



VdS analysis of 25-year inspections of sprinkler system

Marcel Ruesink,
Powered by Leo de Groot

FSI Amsterdam 2023



Agenda

Enter your subtitle here

1.0

VdS long history old sprinkler test

1999 report

1.1

Overview of standards

Service & maintenance sprinkler test

1.2

VdS 2091 test procedure

Service & maintenance sprinkler test

1.3

Five year test data from lab

Sprinkler test per VdS 2091

1.4

RTI Value

Outcome sample test

1.5

Consideration ESFR

In process

2.0

Sprinkler pipe inspection

How does it look?

3.0

About VdS Nederland

Independent company

3.1

How to contact

Meet the team

Disclaimer


This presentation contains potential fire protection related analyses for certain areas -industrial, commercial or residential facilities, any type of object / operation or product & system type- which may be exposed or part of a fire risk (analyze). Any data shared that could mistakenly be used to mitigate risks or failures shall be executed on a case-by-case basis considering local legislation, regulation, test protocols and/or standards and project-specific parameters; So far as VdS Netherlands, shown at the homepage (www.vds-nederland.nl) provide information free of charge, this is done in good faith and without any liability.

Agenda item 1.0

VdS long history

VdS long history



VdS SCHADENVERHÜTUNG 

Interne Mitteilung an die Technische Prüfstelle
Büro Darmstadt

erhalten Sie das beiliegende Ergebnisblatt.


Ergebnis der Begutachtung der Stichprobe:

Aufgrund der vorliegenden Stichprobe sind die zugrundegelegten Bedingungen zum Verbleib in der Anlage derzeit nicht erfüllt. Bitte informieren Sie den Betreiber / die Errichterfirma.
Sollten Sie aufgrund des negativen Prüfungsergebnisses eine Erweiterung des Stichprobenumfangs um weitere 20 Sprinkler wünschen, so geben Sie bitte bei deren Übersendung die o.g. Prüfnummer an.

Die Prüfung wurde gemäß der derzeit gültigen Prüfanweisung Nr. WAL SP-AL für die Prüfung von Sprinklern aus Altanlagen durchgeführt.

Köln, 17.08.99
Bch/PC



VdS SCHADENVERHÜTUNG 

Sprinkler aus Altanlagen - Prüfungsergebnis SPA 99132

| Fehler 1: Versagen von Sprinklern: | Anzahl |
|----------------------------------------------------------------|---------|
| Maximal zulässige Fehlerquote der 20 geprüften Sprinkler: 2,5% | |
| Keine Auslösung bei 1bar: | 1 Stck. |
| K-Faktor bei 1bar um mehr als 30% reduziert: | 0 Stck. |
| Keine Wasserverteilung bei 1bar: | 0 Stck. |
| Ansprechtemperatur mehr als 20°C aus Toleranz: | 0 Stck. |
| Fehlerquote: | 5,0% |
| Ergebnis: | Negativ |

| Fehler 2: Eingeschränkte Funktion von Sprinklern: | Anzahl |
|---------------------------------------------------------------|---------|
| Maximal zulässige Fehlerquote der 20 geprüften Sprinkler: 25% | |
| Auslösetemperatur außerhalb Toleranzfeld: | 0 Stck. |
| Sprühbehinderungen bei 1bar: | 0 Stck. |
| K-Faktor bei 1bar um mehr als 10% reduziert: | 0 Stck. |
| Fehler aus 1: | 1 Stck. |
| Fehlerquote: | 5,0% |
| Ergebnis: | Positiv |

Bemerkungen:
Die Sprinkler waren äußerlich nur wenig verschmutzt. Ein Muster öffnete in der Funktionsprüfung nach dem Ansprechen des Auslöseelements erst bei einem Druck von 3,5bar.

| | |
|-------------------------------------------------------|--------------------------|
| Zulässige Fehlerquote: Köln, den 17.08.1999 | Nicht eingehalten |
|-------------------------------------------------------|--------------------------|

VdS Schadenverhütung GmbH, WAL, Amsterdamerstr. 176-178, 50735 Köln, Tel 7766-355, Fax -418



Why testing e.g. old sprinklers

How does it look?

K-factor reduction >10%



K-factor reduction >30%



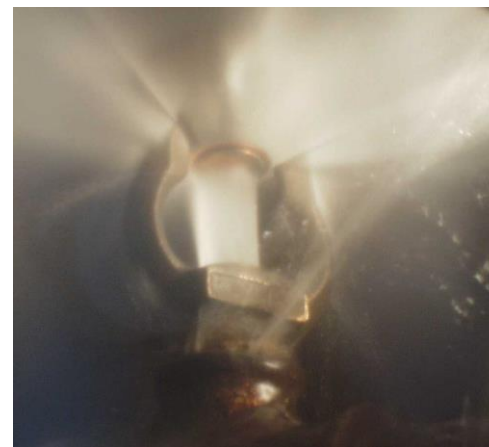
K-factor reduction >30%



ESFR K25 (2002) dirt at sealing



Spray obstruction by sealing



Sealing assembly blocking



Agenda item 1.1

Overview of standards

Overview of standards

What to do?

REQUIREMENTS FOR OLD SPRINKLER CHECK

| DESCRIPTION | VDS 2091 | TB80 | FM 2-81 | NFPA 25 |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Initial sample size | <p>E.g. up to 5000spk / 20 samples.</p> <p>Minimum 20 / building</p> <p>A standard building of 18.000 m² = 1%</p> | <p>Minimum 4, or 1% per sprinkler type</p> | <p>xxx</p> | <p>Minimum 4, or 1% per object section</p> |
| Actions at the lab | <p>Visual assessment</p> <p>a) 20% of the sprinklers (usually 4) test nominal response temperature</p> <p>b) 80% percent of the sprinkler functional test</p> | <p>Per selected test protocol</p> | <p>xxx</p> | <p>Visual assessment, pass, then second test at the lab</p> <p>a) Functional test at 0.5 bar</p> <p>b) RTI testing</p> <ul style="list-style-type: none"> - SR sprinkler RTI ≤ 350 - QR sprinklers RTI ≤ 65 - ESFR sprinklers RTI ≤ 50 |

Overview of standards

Then what?

REQUIREMENTS FOR OLD SPRINKLER CHECK

| DESCRIPTION | VDS2091 | TB80 | FM 2-81 | NFPA 25 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Interval | <ul style="list-style-type: none"> - Generally every 25 years - Dry pendent in wet 12.5 years - Dry pendent in dry 6.25 years - Safety double sprinkler after 12.5 years - The sprinkler should be replaced after 50 years | <ul style="list-style-type: none"> - Replace or test every 50, or test continuing every 10 years. - Every 15 years via the pipe network inspection, visual check 5 sprinklers. If necessary replace or test. | <ul style="list-style-type: none"> - Fusible link > 182°C, every 3 years - O-ring sprinklers, every 5 years - Dry type sprinklers, every 15 years. Replace al dry-type sprinkler before 2003 - After fire, replace all non-operated sprinklers within a minimum of 6 m of any operated sprinklers - Conduct a physical an visual inspection of sealed concealed sprinklers. Physically minimum of 10% of the total number per room, and visually inspect all remaining sprinklers | <ul style="list-style-type: none"> - SR after 50 years, then every 10 years up to the year 75, from the year 75 every 5 years. (50->60->70->75->80->85...etc.) - QR & ESFR after 20 years, then every 10 years up to 75 years, from 75 years every 5 years. - > 163°C Fusible link every 5 years. - Dry sprinklers - after 15 years, further checks every 10 years - Listed corrosion resistant sprinklers in hostile environments, every 10 years. Non listed, every 5 years |
| Then what | <p>The error rate possibly causing failure > 2,5%</p> <p>The error rate possibly causing impairment > 25</p> <p>The sum of both > 25%</p> <p>Addition sample tests may be sensible other wise replace all sprinklers</p> | <p>Test fails, replace all sprinklers or redo test with 4% of total installed</p> | <p>xxx</p> | <p>If one sprinkler does not meet requirement, all should be replaced</p> |

Overview of standards

Test protocol reverence

REQUIREMENTS FOR OLD SPRINKLER CHECK

| DESCRIPTION | VDS 2091 | TB80 | FM 2-81 | NFPA 25 |
|---------------------------|--------------------------------------------------------------------------------------------|-------------------------------------|---------|-----------------------------------------------------------------------------------------------|
| Standard reverence | EN 12259-1, Annex B (temp) EN 12259-1, Annex C (flow) EN 12259-1, Annex E (function) | Depending on selected test standard | xxx | EN 12259-1, Annex E (0,5b function) EN 12259-13, Annex G (ESFR @ RTI ≤ 50) UL199 |

Standard samples

VdS 2091

location & number samples

| Total number of sprinklers | Number of sprinklers to be submitted |
|----------------------------|--------------------------------------|
| up to 5.000 | 20 |
| up to 10.000 | 40 |
| up to 20.000 | 60 |
| up to 30.000 | 80 |

Sprinklers should mainly be taken from those areas in which operational influences may have caused damage to the sprinklers, e.g.:

- frequent change of water due to sprinkler system extensions;
- highly corrosive ambient conditions;
- influence of the water used;
- periodical temperature variations;
- vibrations;
- radiant heat.

Where the sprinklers are located in different buildings, at least 20 sprinklers per building shall be submitted.

In the case of different operational influences within one building it may be necessary to check a larger number of sprinklers. VdS will determine the number according to the hazard in question.

Additional measures shall be taken if

- the error rate possibly causing failure > 2,5%;
- the error rate possibly causing impairment > 25%;
- the sum of both > 25%.

VdS
risk
ers

NFPA 25

location & number of sample (location)

Examples of documents that can be used to determine the installation date include the Contractor's Material and Test Certificate for Aboveground Piping or the Certificate of Occupancy. Where documentation of the installation date is not available, the start date for the in-service performance testing interval should be based upon the sprinkler's manufacture date.

A.5.3.1.1 Sprinklers should be first given a visual inspection in accordance with 5.2.1.1.1 to determine if replacement is required. Sprinklers that have passed the visual inspection should then be laboratory tested for sensitivity and functionality. The waterway should clear when sensitivity/functionality tested at 7 psi (0.5 bar) or the minimum listed operating pressure for dry sprinklers.

The thermal sensitivity should be such that the RTI does not exceed 350 (meters-seconds)^{1/2} for standard-response sprinklers, 65 (meters-seconds)^{1/2} for quick-response and residential sprinklers and 50 (meters-seconds)^{1/2} for ESFR sprinklers.

TB80 5.13

what to do with failures

Sprinklers,
Ouder dan 50
jaar
Testen of
vervangen

Basiseis

Sprinklers die ouder zijn dan 50 jaar moeten vervangen te worden.

Alternatief

Als alternatief mag ook met een representatieve steekproef aangetoond worden dat de sprinklers nog goed functioneren. Deze steekproef moet dan wel elke 10 jaar herhaald te worden.

Eisen aan de beproeving

In plaats van het vervangen van de sprinklers kan een representatieve steekproef worden genomen waarbij de geselecteerde sprinklers worden uitgenomen en beproefd. De steekproef moet bestaan uit ten minste vier sprinklers of 1% van de sprinklers (grootste waarde aanhouden) per sprinklertype uit elk gebied met gelijke omstandigheden.

De beproeving moet zijn afgestemd op sprinklers die in gebruik zijn geweest en moet bij voorkeur plaatsvinden op basis van de norm ten tijde van de aanleg of anders plaatsvinden aan de hand van de meest recente versie van EN 12259-1, UL 199 VdS 2091 of FM Approvals LLC Approval Standard Class Number 2000.

Van de sprinklers moet het aanspreken, 'Thermal response' en 'Functional test', bij verschillende voordrukken worden beproefd waarna de waterdoorlaat (K-factor) moet worden gemeten.

Indien de sprinklers goedgekeurd zijn dan hoeven de sprinklers niet vervangen te worden.

Indien de sprinklers niet voldoen aan de eisen uit de onderhavige norm dan moet:

- c. de sprinklers vervangen worden of
- d. de steekproef vergroot (*) worden of
- e. middels een analyse aangetoond worden dat het blussysteem voldoet aan de vereiste functionaliteit.

Opmerking (*)

De steekproef moet opnieuw uitgevoerd worden met ten minste twaalf sprinklers of 4 % van de sprinklers (grootste waarde aanhouden) per sprinklertype uit elk gebied met gelijke omstandigheden.

Indien de sprinklers opnieuw niet voldoen dan moet:

- f. de sprinklers vervangen worden of
- g. middels een analyse aangetoond worden dat het blussysteem voldoet aan de vereiste functionaliteit.

De resultaten moeten in het logboek aanwezig zijn.

Agenda item 1.2

VdS 2109 test procedure

VdS 2091 test procedure

Sprinkler test

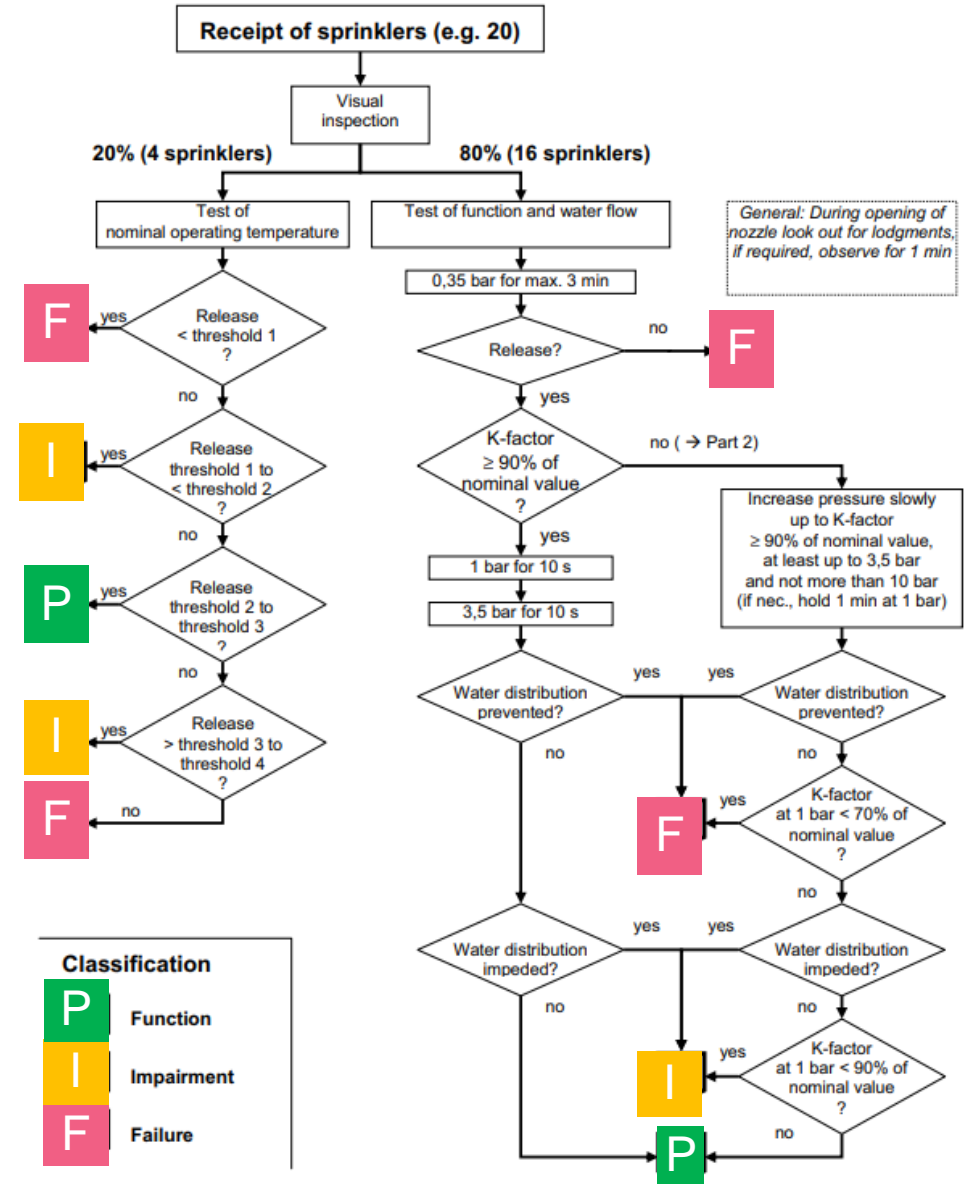
Additional measures shall be taken if:

the error rate possibly causing failure > 2,5% (5% or 3,25%)

the error rate possibly causing impairment > 25% (<50% or <35%);

the sum of both > 25% (<50% or 37.5%)

| Fehler 1: Versagen von Sprinklern: | Anzahl |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Maximal zulässige Fehlerquote der 20 geprüften Sprinkler: 2,5% | |
| Keine Auslösung bei 1bar: | 1 Stck. |
| K-Faktor bei 1bar um mehr als 30% reduziert: | 0 Stck. |
| Keine Wasserverteilung bei 1bar: | 0 Stck. |
| Ansprechtemperatur mehr als 20°C aus Toleranz: | 0 Stck. |
| Fehlerquote: | 5,0% |
| Ergebnis: | Negativ |
| Fehler 2: Eingeschränkte Funktion von Sprinklern: | Anzahl |
| Maximal zulässige Fehlerquote der 20 geprüften Sprinkler: 25% | |
| Auslösetemperatur außerhalb Toleranzfeld: | 0 Stck. |
| Sprühbehinderungen bei 1bar: | 0 Stck. |
| K-Faktor bei 1bar um mehr als 10% reduziert: | 0 Stck. |
| Fehler aus 1: | 1 Stck. |
| Fehlerquote: | 5,0% |
| Ergebnis: | Positiv |
| Bemerkungen: | |
| Die Sprinkler waren äußerlich nur wenig verschmutzt. Ein Muster öffnete in der Funktionsprüfung nach dem Ansprechen des Auslöseelements erst bei einem Druck von 3,5bar. | |



Trestholds EN12259-1 Annex B

Nominal operating temperature

| Nominal operating temperature t | Calculation aid T | Threshold 1 ²⁾ | Threshold 2 ²⁾ | Threshold 3 ²⁾ | Threshold 4 ²⁾ |
|---------------------------------|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| [°C] | | [°C] | [°C] | [°C] | [°C] |
| general ¹⁾ | $(0,035 \cdot t + 0,62)$ | $(t - T - 20)$ | $(t - T)$ | $(t + T)$ | $(t + T + 20)$ |
| 71 | 3,105 | 47,8 | 67,8 | 74,2 | 94,2 |
| 74 | 3,210 | 50,7 | 70,7 | 77,3 | 97,3 |
| 100 | 4,120 | 75,8 | 95,8 | 104,2 | 124,2 |
| 104 | 4,260 | 79,7 | 99,7 | 108,3 | 128,3 |
| 138 | 5,450 | 112,5 | 132,5 | 143,5 | 163,5 |
| 141 | 5,555 | 115,4 | 135,4 | 146,6 | 166,6 |

¹⁾ nominal operating temperature t as per marking of sprinkler
²⁾ rounded to one decimal place
³⁾ rounded to one decimal place

Table A.3: Thresholds for tests of nominal operating temperature of fusible element sprinklers

| Result | Result classification |
|------------------------------------------|-----------------------|
| Release below threshold 1 | Failure |
| Release threshold 1 to below threshold 2 | Impairment |
| Release threshold 2 to threshold 3 | Function |
| Release above threshold 3 to threshold 4 | Impairment |
| No release up to threshold 4 | Failure |

Table A.4: Classification of results

Nominal operating temperature



Tresholds EN12259-1 Annex B

Functional test and test of water flow (K-factor)

| Result from part 1 | Result classification |
|----------------------------------------------------------------------------------------|------------------------------|
| No release | Failure |
| Water distribution impaired | Failure |
| K-factor from 0,35 bar \geq 90% of nominal value, but water distribution impaired | Impairment |
| K-factor from 0,35 bar \geq 90% of nominal value and water distribution not impaired | Function |
| K-factor at 0,35 bar $<$ 90% of nominal value | Classification as per part 2 |
| Table A.5: Classification of the results from part 1 | |

| Result from part 2 | Result classification |
|-------------------------------------------------------------------------------------------------|-----------------------|
| Water distribution prevented | Failure |
| Water distribution impaired | Impairment |
| K-factor at 1 bar $<$ 70% of nominal value | Failure |
| K-factor at 1 bar $<$ 90% of nominal value | Impairment |
| K-factor at the latest at 1 bar \geq 90% of nominal value and water distribution not impaired | Function |
| Table A.6: Classification of results from part 2 | |

Note: If a sprinkler has faults of result classifications 'Failure' and 'Impairment', it will be classified as 'Failure'.

Agenda item 1.3

Five year test data from lab

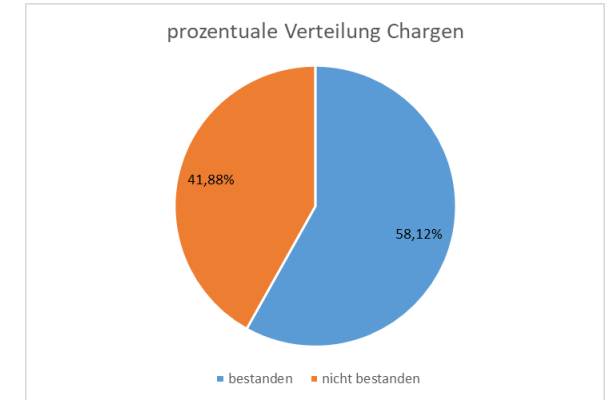
Test result analyse

Both, impairment & failure = nicht bestanden

Batch test past 5 years

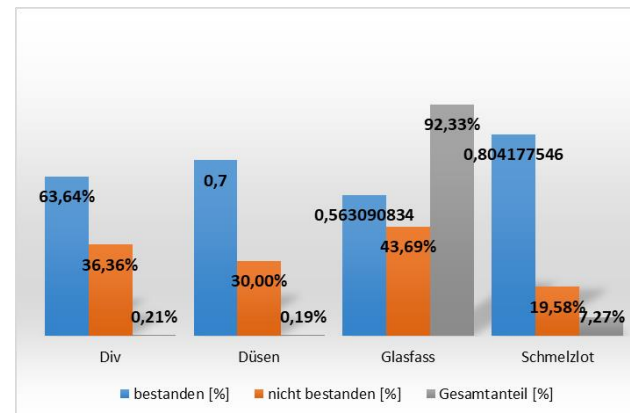
Pass / fail of batches

Overview pass/fail past 5 years



Batch analyse per activation element

Pass / fail of batches

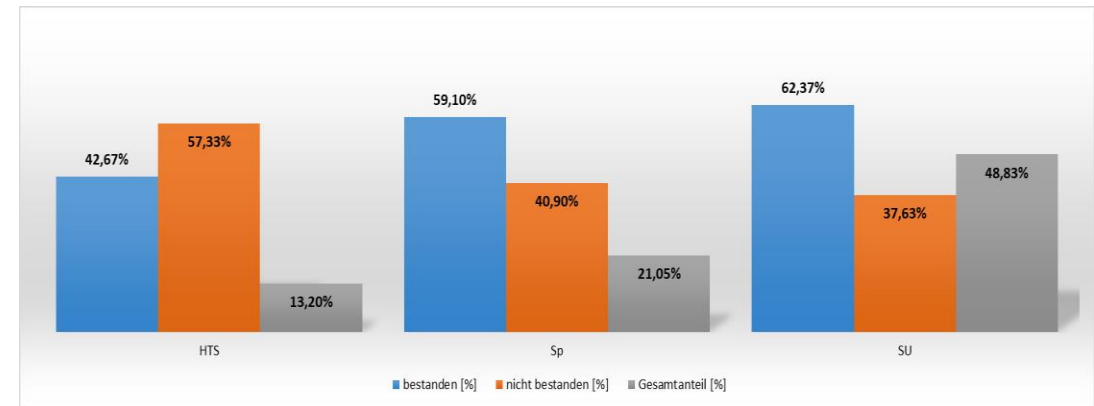


Test result analyze

Both, impairment & failure = nicht bestanden

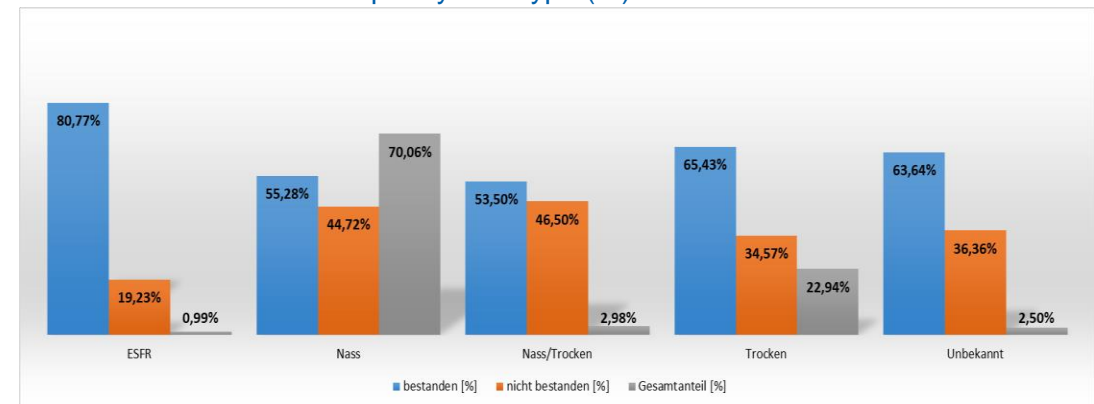
Batch test per sprinkler position (value)

Batch per sprinkler position (%)



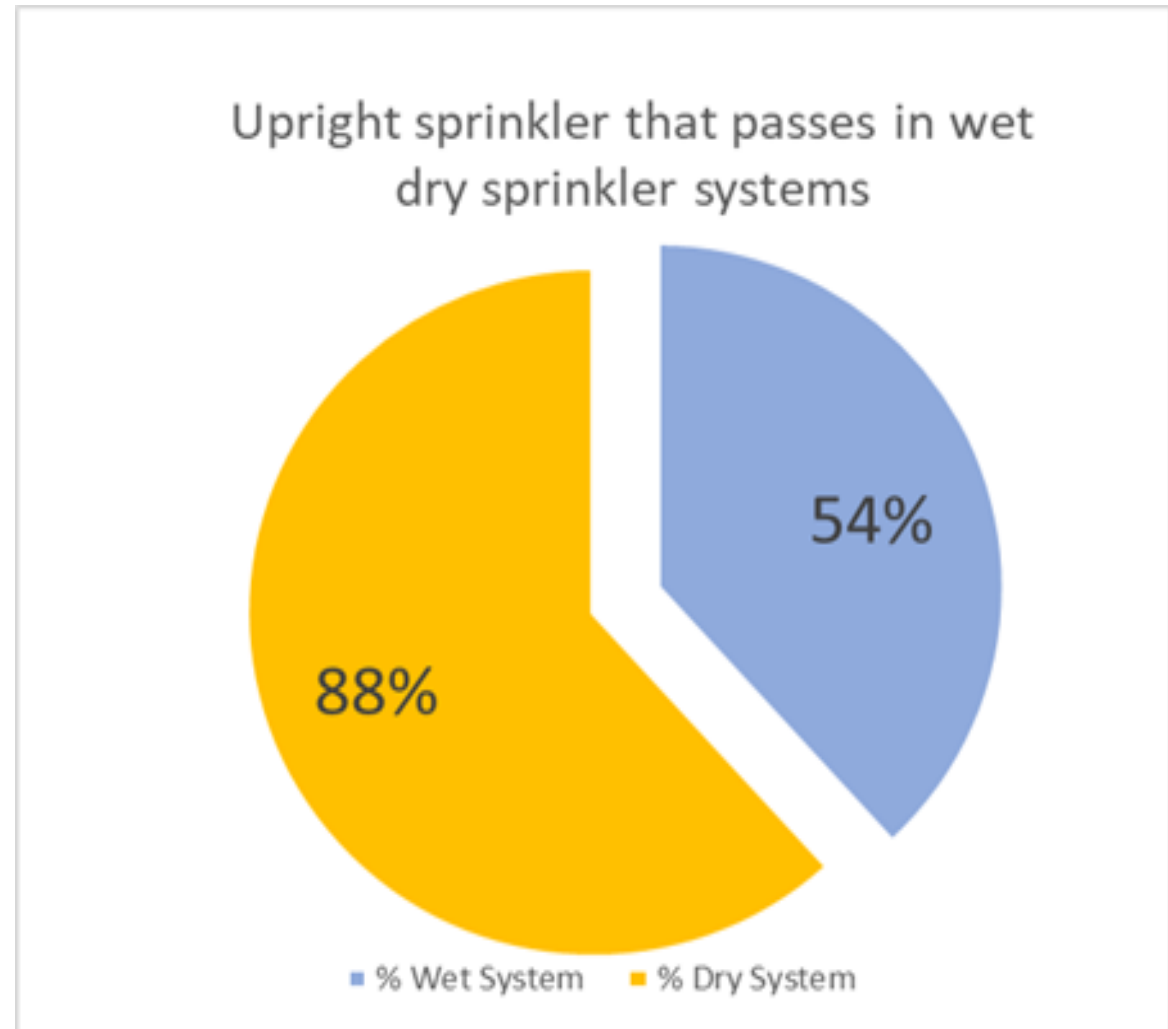
Batch test per system type (value)

Batch per system type (%)



Test result analyze

Both, impairment & failure = nicht bestanden



VdS 2091 test procedure, Netherlands

Both, impairment & failure = fail

| All sprinkler test 2018 - 2022: 224 batches & 2105 sprinklers | | | | |
|---------------------------------------------------------------|-------|---------------|-------------|-------------|
| | | pass | fail | total |
| batches | | 69% | 31% | 100% |
| sprinkler | | 64% | 36% | 100% |
| lodge | spray | K-F >10 % red | K-F 30% red | opening red |
| 3% | 1% | 57% | 17% | 21% |
| Wet system 2018 - 2022: 174 batches & 1776 sprinklers | | | | |
| | | pass | fail | total |
| batches | | 66% | 34% | 100% |
| sprinkler | | 62% | 38% | 100% |
| lodge | spray | K-F >10 % red | K-F 30% red | opening red |
| 2% | 1% | 58% | 18% | 22% |

| Dry pipe system 2018 - 2022: 29 batches & 156 sprinklers | | | | |
|----------------------------------------------------------|-------|---------------|-------------|-------------|
| | | pass | fail | total |
| batches | | 86% | 14% | 100% |
| sprinkler | | 89% | 11% | 100% |
| lodge | spray | K-F >10 % red | K-F 30% red | opening red |
| 0% | 0% | 63% | 13% | 25% |
| Dry sprinkler 2018 - 2022: 49 batches & 242 sprinklers | | | | |
| | | pass | fail | total |
| batches | | 76% | 24% | 100% |
| sprinkler | | 73% | 27% | 100% |
| lodge | spray | K-F >10 % red | K-F 30% red | opening red |
| 3% | 3% | 50% | 13% | 31% |

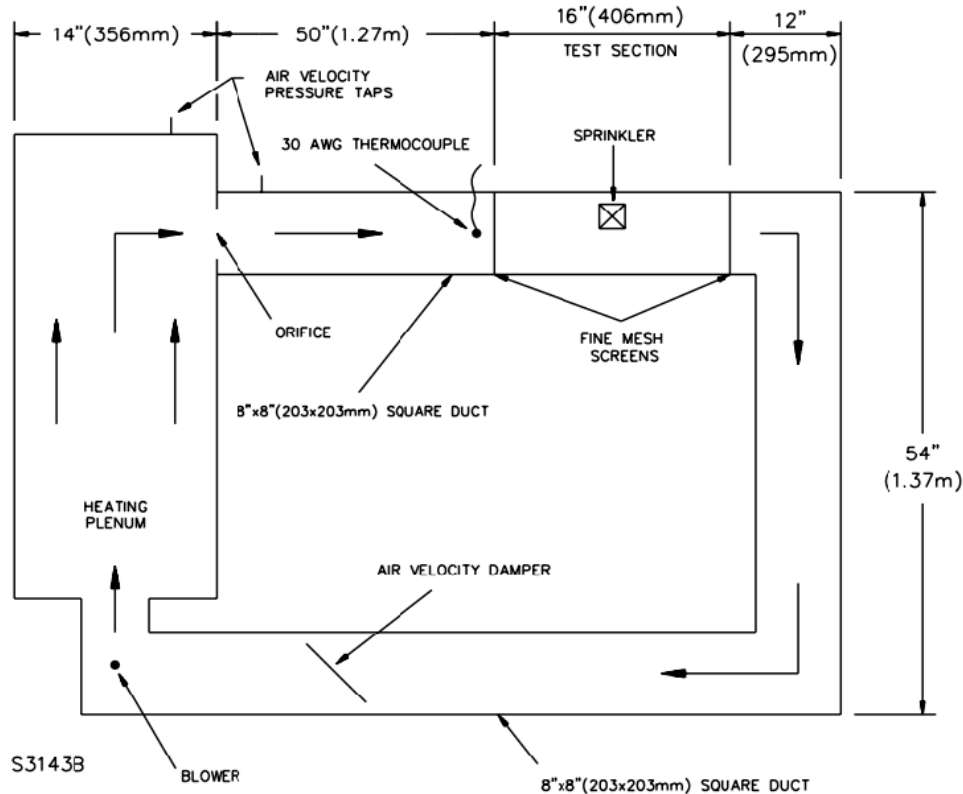
- Lodge - Lodgment (closing part that gets stuck on the deflector)
- Spray - spray impediment (e.g. in the case of a damaged spray disc)
- K-F >10% red - K-Factor Reduced greater than 10%
- K-F 30% red - K-Factor Reduced greater than 30%
- Opening red - stuck cap (the cap prevents the flow of water)

Agenda item 1.4

RTI

Response time index

EN12259-13, 4.15.1



$$RTI = \frac{-t_r (u)^{1/2}}{\ln \left[1 - \frac{\Delta T_b}{\Delta T_g} \right]}$$

t_r = time van activation (seconds)

U = actual air velocity test section of the duct, 2.56 ± 0.07 m/s

ΔT_b = average sprinkler operating temperature minus the ambient temperature, in °C

ΔT_g = actual temperature of the gas (197°C) minus the ambient temperature, in °C.

EN12259-13, 4.15.1

The conductivity (C factor) is set to zero. Because ESFR sprinklers are designed to operate quickly, the contribution of conductivity to overall sensitivity negligible.

RTI results

ESFR approval test

| ESFR type @ lab | Metric K-factor | RTI-value $\sqrt{(m*s)}$ (excl. C-value) |
|--------------------------|-----------------|---------------------------------------------|
| K14 bulb 68°C @ VdS | 202 | 26,7 |
| K14 bulb 68°C @ Lab Y | 202 | 24,1 |
| K17 link 74°C @ VdS | 242 | 27,0 |
| K17 link 74°C @ Lab Y | 242 | 31,2 |
| K17 link 100°C @ VdS | 242 | 28,0 |
| K22 link 74°C @ VdS | 323 | 28,0 |

Average: 27,5

RTI results per EN 12259-13, 4.15.1

ESFR installed sprinkler

| Type | Production year | Number | Plunge test air temp (°C) | Plunge test air velocity (m/s) | Activation (s) | RTI-value $\sqrt{(m*s)}$ (excl. C-value) |
|-----------------------|-----------------|------------|---------------------------|--------------------------------|----------------|------------------------------------------|
| ESFR K360 74 °C | 2002 | 1 | 197,3 | 2,57 | 4,9 | 23,3 |
| | | 2 | 197,3 | 2,57 | 5,0 | 23,8 |
| | | 3 | 197,5 | 2,55 | 5,7 | 27,1 |
| | | 4 | 197,3 | 2,57 | 5,4 | 25,7 |
| | | 5 | 197,2 | 2,55 | 4,1 | 19,4 |
| | | Nominal -> | 197±6 °C | 2,56±0,07m/s | Average-> | 23,9 |



Agenda item 1.5

Consideration ESFR

VdS lab is planning to update ESFR old sprinkler test

Considerations: With (like NFPA) or without RTI test?

If testing RTI for ESFR, why not for any storage sprinkler?

Starting pressure at flow test: 0,5 bar (like NFPA) or take the lowest design pressure?

How many samples per batch?

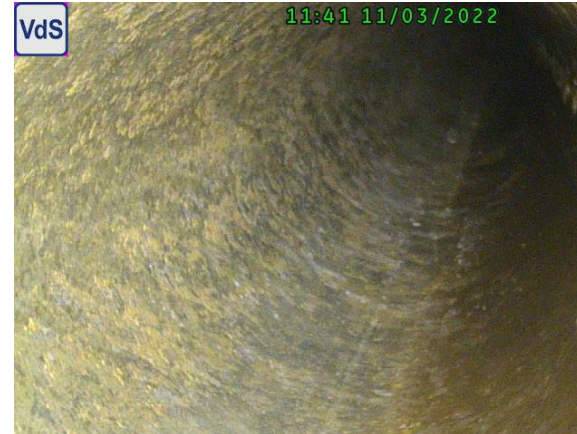
So far, 80% of ESFR pass the functional test

Agenda item 2.0

Sprinkler pipe inspection

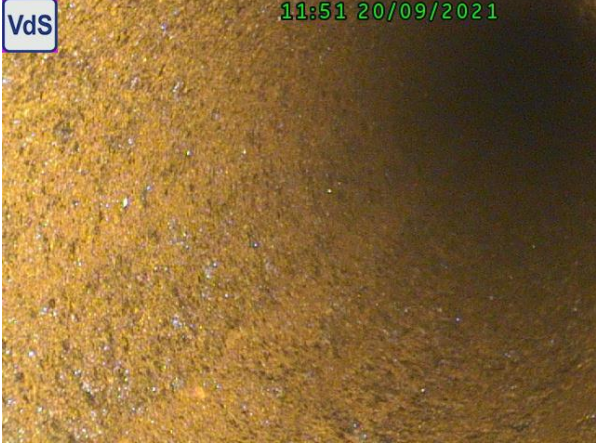
Sprinkler pipe inspection: Why?

Pipes change on the inside



Sprinkler pipe inspection: Why?

Pipes change on the inside



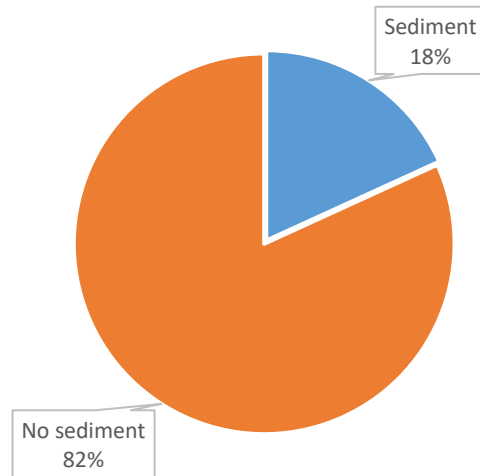
Sprinkler pipe inspection: Why?

Pipes change on the inside

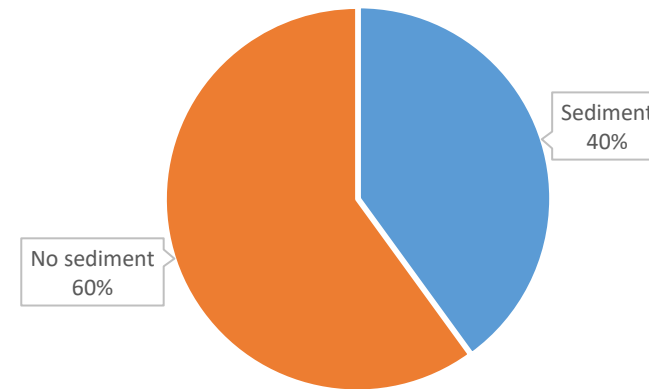
In open water (Rivers, ponds) → 100% sure to find sediment in de pipes

Dry pipe installations →

Sediment in Dry pipe branchlines



Sediment in Dry pipe cross mains



Sprinkler pipe inspection: Why?

Wall thickness changes too



Micro organism



Typical air - water line



General Corrosion

Agenda item 3.0

About VdS Nederland

VdS Nederland is NEN-EN-ISO 17020 Type A

VdS Nederland inspect systems per
NFPA, FM, VdS, CEA 4001, EN's



NEN-EN-ISO/IEC 17020
type A, RVA Accreditatie

*** Voor inspecties:**

- Blusschuiminstallaties
- Sprinklerinstallaties
- Blusgasinstallaties
- Rookbeheersing
- Brandmeldinstallaties
- Ontruimingsinstallaties

*** CCV inspectieschema**

- PGS
- Vuurwerk

*** Normconformiteit:**

- Oude sprinklersystemen
- Zuurstofreductie



Agenda item 3.1

How to connect?

Our inspectors are available, transparent & open

This is Leo 😊



Visit our website for more information

www.vds-nederland.nl or info@vds-Nederland.nl



Work hard. Play hard.

Bij VdS Nederland geloven we in een goede informele werksfeer.

Er wordt door iedereen hard gewerkt, maar er is ook tijd om gezellig een praatje met elkaar te maken. Met een team op kantoor en een nog veel groter team van inspecteurs in de buitendienst werken we gezamenlijk aan de hoge kwaliteit die u van ons gewend bent.

Team van Managers:

