiveness is carried out on a scale of 1:1 and must be verifiable and repeatable!

The following is needed to carry out proof of effectiveness in accordance with the fire test concept:

- Suitable fire test center
  - Including measurement technology, documentation, and test report
- Automatic fire extinguishing system, in this case a sprinkler system
  - Safety margins: e.g. Water density in the test reduced by 10 % compared to the planned design
- Test setup storage system
  - Storage material and targets
  - Size of setup and mock-Up

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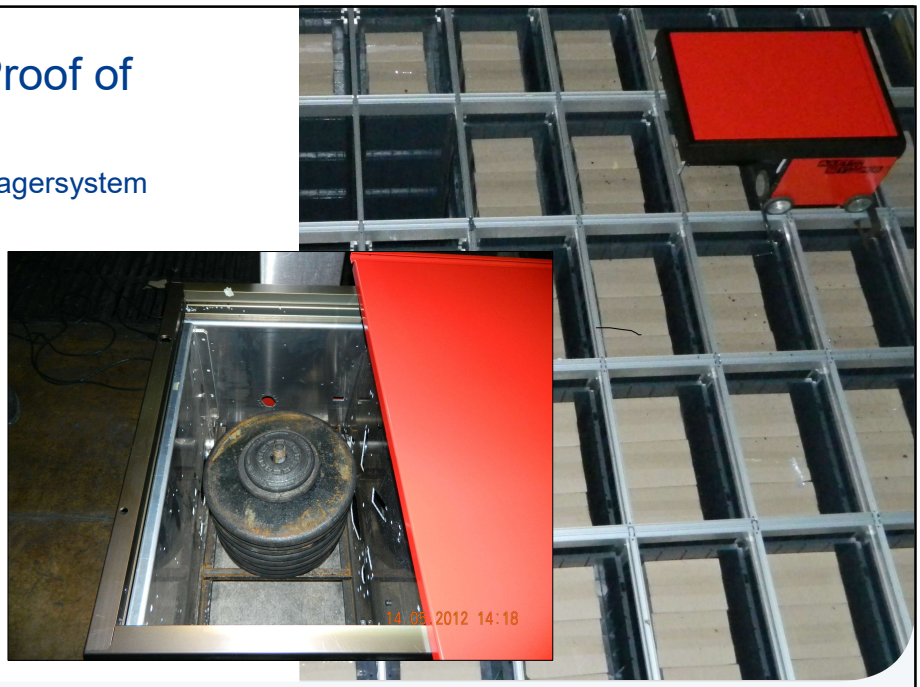
5 Conducting Proof of Effectiveness

TL-ASRS Autostore® Lagersystem

- Test set-up
- Robot Mock-Up



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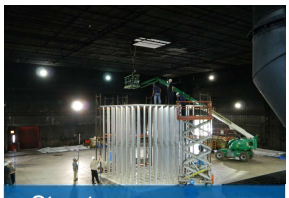
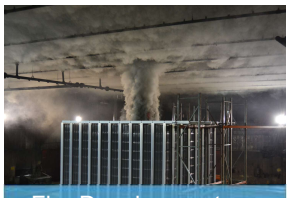
5 Conducting Proof of Effectiveness

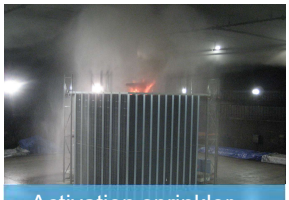
Snapshots of a large scale fire and extinguishing test


Structure


Top view


Ignition


Fire Development


Activation sprinkler


Operating sprinkler


End of test


Evaluation

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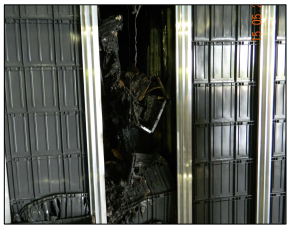
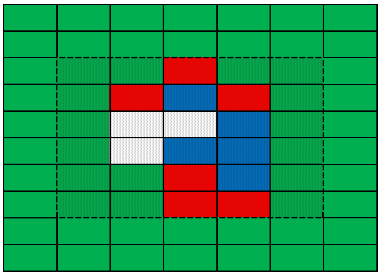
5 Conducting Proof of Effectiveness

Evaluation of fire damage



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6 Protection Concept

Certificate

Based on positive evaluated proof of effectiveness and the parameters determined, a detailed protection concept is created and certified as the final component of the process.

- Key elements of a protection concept:
  - Description of the protection objective and the risk to be protected against
  - Description of deviations from the regulations
  - Design parameters of the sprinkler system
  - Boundary parameters to be observed
  - Structural measures
  - Organizational measures
  - Additional fire protection systems, if applicable
  - Exclusion of storage materials not considered
  - …

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7 Limits of application

Deviation from the protection concept

Applicability is only given if the protection concept can be fully implemented in all points!

Observe restrictions, e.g., excluded stored goods

If and to what extent changes or deviations can be accepted without further proof of effectiveness shall be considered and examined on a case-by-case basis.

Every parameter that is changed has an impact on fire behavior, e.g.:

- Changes to the storage system technology itself
- Examples of seemingly minor changes:
  - New materials,
  - New structure of storage containers, e.g., reinforcement ribs, or
  - New design of storage containers, e.g., foldable boxes.

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