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PRODUCTS RELATED TO INSTALLATION SYSTEMS SUPPORTING TECHNICAL EQUIPMENT FOR BUILDING SERVICES SUCH AS PIPES, CONDUITS, DUCTS AND CABLES

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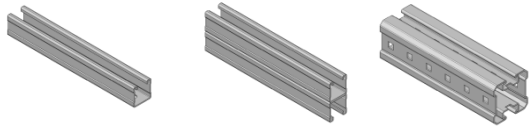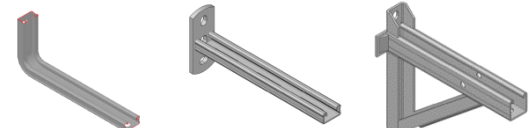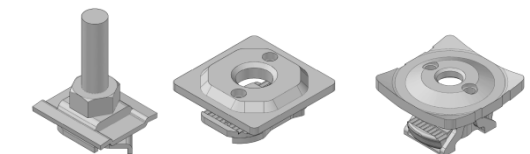
Contents

1   SCOPE OF THE EAD

1.1   Description of the construction product

The scope of this EAD covers kits (see Table 1.2) as well as their components which are also marketed as products of their own (see Table 1.1). Installation systems are used to provide mechanical support for building services installations such as sprinkler system pipes, waste water pipes, heating pipes, drinking water pipes, refrigeration pipes, oil and gas pipes, ducts and cables. Various kits, to be assembled by the user of the products, can be applied to fulfil these load supporting functions. Table 1.1 shows products which also can be used as a component in a kit as covered by table 1.2.

Table 1.1: Products which also can be used as a component in a kit according to table 1.2, and their definition

Designation	Definition	Exemplary illustrations
Channel	Cold-formed continuous metal element with open or closed profile section. Multiple channels may be combined by welding or other means.	
Cantilever	Metal element for fastening to a vertical substructure to serve as a cantilever support.	
Pipe clamp	Metal element designed to hold pipes in position, allowing the resulting loads to be transferred to a channel, bracket or the substructure. The pipe clamp may incorporate a rubber inlay designed to reduce structure-borne noise caused by the piping system and/or for corrosion protection purposes.	
Saddle nut	Load transferring connecting element positioned between a channel element and threaded rod. The saddle nut and attached threaded rod may be preassembled.	
Angle connector	Load-transferring and connecting element located at a junction between channels and connected to the channels by means of a channel connector.	
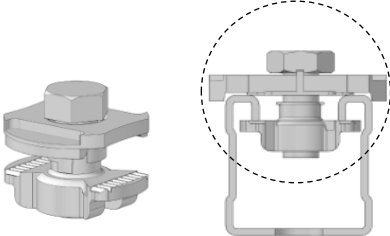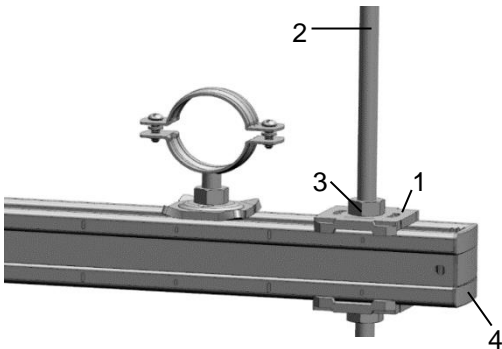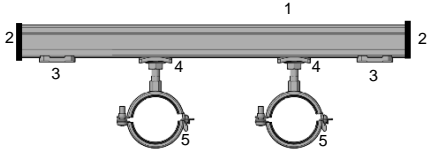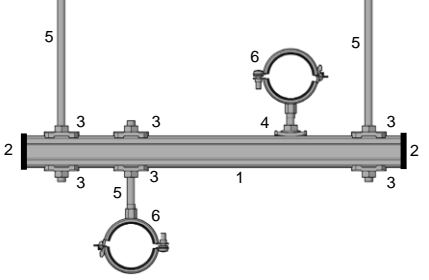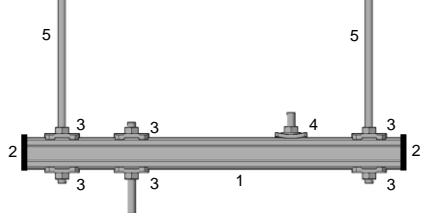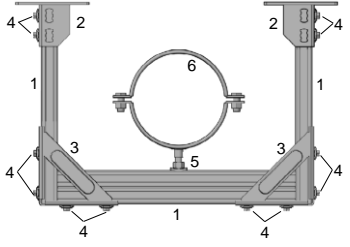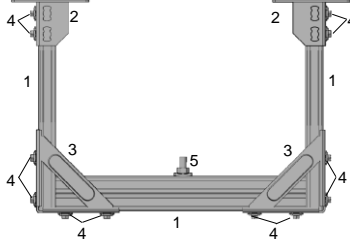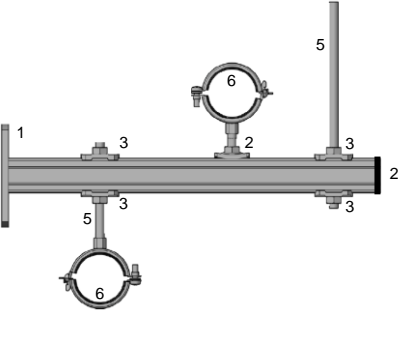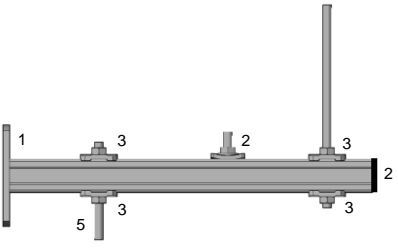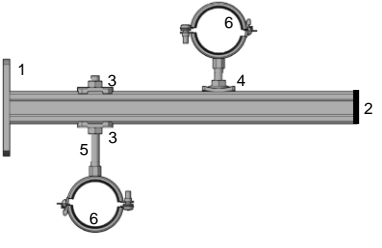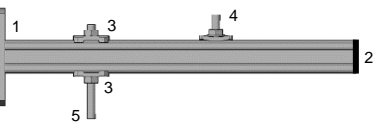
Designation	Definition	Exemplary illustrations
Base connector	Load-transferring and connecting element located between a channel and the substructure and connected to the channel by means of a channel connector.	
Channel connector	Element consisting of a nut, plate and a bolt used to connect angle connectors, base connectors or other metal plate connectors to the channel. The nut of the channel connector is positioned in the continuous slot of the channel and tightened by turning the bolt.	
1 Drilled plate	Metal plate with a hole or thread used as a load-transferring and connecting element between a channel and threaded rod, bolt or anchor etc.	
2 Threaded rod	Used as load-transferring element between: - a pipe clamp and a channel, bracket or the sub-structure - the substructure and a suspended channel or bracket.	
3 Hexagon nut	Used to fasten threaded rods to adjacent elements.	
4 End cap	Plastic element without load bearing function used to close the end of a channel, to cover sharp edges and thus help avoid the risk of injury.	

Table 1.2 shows kits and the associated components. Only kit components which can themselves be assessed according to this EAD are part of the kit.

Table 1.2: Kits and their components

Kit designation	Exemplary illustrations	Kit components
Single pipe clamp		1 Pipe clamp+threaded rod

Kit designation	Exemplary illustrations	Kit components
Head rail (with or without pipe clamp)		1 Channel 2 End cap 3 Drilled plate 4 Sadde nut+hex. nut+ threaded rod 5 Pipe clamp
Trapeze rod (with or without pipe clamp)		1 Channel 2 End cap 3 Drilled plate+hex. nut 4 Saddle nut + hex. nut+ threaded rod 5 Threaded rod 6 Pipe clamp
Trapeze frame (with or without pipe clamp)		1 Channel 2 Base connector 3 Angle connector 4 Channel connectors 5 Sadde nut+hex. nut+ threaded rod 6 Pipe clamp

Kit designation	Exemplary illustrations	Kit components
Suspended cantilever (with or without pipe clamp)		
		1 Cantilever 2 End cap 3 Drilled plate+hex. nut 4 Saddle nut+hex. nut+ threaded rod 5 Threaded rod 6 Pipe clamp
Non-suspended cantilever (with or without pipe clamp)		

The kits can be defined as follows:

Single pipe clamp   Pipe clamp which is connected to one or two threaded rods suspended from a structure.

Head rail   Installation channel fixed directly to the ceiling structure (not suspended), supporting the building services installations.

Trapeze rod   Installation system consisting of at least 2 vertical threaded rods suspended from a structure and connected to a horizontal channel supporting the building services installations.

Trapeze frame   Installation system consisting of at least 2 vertical channels suspended from a structure and connected to a horizontal channel supporting the building services installations.

Suspended cantilever   Installation system consisting of at least 1 vertical threaded rod suspended from a structure and connected to a horizontal channel fixed to a vertical structural

element. The building service installations are supported by the horizontal channel.

Cantilever   Horizontal channel fixed to a vertical structural element. The building services installations are supported by the horizontal channel

Various versions of the products with respect to material and dimensions are marked such that the relevant product characteristic is allocated to the corresponding product-type, e.g. pipe clamps showing the clamping range on the product.

The products are not covered by a harmonized European standard.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise the clients on the transport, storage, maintenance, replacement and repair of the products as he considers necessary.

It is assumed that the products will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of a product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The products are intended to be used as installation system kits or as products which can be used in installation system kits to support building services installations such as pipes, ducts and cables. The products are required to fulfil their mechanical support function even when subjected to elevated temperatures. Intended use at elevated temperatures includes supporting building services such as:

- sprinkler installations
- water spraying installations designed to protect the building structure
- installations in escape and rescue routes
- installations above suspended fire protection ceilings
- heating installations
- water supply systems serving fire safety installations
- smoke and heat exhaust ventilation installations

This EAD does not provide assessment methods for the performance of the structures to which the installation system may be attached nor for the types of building services installations that can be supported. The assessment of the fixation of the products, combined to kits, to the substructure is not covered by this EAD.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the installation systems products for the intended use under ambient temperatures in dry indoor areas of 50 years when installed in the works provided that the installation systems products are subject to appropriate installation (see 1.1). These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the products, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[1].

The indications given as to the working life of the installation systems products cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are to be regarded only as a means for expressing the expected economically reasonable working life of the products.

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[1] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the products may also be shorter than the working life referred to above.

1.3　Specific terms used in this EAD

1.3.1　General

Ambient temperatures	20°C $\pm$ 5°C
Component	Product according to Table 1.1 used in a kit according to Table 1.2
Elevated temperatures	Temperatures above 750°C and below 1214°C
Kit	Kit based on one of the systems according to Table 1.2
Pipe clamp range	Pipe clamps of the same type to be used for different pipe diameters
Product	Product according to Table 1.1

1.3.2　Abbreviations

$E_{a,\theta}$	Slope of the linear elastic range for the steel member at elevated temperature θ_a
F	Force
F_{Rd}	Design resistance at ambient temperature
F_{Rk}	Characteristic resistance at ambient temperature
$F_{Rk}(t)$	Resistance time function at elevated temperatures according to the Annexes D and F
F_{SLS}	Serviceability limit state capacity under ambient temperature
F_T	Test load applied in a test at elevated temperatures according to the Annexes D, F, G and H
$F_{Rd,t}$	Design resistance according to chapter 2.2.2
$F_{Rk,30}(\delta)$	Load displacement function for an exposure time t= 30 min to elevated temperatures according to the Annexes D and G
$F_{Rk,t}$	Resistance after an exposure time t to elevated temperatures according to the Annexes D and F
$F_{T,i}$	Test load of the specimen i applied in test for elevated temperatures according to Annex D, F, G and H
L_0	Distance L_0 measured on the test specimen before the beginning of the transient heat creep test in accordance with Annex J
M	Moment
$R_{F,\delta}$	Regression of the pairs of variates ($F_{T,i}$ / $\delta_{F(T,i),30}$) according to Annex G
$R1_{F,tu}$	Regression of the pairs of variates ($F_{T,i}$ / $t_{u,i}$) according to Annex F
STTC	Standard temperature / time curve
T_f	Furnace temperature in accordance with Annex J
V	Shear force
$f_{2\%,\theta a}$	Stress limit at 2% strain at elevated temperature θ_a
$f_{y,N}$	Nominal yield strength
i	Number of the tested specimen
k_n	Characteristic fractile factor

l	Cantilever arm length
m	Number of pairs of variates according to Annex F or Annex G
n	Number of time intervals
t	Exposure time to elevated temperatures according to EN 1363-1
$t_{max,B}$	Time at which loss of rigidity or plastic hinging of the channel occurs under bending stress in accordance with Annex I
t_u	Exposure time to elevated temperatures according to EN 1363-1 when failure occurs
$t_{u,i}$	Exposure time to elevated temperatures according to EN 1363-1 of specimen i when failure occurs.
$\Delta u_{VK}(t)$	Extension of the distance L_0 measured on the test specimen during the transient heat creep test at the point in time "t" in accordance with Annex J
θ_a	Steel temperature
α	Channel angle to the horizontal
δ	Displacement
$\delta_{max,t}$	Maximum deformation at the time t of reaching the load-bearing capacity (or ultimate state) in accordance with Annex D, F and H
δ_t	Displacement after an exposure time t to elevated temperatures
$\delta_{tmax;B}$	Deformation of the channel at the point in time of stability failure or of the plastic hinging in accordance with Annex I
$\delta_{F(T,i);t}$	Displacement after t minutes exposure to elevated temperatures according to Annexes D, F and H under the test load $F_{T,i}$
$max(\delta_{F(T,i);t})$	Maximum displacement at the end of the interval n immediately following the point of time t under the test loads $F_{T,i}$
ε	Total elongation
$\varepsilon_\sigma = \varepsilon - \varepsilon_{th}$	Mechanical elongation
$\varepsilon_{B,\theta a}$	Channel bending strain at elevated temperature θ_a
ε_{th}	Thermal elongation
σ	Stress
σ_0	Nominal stress level in accordance with Annex J
σ_B	Channel bending stress
$\sigma_{m,i}$	Arithmetical mean value for the measured stress in accordance with Annex J

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the products

Table 2.1.1 shows how the performance of products is assessed in relation to reaction to fire with respect to the relevant intended use according to section 1.2.1.

Tables 2.1.2 through 2.1.12 show how the performance of products which may also be used as components in a kit is assessed in relation to the essential characteristics with respect to the relevant intended use according to section 1.2.1.

Tables 2.1.13 through 2.1.16 show how the performance of kits is assessed in relation to the essential characteristics with respect to the relevant intended use according to section 1.2.1.

Table 2.1.1 Essential characteristics of the products according to table 1.1 and methods and criteria for assessing their performance in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Members made of metal: Class (A1)

Table 2.1.2 Essential characteristics of the pipe clamp and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Pipe clamp			
1	Shape	2.2.2.1.1	Description
2	Dimension	2.2.2.1.2	Level
3	Material	2.2.2.1.3	Description
4	Characteristic resistance at ambient temperatures	2.2.2.1.4	Level
5	Serviceability Limit State	2.2.2.1.4	Level
6	Resistance and deformation at elevated temperatures	2.2.2.1.5	Level, Description

Table 2.1.3 Essential characteristics of the channel and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Channel			
1	Shape	2.2.2.2.1	Description
2	Dimension	2.2.2.2.2	Level
3	Material and cross-section characteristics	2.2.2.2.3	Level, Class, Description
4	Characteristic pull-through resistance of channel back holes at ambient temperatures	2.2.2.2.4	Level
5	Pull-through resistance of channel back holes at elevated temperatures	2.2.2.2.5	Level, Description
6	Bending characteristics of the channel at elevated temperatures	2.2.2.2.6	Level, Description

Table 2.1.4 Essential characteristics of the threaded rod and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Threaded rod			
1	Dimensions	2.2.2.3.1	Level
2	Material	2.2.2.3.2	Description
3	Resistance to combined bending and tension at elevated temperatures	2.2.2.3.3	Level
4	Tension resistance at elevated temperatures	2.2.2.3.4	Level, Description
5	Compression resistance at elevated temperatures	2.2.2.3.5	Level

Table 2.1.5 Essential characteristics of the hexagon nut and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Hexagon nut			
1	Dimensions	2.2.2.4.1	Level
2	Material	2.2.2.4.2	Description
3	Characteristic resistance at ambient temperature	2.2.2.4.3	Level

Table 2.1.6 Essential characteristics of the drilled plate and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Drilled plate			
1	Shape	2.2.2.5.1	Description
2	Dimensions	2.2.2.5.2	Level
3	Material	2.2.2.5.3	Description
4	Characteristic pull-through resistance at ambient temperatures	2.2.2.5.4	Level
5	Pull-through resistance at elevated temperatures	2.2.2.5.5	Level, Description

Table 2.1.7 Essential characteristics of the saddle nut and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Saddle nut			
1	Shape	2.2.2.6.1	Description
2	Dimensions	2.2.2.6.2	Level
3	Material	2.2.2.6.3	Description
4	Characteristic pull-out resistance at ambient temperatures	2.2.2.6.4	Level
5	Pull-out resistance with $\varepsilon_{B,\theta a} \leq 2\%$ at elevated temperatures	2.2.2.6.5	Level, Description
6	Pull-out resistance with $\varepsilon_{B,\theta a} > 2\%$ at elevated temperatures	2.2.2.6.6	Level, Description

Table 2.1.8 Essential characteristics of the channel connectors and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Channel connector			
1	Shape	2.2.2.7.1	Description
2	Dimensions	2.2.2.7.2	Level
3	Material	2.2.2.7.3	Description
4	Characteristic pull-out resistance at ambient temperatures	2.2.2.7.4	Level
5	Characteristic shear resistance at ambient temperatures	2.2.2.7.5	Level
6	Pull-out resistance at elevated temperatures	2.2.2.7.6	Level, Description
7	Shear resistance at elevated temperatures	2.2.2.7.7	Level, Description

Table 2.1.9 Essential characteristics of the cantilever and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Cantilever			
1	Shape	2.2.2.8.1	Description
2	Dimensions	2.2.2.8.2	Level
3	Material	2.2.2.8.3	Description
4	Characteristic resistance at ambient temperatures	2.2.2.8.4	Level, Description
5	Resistance at elevated temperatures	2.2.2.8.5	Level, Description

Table 2.1.10 Essential characteristics of the base connector and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Base connector			
1	Shape	2.2.2.9.1	Description
2	Dimensions	2.2.2.9.2	Level
3	Material	2.2.2.9.3	Description
4	Characteristic resistance at ambient temperatures	2.2.2.9.4	Level, Description
5	Resistance at elevated temperatures	2.2.2.9.5	Level, Description

Table 2.1.11 Essential characteristics of the angle connector and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
Angle connector			
1	Shape	2.2.2.10.1	Description
2	Dimensions	2.2.2.10.2	Level
3	Material	2.2.2.10.3	Description
4	Characteristic resistance at ambient temperatures	2.2.2.10.4	Level, Description
5	Resistance at elevated temperatures	2.2.2.10.5	Level, Description

Table 2.1.12 Essential characteristics of the end cap and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 4: Safety and accessibility in use			
End cap			
1	Shape	2.2.2.11.1	Description
2	Dimensions	2.2.2.11.2	Level
3	Material	2.2.2.11.3	Description
4	Resistance at ambient temperature	2.2.2.11.4	Level

Table 2.1.13 Essential characteristics of the headrail and criteria for assessing the performance of the kit in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of kit performance
Basic Works Requirement 4: Safety and accessibility in use			
Head rail			
1	Shape	2.2.2.12.1	Description
2	Dimensions	2.2.2.12.2	Level
3	Material	2.2.2.12.3	Description
4	Resistance and deformation at elevated temperatures determined for headrail kits without pipe clamps	2.2.2.12.4	Level, Description
5	Resistance and deformation at elevated temperatures determined for headrail kits with pipe clamps	2.2.2.12.5	Level, Description

Table 2.1.14 Essential characteristics of the trapeze rod and criteria for assessing the performance of the kit in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of kit performance
Basic Works Requirement 4: Safety and accessibility in use			
Trapeze rod			
1	Shape	2.2.2.13.1	Description
2	Dimensions	2.2.2.13.2	Level
3	Material	2.2.2.13.3	Description
4	Resistance and deformation at elevated temperatures determined for trapeze rod kits without pipe clamps	2.2.2.13.4	Level, Description
5	Resistance and deformation at elevated temperatures determined for trapeze rod kits with pipe clamps	2.2.2.13.5	Level, Description

Table 2.1.15 Essential characteristics of the trapeze frame and criteria for assessing the performance of the kit in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of kit performance
Basic Works Requirement 4: Safety and accessibility in use for kits			
Trapeze frame			
1	Shape	2.2.2.14.1	Description
2	Dimensions	2.2.2.14.2	Level
3	Material	2.2.2.14.3	Description
4	Resistance and deformation at elevated temperatures determined for trapeze frame kits without pipe clamps	2.2.2.14.4	Level, Description
5	Resistance and deformation at elevated temperatures determined for trapeze frame kits with pipe clamps	2.2.2.14.5	Level, Description

Table 2.1.16 Essential characteristics of the suspended and non-suspended cantilever and criteria for assessing the performance of the kit in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of kit performance
Basic Works Requirement 4: Safety and accessibility in use for kits			
Suspended and non-suspended cantilever			
1	Shape	2.2.2.15.1	Description
2	Dimensions	2.2.2.15.2	Level
3	Material	2.2.2.15.3	Description
4	Resistance and deformation at elevated temperatures determined for suspended and non-suspended cantilever kits without pipe clamps	2.2.2.15.4	Level, Description
5	Resistance and deformation at elevated temperatures determined for suspended and non-suspended cantilever kits with pipe clamps	2.2.2.15.5	Level, Description

2.2 Methods and criteria for assessing the performance of the products in relation to essential characteristics of the products

This EAD describes the methods used to assess the performance of products according to table 1.1, which can be used as components in kits according to table 1.2, at ambient and elevated temperatures. Furthermore, this EAD describes the methods used to assess the performance of the kits according to table 1.2 at elevated temperatures.

Where reference is made in this EAD to what is to be indicated in an ETA, this is in any case based on the wish of the manufacturer to declare the respective product performance.

Table 2.2.1 Assessment for the products according to table 1.1

Temperature	Assessment via	Applicable for
Ambient temperature	- FEM - Analytic calculations - Tests	Products to be used as components in kits
Elevated temperatures	- FEM analysis for the channel - Analytic calculations - Tests	

For kits two methods are available for the assessment at elevated temperatures:
Method 1: Assessment of kits by using FEM analysis for the channel
Method 2: Assessment of kits without using FEM analysis for the channel

Table 2.2.2 Assessment for kits at elevated temperatures

Temperature	Assessment via	Applicable for
Elevated temperatures	Method 1: - FEM analysis for the channel - Analytic calculations - Tests on components Method 2: - Tests on kits without pipe clamps	Kits without pipe clamps
Elevated temperatures	Method 1: - FEM analysis for the channel - Analytic calculations - Tests on components Method 2: - Tests on kits without pipe clamps - Analytic calculations for threaded rods - Tests on pipe clamps	Kits with pipe clamps

The rating of a kit on the basis of the assessment Method 1 or Method 2 is determined by the least favorable performance level of the products contained in this kit. Details are described in the relevant chapters and Annex K.

The conditions under which the product performances related to the essential characteristics have been assessed are to be reflected in the ETA:

- The application of the reduction factors described in the Eurocode 3 (EN 1993-1-2, Table 3.1) is not permissible for the assessment of thin metal profiles above 750°C because of underestimating deformations.
- Bolted connections are tightened to the manufacturer's recommended torque. Over- or under tightening will reduce the load-carrying capacity and possibly causing premature failure.
- A saddle nut or a connection element placed near to the open end of a channel has a lower ultimate load capacity compared to a fastening in the center of a channel.
- The coating of the channel and the attached connecting element can have a significant impact on the ultimate slip loads.

2.2.1   Reaction to fire

Steel parts
Steel parts of the products are considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire, in accordance with the provisions of EC Decision 96/603/EC (as amended) without the need for testing on the basis of its listing in that Decision.

Plastic parts
Plastics for inlays of pipe clamps are considered as small components[2] and therefore do not need to be tested and classified.
The plastic parts are embedded on a surface which is class A1 according to EN 13501-1. In connection with pipes or pipe insulation not class A1 a contribution to fire growth, smoke development and production of flaming particles/droplets is not expected. Also the reaction to fire performance of surrounding material not class A1 is not influenced.

2.2.2   Safety and accessibility in use

The resistance to static loads at ambient temperatures shall be assessed by analysis according to EN 1993-1-1, EN 1993-1-3, EN 1993-1-4 and EN 1993-1-8 or assessed by tests as described in this EAD and evaluated according to EN 1990 Appendix D. The results shall be stated in the ETA. The design resistance by analysis for ambient temperatures is the characteristic resistance according to EN 1993 divided by the recommended partial safety factor γ_M given in the national regulations of the Member States where the Installation Systems are to be used. In cases in which no partial safety factors are given in a Member State the recommended γ_M should be stated in the ETA. For design assisted by tests, γ_M can be assumed to be F_{Rk} / F_{Rd} in accordance with Annex B.2 in cases in which no partial safety factor is given. Service limit state criteria shall be assessed case by case and be documented in the ETA if applicable. Determination of performance at elevated temperatures is according to the conditions given in EN 1363-1 and the Appendix D through Appendix J. For elevated temperatures the products shall be tested and evaluated in accordance with the procedures specified in Annex D through Annex J. The design resistances $F_{Rd,t}$ at elevated temperatures are the results of these tests and calculations.

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2   EOTA TR 021 "Reaction to fire requirements for small components"

2.2.2.1   Pipe clamp

2.2.2.1.1   Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.1.2   Dimensions

The relevant dimensions of the pipe clamp shall be determined. The dimensions shall conform to the pipe clamp's specification.

2.2.2.1.3   Material

Material characteristics of the components of the pipe clamp shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel components shall be assessed on the basis of material inspection certificates 3.1. The rubber inlay material shall be in accordance with the ETA.

2.2.2.1.4   Characteristic resistance at ambient temperature

The characteristic resistance F_{Rk} at ambient temperature shall be assessed on the basis of tests. Each pipe clamp size of a range may be tested or the following provisions shall apply for the selection of the test specimen. The pipe clamp range is clustered into subgroups. Within these subgroups the following properties are identical:

1. Cross sectional geometry of the pipe clamp steel band
2. Material specifications
3. Closing mechanism
4. Joint between the threaded boss and pipe clamp band
5. Threaded boss
6. Material and cross-section geometry of the rubber inlay

As a minimum, the largest and the smallest dimension from each of these subgroups must always be tested. At least 5 tests shall be performed for each selected pipe clamp to be assessed, in accordance with the following provisions: The pipe clamp shall be mounted on a steel pipe dummy in accordance with the manufacturer's instructions. The pipe dummy shall correspond to the maximum diameter of the clamping range of the test specimen. The width of the pipe dummy shall equal the width of the pipe clamp plus at least 10 mm. The pipe clamp with pipe dummy shall be installed in a tensile testing machine (see Annex A1) having sufficient strength to support the load until failure occurs. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute) until failure occurs. The test is complete once the specimen has been observed to break. The specimen is replaced with a new one of same type and size and testing resumed until a total of at least five tests have been completed. See Annex B.1 for details of assessing the characteristic resistance F_{Rk}. See Annex B.2 for details of assessing the design resistance F_{Rd} and $\gamma_M = F_{Rk} / F_{Rd}$ in cases in which a partial safety factor is not given. It is always the minimum assessed F_{Rk} and F_{Rd} of a subgroup that shall apply to the complete subgroup. See Annex C for details of assessing F_{SLS}.

2.2.2.1.5   Resistance and deformation at elevated temperatures

The resistance $F_{Rk,t}$ at elevated temperatures shall be assessed on the basis of tests. Each pipe clamp size of a range may be tested or the following provisions shall apply for the selection of the test specimen. The pipe clamp range is clustered in subgroups. Within these subgroups the following properties are identical:

1. Cross sectional geometry of the pipe clamp steel band
2. Material specifications
3. Closing mechanism
4. Joint between threaded boss and pipe clamp band
5. Threaded boss with the least favorable cross section

The smallest and largest clamp size from each of these subgroups must always be tested with the smallest suitable diameter of the threaded rod. The selection of the test loads for the smallest and largest clamp size from each of the subgroups shall follow Table F.1. The assessment applies to pipe clamps fixed with threaded rods to the ceiling of a strength class equal to or higher than the threaded rod used for the testing.

When evaluating pipe clamps supplied either with or without rubber inlays, tests for both groups may be performed using the pipe clamps with inserts. The results of the assessment at elevated temperatures for pipe clamps with rubber inlays may be transferred to pipe clamps with identical steel members but with other rubber materials up to the same thickness and same or better reaction to fire class. The general test requirements shall comply with Annex D. See Annex E.1 for details of the test setup. The pipe clamps shall be mounted in accordance with the manufacturer's instructions. The pipe dummies shall correspond to the maximum diameter of the clamping range and the width of the pipe dummy shall equal the width of the pipe clamp plus at least 10 mm. The pipe clamp with pipe dummy shall be installed in the furnace. The test specimen shall be fixed by means of threaded rods running across the ceiling. At least 100 mm of the thread shall be exposed to flames. If the threaded rods in reality are longer than those used in the testing in accordance with this section, the thermal elongation of the threaded rods shall be calculated in accordance with EN 1993-1-2, section 3.4. The pipe clamps shall be loaded by centrically arranged test loads connected to the test dummy via tension rods. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. With all the recorded loads and deformations within a subgroup

- $F_{Rk,t}$ shall be evaluated in accordance with Annex F,
- $F_{Rk,30}(\delta)$ shall be evaluated in accordance with Annex G
- $\delta_{max,t}$ shall be evaluated in accordance with Annex H

2.2.2.2 Channel

2.2.2.2.1 Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.2.2 Dimensions

The relevant dimensions of the channel shall be determined. The dimensions shall conform to the channel's specification.

2.2.2.2.3 Material and cross-section characteristics

Material characteristics of the channel shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel shall be assessed on the basis of material inspection certificate 3.1. Material and cross-section characteristics shall be assessed according to EN 1993-1-1, EN 1993-1-3, and EN 1993-1-8.

The ETA shall state and contain:
- material specification based on cold forming
- classification of the cross section according to Eurocode 1993-1-1
- the cross section areas
- the shear areas
- the centroid position
- the moments of inertia
- the polar moments of inertia
- the radii of gyration
- the polar radii of gyration
- the warping radius of gyration
- the torsional constant
- the secondary torsional constant
- the location of the shear center
- the warping constants
- the section moduli
- the torsional section modulus
- max. plastic bending moments
- max. plastic section moduli

- plastic shear areas
- area bisecting axis position
- plastic shear forces
- plastic axial force
- buckling curves
- the coating type and the coating thickness

2.2.2.2.4   Characteristic pull-through resistance of channel back holes at ambient temperatures

The objective of this test is to determine the characteristic pull-through resistance of a hole in the back of the channel. The channel to be tested shall have a maximum length of 250 mm and it shall be fastened to the supporting material by way of a hex. head bolt as per EN ISO 4014, in conjunction with a washer as per EN ISO 7089, which passes through the hole to be tested in the middle of the length of the back of the channel. With oblong holes, the bolt shall be positioned centrally in the hole. The combinations of bolts and washers listed in Table 2.2 represent a recommendation of the setup to be used for testing the pull-through resistance. Any other setup not shown in Table 2.2 may be assessed and documented with its performance in the ETA. The test load is to be applied centrally by way of a metal profile of the same length as the channel and inserted in the channel. See Annex A.2 for details of the test setup. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute) until failure occurs. The test is complete once breakage of the specimen has been observed. The specimen and the fixation are replaced with a new one of same type and size and testing resumed until a total of at least five tests have been completed. See Annex B.1 for assessing the characteristic resistance. See Annex B.2 for assessing the design resistance and γ_M in cases in which a partial safety factor is not given.

Table 2.2: Combinations of hexagon head bolts and flat washers to assess the characteristic pull-through resistance of the back holes at ambient temperatures

No.	Hexagon head bolt	Flat washer
1	EN ISO 4014 – M8×50 - 8.8	EN ISO 7089-8-200 HV (8.40 mm/16.0 mm/1.6 mm)
2	EN ISO 4014 - M10×50 - 8.8	EN ISO 7089-10-200 HV (10.5 mm/20.0 mm/2.0 mm)
3	EN ISO 4014 - M12×50 - 8.8	EN ISO 7089-12-200 HV (13.0 mm/24.0mm/2.5mm)

2.2.2.2.5   Pull-through resistance of channel back holes at elevated temperatures

The objective of this test is to determine the characteristic pull-through resistance of a hole in the back of the channel under exposure to elevated temperatures. The general test requirements shall comply with Annex D. See Annex E.2 for details of the test setup. The channel to be tested shall have a maximum length of 250 mm. The test specimen shall be fastened by means of a threaded rod running across the ceiling of the furnace. The fastening, consisting of a hexagon nut as per EN ISO 4032 in conjunction with a washer as per EN ISO 70898, shall be positioned in the hole to be tested in the middle of the length of channel. With oblong holes, the bolt shall be positioned centrally in the hole. The combinations of threaded rods, hexagon nuts and washers listed in Table 2.3 represent a recommendation to be used for pull-through resistance testing. Any other setup not shown in Table 2.3 may be assessed and documented with its performance in the ETA. The test load is to be applied centrally by way of a stainless steel profile of the same length as the channel and inserted in the channel. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the test load and the time until failure. $F_{Rk,t}$ shall be evaluated in accordance with Annex F, with the recorded loads.

Table 2.3: Combinations of metric thread stud bolts, hexagon nuts and flat washers to assess the pull-through resistance of the back holes at elevated temperatures

No.	Metric thread stud bolt	Hexagon nut	Flat washer
1	DIN 976-1 M8-4.8	ISO 4032 – M8 – 8	ISO 7089-8-200 HV (8.40 mm/ 16.0 mm / 1.6 mm)
2	DIN 976-1 M10-4.8	ISO 4032 – M10– 8	ISO 7089-10-200 HV (10.5 mm/ 20.0 mm / 2.0 mm)
3	DIN 976-1 M12-4.8	ISO 4032 – M12 – 8	ISO 7089-12-200 HV (13.0 mm/ 24.0mm / 2.5mm)

2.2.2.2.6   Bending characteristics of the channel at elevated temperatures

The material characteristics of the channel and its behavior under exposure to elevated temperatures shall be assessed in accordance with Annex I and Annex J.

2.2.2.3   Threaded rod

2.2.2.3.1   Dimensions

The relevant dimensions of the threaded rod shall be determined. The dimensions shall conform to the threaded rod's specification.

2.2.2.3.2   Material

Material characteristics of the threaded rod shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The threaded rod shall be assessed on the basis of material inspection certificate 3.1.

2.2.2.3.3   Resistance to combined bending and tension at elevated temperatures

In the case of threaded rods subject to combined tensile and bending stresses, the assessment must be determined with the aid of the exposure tests to elevated temperatures described in the following paragraphs. The values determined in this way may also be applied to threaded rods subject to pure tensile stresses. The general test requirements shall comply with Annex D. See Annex E.4 for details of the test setup. The test setup consists of a horizontally positioned threaded rod cantilever fastened to a steel profile projecting vertically from the ceiling of the furnace. The steel profile must be suitably selected and securely installed to prevent horizontal deflection during the test. The node presented by the threaded rod and steel profile must be formed in such a way that these two parts remain rigidly connected to each other for the duration of the test. The distance between node axis and the ceiling of the furnace should be between 200 mm and 300 mm. A lifting eye nut as per DIN 582, used to attach the test load, is fitted at the end of the horizontally positioned threaded rod cantilever. The distance between the steel profile and the center of the lifting eye nut at the outer end of the threaded rod should be 150 mm. A suitable loading device is attached to the lifting eye nut. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. As an alternative the resistance to combined bending and tension at elevated temperatures of the threaded rod may be assessed by testing a trapeze rod according to method 2 as described in chapter 2.2.2.13.4 with the maximum applicable span and suspension height of the trapeze rod system. A record is to be kept of the test load and the time until failure. $F_{Rk,t}$ shall be evaluated in accordance with Annex F, with the recorded loads.

2.2.2.3.4   Tension resistance at elevated temperatures

The tensile stress, respectively failure (fracture) load shall be assessed by test results in accordance with section 2.2.2.5.5 or shall be assessed in accordance with EN 1993-1-2.

2.2.2.3.5   Compression resistance at elevated temperatures

The compression resistance of a threaded rod at elevated temperatures shall be assessed in accordance with EN 1993-1-2.

2.2.2.4   Hexagon nut

2.2.2.4.1   Dimensions

The relevant dimensions of the hexagon nut shall be determined. The dimensions shall conform to the hexagon nut's specification.

2.2.2.4.2   Material

Material characteristics of the hexagon nut shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The hexagon nut shall be assessed on the basis of material inspection certificate 3.1.

2.2.2.4.3 Resistance at ambient temperature

The characteristic resistance F_{Rk} at ambient temperature shall be assessed on the basis of tests. The test setup and procedure shall follow the provisions described in chapter 9.1 of ISO 898-2:2012-03. At least 5 tests shall be performed for each combination of hexagon nut and threaded rod according to chapter 2.2.2.3. See Annex B.1 for details of assessing the characteristic resistance F_{Rk}. See Annex B.2 for details of assessing the design resistance F_{Rd} and $\gamma_M = F_{Rk} / F_{Rd}$ in cases in which a partial safety factor is not given. Furthermore, the ETA shall state and contain for the threaded rod the essential characteristics in accordance with the chapters 2.2.2.3.1 – 2.2.2.3.2.

2.2.2.5 Drilled plate

2.2.2.5.1 Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.5.2 Dimensions

The relevant dimensions of the drilled plate shall be determined. The dimensions shall conform to the drilled plate's specification.

2.2.2.5.3 Material

Material characteristics of the drilled plate shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel components shall be assessed on the basis of material inspection certificate 3.1.

2.2.2.5.4 Characteristic pull-through resistance at ambient temperatures

The objective of this test is to assess the characteristic pull-through resistance F_{Rk} of a drilled plate when pulled out of a channel. The characteristic resistance shall be assessed for the fastening of the drilled plate at the channel end. Any other distance of the drilled plates from the channel end may be also assessed. A complete test series, as described below, is required for each configuration. See Annex A.3 for details of the test setup. The means of fastening the channel to the test device shall have no influence on the test results. The length of the channel shall not exceed 300 mm. The load shall be introduced on the channel back side with a load distribution plate. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute) until failure occurs. The test is complete once breakage of the specimen has been observed. The failure loads for further evaluation are divided by 2. The specimen is replaced with a new one of same type and size and testing resumed until a total of at least five tests have been completed. See Annex B.1 for assessment of the characteristic resistance F_{Rk}. See Annex B.2 for assessment of the design resistance F_{Rd} and $\gamma_M = F_{Rk} / F_{Rd}$ in cases in which a partial safety factor is not given. Furthermore, the ETA shall state and contain for the associated members the essential characteristics: for the channel in accordance with the chapters 2.2.2.2.1 – 2.2.2.2.3, for the threaded rod in accordance with the chapters 2.2.2.3.1 – 2.2.2.3.2 and for the hexagon nut in accordance with the chapters 2.2.2.4.1 – 2.2.2.4.2.

2.2.2.5.5 Pull-through resistance at elevated temperatures

The objective of this test is to assess the pull-through resistance of a drilled plate at elevated temperatures. The requirements described in Annex D must be observed. See Annex E.5 for details of exemplary test setups. The drilled plates are fastened at the channel ends in accordance with the manufacturer's installation instructions. The length of the channel shall not exceed 300 mm. The load shall be introduced with a load distribution plate on the channel backside. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the test load and the time until failure. $F_{Rk,t}$ shall be evaluated in accordance with Annex F, with the recorded loads.

2.2.2.6 Saddle nut

2.2.2.6.1 Shape

Exemplary drawings and figures of the shape shall be stated in the ETA.

2.2.2.6.2 Dimensions

The relevant dimensions of the saddle nut shall be determined. The dimensions shall conform to the saddle nut's specification.

2.2.2.6.3 Material

Material characteristics of the saddle nut shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel components shall be assessed on the basis of material inspection certificate 3.1.

2.2.2.6.4 Characteristic pull-out resistance at ambient temperature

The objective of this test is to assess the characteristic pull-out resistance F_{Rk} of a saddle nut pulled out of a channel. The characteristic resistance shall be assessed for the fastening of the saddle nut in the middle of the channel and for the fastening of the saddle nut at the channel end. The results from the testing at the channel end may be used to assess the performance of the saddle nut installed in the middle of the channel. A complete test series, as described below, is required for each configuration. For details of the test setups see Annex A.4 for testing the saddle nut in the channel center and Annex A.5 for testing the saddle nut at the channel end.

For testing the saddle nut at the channel end according to Annex A.5 the following provisions shall be considered: The means of fastening the channel to the test device shall have no influence on the test results. The length of the channel shall be at least 250 mm. The means of fastening the channel must resist bending and shall not be in contact with the sides of the channel and shall not be in contact with the saddle nut or affect the nut in any way. Any setup with another distance of the saddle nut from the channel end may be assessed. For testing the saddle nut in the center of the channel according to Annex A.4 the following provisions shall be considered: The saddle nut is fastened centrally in the channel in accordance with the manufacturer's installation instructions. The channel length between the fixations shall be 100 mm. The threaded rods that form this suspended system pass through the holes provided in the back of the installation channel and shall be fastened to the channel with a nut that prevents the threaded rod being pulled through the hole provided in the back of the channel. The assembly used to apply the test force to the saddle nut shall be mounted in accordance with the manufacturer's installation instructions. The introduction of force occurs via a set screw of strength class 4.6, ISO 898-1. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute) until failure occurs. The test is complete once breakage of the specimen has been observed. The specimen is replaced with a new one of same type and size and testing resumed until a total of at least five tests have been completed. Replace the channel and saddle nut with new ones of same type and size until a total of five tests are at least completed. See Annex B.1 for assessing the characteristic resistance F_{Rk}. See Annex B.2 for assessing the design resistance F_{Rd} and $\gamma_M = F_{Rk} / F_{Rd}$ in cases in which a partial safety factor is not given. Furthermore, the ETA shall state and contain for the associated members the essential characteristics: for the channel in accordance with the chapters 2.2.2.2.1 – 2.2.2.2.3 and for the threaded rod in accordance with the chapters 2.2.2.3.1 – 2.2.2.3.2.

2.2.2.6.5 Pull-out resistance with $\varepsilon_{B,\theta a} \leq 2\%$ at elevated temperatures

The objective of this test is to assess the pull-out resistance of a saddle nut pulled out of a suspended channel exposed to elevated temperatures. The results may also be transferred to a channel mounted directly on a ceiling. As a minimum the assessment shall be made for installation angles of 0° and with the maximum allowable inclination. The assessment with the lowest result for these two angles shall be applicable for the angle range of 0° to maximum allowable inclination. Other angle ranges may be assessed in the same way. The requirements described in Annex D must be observed. See Annex E.6 and Annex E.7 for details of exemplary test setups. The saddle nut is fastened centrally in the channel in accordance with the manufacturer's installation instructions. The channel length between the suspension points shall be 100 mm. The threaded rods that form this suspended system pass through the holes provided in the back of the installation channel. To prevent the nut on the threaded rod being pulled through the hole provided in the back of the channel, a stainless steel plate with a hole of the appropriate size is fitted under the nut. The thickness of this plate must be at least 3 mm and it must have a length of at least 35 mm. The width of the plate should be selected so that it reaches to the beginning of the bending radius of the channel sidewall, but lies completely flat over its entire area against the back of the channel. The specimens are

then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the test load and the time until failure. $F_{Rk,t}$ shall be evaluated in accordance with Annex F, with the recorded loads.

2.2.2.6.6   Pull-out resistance with $\varepsilon_{B,\theta a}$ > 2% at elevated temperatures

In cases in which plasticization of the channel occurs prematurely on exposure to elevated temperatures, a test must be carried out at elevated temperatures with an installation angle of 0°. The distance between the fastening points in the ceiling of the furnace must be selected so that, with the minimum test load for the channel at room temperature, the figure σ_B > 35 N/mm^2 is applicable. The other instructions listed under 2.2.2.6.5 must be observed. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the test load and the time until failure. $F_{Rk,t}$ shall be evaluated in accordance with Annex F, with the recorded loads.

2.2.2.7   Channel connector

2.2.2.7.1   Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.7.2   Dimensions

The relevant dimensions of the channel connector shall be determined. The dimensions shall conform to the channel connector's specification.

2.2.2.7.3   Material

Material characteristics of the channel connector shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel components shall be assessed on the basis of material inspection certificates 3.1.

2.2.2.7.4   Characteristic pull-out resistance at ambient temperatures

The objective of this test is to assess the characteristic pull-out resistance F_{Rk} of a channel connector when pulled out of a channel. The characteristic resistance shall be assessed for the fastening of the nut in the middle of the channel and for the fastening of the nut at the channel end. The results from the testing at the channel end may be used to assess the performance of the channel connector installed in the middle of the channel. A complete test series, as described below, is required for each configuration. For details of the test setups see Annex A.6 for testing the channel connector in the channel center and Annex A.7 for testing the channel connector at the channel end. For testing the channel connector at the channel end according to Annex A.7 the following provisions shall be considered: The means of fastening the channel to the test device shall have no influence on the test results. The holes in the back of the channel shall also have no influence on the test result. The length of the channel shall be at least 250 mm. The means of fastening the channel must resist bending and shall not be in contact with the sides of the channel and shall not be in contact with the channel connector or affect the nut in any way. Any other distance of the channel connector from the channel end may be also assessed.

For testing the channel connector in the center of the channel according to Annex A.6 the following provisions shall be considered: The channel connector is fastened centrally in the channel in accordance with the manufacturer's installation instructions. The channel length between the fixations shall be 100 mm. The threaded rods that form this suspended system pass through the holes provided in the back of the installation channel and shall be fastened to the channel with a nut that prevents the threaded rod being pulled through the hole provided in the back of the channel. The assembly used to apply the test force to the channel connector shall be mounted in accordance with the manufacturer's installation instructions, using an adapter if necessary. The interface of the adapter to the channel shall be in such way that corresponds to the assembly of the channel connector in real situations. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute) until failure occurs. The test is complete once breakage of the specimen has been observed. The specimen is replaced with a new one of same type and size and testing resumed until a total of at least five tests have been completed. See Annex B.1 for assessment the characteristic resistance F_{Rk}. See Annex B.2 for assessment of the design resistance F_{Rd} and $\gamma_M = F_{Rk} / F_{Rd}$ in cases in which a partial safety factor is not given. Furthermore, the ETA shall state and contain for the channel the essential characteristics in accordance with the chapters 2.2.2.2.1 – 2.2.2.2.3.

2.2.2.7.5 Characteristic shear resistance at ambient temperatures

The objective of this test is to assess the characteristic shear resistance of a channel connector fitted to a channel with a steel connecting member. See Annex A.8 for details of the test setup. The back of the channel is directly attached to the test device and shall be secured to prevent toppling. The assembly consisting of the channel connector and angle connector shall be fitted to the channel in accordance with the manufacturer's installation instructions. Depending on the type of angle connector, more than one channel connector may be used to attach it to the channel. At least a system using one channel connector shall be assessed. The force is applied centrally to the angle connector, as close as possible to the channel. The specimen shall be subjected to continuous displacement-controlled loading (10 mm/minute) until failure occurs. The test is complete once breakage of the specimen has been observed. The specimen is replaced with a new one of same type and size and testing resumed until a total of at least five tests have been completed. The ETA shall state the type of coating and coating thickness of the channel. See Annex B.1 for assessment of the characteristic resistance F_{Rk}. See Annex B.2 for assessment of the design resistance F_{Rd} and $\gamma_M = F_{Rk} / F_{Rd}$ in cases in which a partial safety factor is not given. Furthermore, the ETA shall state and contain for the channel the essential characteristics in accordance with the chapters 2.2.2.2.1 – 2.2.2.2.3.

2.2.2.7.6 Pull-out resistance at elevated temperatures

The objective of this test is to assess the pull-out resistance of a channel connector pulled out of a suspended channel exposed to elevated temperatures. The results may also be transferred to a channel mounted directly on a ceiling. The requirements described in Annex D must be observed. See Annex E.8 for details of the test setup. The assembly used to apply the test force to the channel connector shall be mounted in accordance with the manufacturer's installation instructions, using an adapter if necessary. The interface of the adapter to the channel shall be in such way that corresponds to the assembly of the channel connector in real situations. The channel length between the suspension points shall be 100 mm. The threaded rods that form this suspended system pass through the holes provided in the back of the installation channel. To prevent the nut on the threaded rod being pulled through the hole provided in the back of the channel, a stainless steel plate with a hole of the appropriate size is fitted under the hexagon nut. The thickness of this plate must be at least 3 mm and it must have a length of at least 35 mm. The width of plate should be selected so that it reaches to the beginning of the bending radius of the channel sidewall, but lies completely flat over its entire area against the back of the channel. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the test load and the time until failure. $F_{Rk,t}$ shall be evaluated in accordance with Annex F, with the recorded loads.

2.2.2.7.7 Shear resistance at elevated temperatures

The objective of this test is to assess the shear resistance of a channel connector fitted to a channel with a base connector under exposure to elevated temperatures. See Annex E.9 for details of the test setup. The assembly consisting of the channel connector, channel and base plate shall be fitted in accordance with the manufacturer's installation instructions. Depending on the type of the base connector, more than one channel connector may be used to attach it to the channel. At least a system using one channel connector shall be assessed. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the test load and the time until failure. $F_{Rk,t}$ shall be evaluated in accordance with Annex F, with the recorded loads.

2.2.2.8 Cantilever

2.2.2.8.1 Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.8.2   Dimensions

The relevant dimensions of the cantilever shall be determined. The dimensions shall conform to the cantilever's specification.

2.2.2.8.3   Material

Material characteristics of the cantilever shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel components shall be assessed on the basis of material inspection certificates 3.1.

2.2.2.8.4   Characteristic resistance at ambient temperatures

The resistance to static loads for ambient temperatures shall be assessed by analysis according to EN 1993-1-1, EN 1993-1-3, EN 1993-1-4, EN 1993-1-5 and EN 1993-1-8.
The ETA shall state and contain:
- the detailed setup of the system configuration to be assessed
- the assembly instruction
- the load directions
- the specification of the cantilever
- the characteristic force resistances in the assessed load directions for each single component of the system configuration (cantilever, welds etc.)
- the characteristic moment resistances around the assessed load directions for each single component of the system configuration (cantilever, welds etc.)
- the minimum characteristic force resistances in the assessed load directions for the system configuration
- the minimum characteristic moment resistances around the assessed load directions for the system configuration

2.2.2.8.5   Resistance at elevated temperatures

The assessment of the cantilever channel profile must follow the provisions set down in section 2.2.2.2.6. The resistance of the joint between base plate and channel at elevated temperatures shall be assessed in the scope of a full-scale testing in accordance with section 2.2.2.15.4 for a suspended cantilever with the maximum applicable span and a centrically applied single load.

2.2.2.9   Base connector

2.2.2.9.1   Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.9.2   Dimensions

The relevant dimensions of the base connector shall be determined. The dimensions shall conform to the base connector's specification.

2.2.2.9.3   Material

Material characteristics of the base connector shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel components shall be assessed on the basis of material inspection certificates 3.1.

2.2.2.9.4   Characteristic resistance at ambient temperatures

The resistance to static loads for ambient temperatures shall be assessed by analysis according to EN 1993-1-1, EN 1993-1-3, EN 1993-1-4, EN 1993-1-5 and EN 1993-1-8. For assessment of the characteristic resistance of components in case an analytic approach is not feasible, tests shall be

performed and assessed according to EN 1990 (see Annex B). See Annex A.9 for a tension test setup for a base connector with associated channel and channel connectors.

The ETA shall state and contain:
- the detailed setup of the system configuration to be assessed
- the assembly instruction
- the load directions
- the specification of the associated channel connector, bolt, channel and the base connector
- the characteristic force resistances in the assessed load directions for each single component of the system configuration (base connector, channel, channel connector, weld etc.)
- the characteristic moment resistances around the assessed load directions for each single component of the system configuration (base connector, channel, channel connector, bolt, weld etc.)
- the minimum characteristic force resistances in the assessed load directions for the system configuration
- the minimum characteristic moment resistances around the assessed load directions for the system configuration

2.2.2.9.5   Resistance at elevated temperatures

The resistance performance of the base connector at elevated temperatures shall be assessed in the scope of the trapeze frame assessment for elevated temperatures in accordance with section 2.2.2.14.4.

2.2.2.10   Angle connector

2.2.2.10.1   Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.10.2   Dimensions

The relevant dimensions of the angle connector shall be determined. The dimensions shall conform to the angle connector's specification.

2.2.2.10.3   Material

Material characteristics of the angle connector shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards. The steel components shall be assessed on the basis of material inspection certificates 3.1.

2.2.2.10.4   Characteristic resistance at ambient temperatures

The resistance to static loads for ambient temperatures shall be assessed by analysis according to EN 1993-1-1, EN 1993-1-3, EN 1993-1-4, EN 1993-1-5 and EN 1993-1-8. For assessment of the characteristic resistance of components in case an analytic approach is not feasible, tests shall be performed and assessed according to EN 1990 (see Annex B). See Annex A.10 and Annex A.11 for test setups of angle connectors used in a trapeze frame.

The ETA shall state and contain:
- the detailed setup of the system configuration to be assessed
- the assembly instruction
- the load directions
- the specification of the associated channel connector, bolt, channel and angle connector
- the characteristic force resistances in the assessed load directions for each single component of the system configuration (angle connector, channel, channel connector, weld etc.)
- the characteristic moment resistances around the assessed load directions for each single component of the system configuration (angle connector, channel, channel connector, weld etc.)
- the minimum characteristic force resistances in the assessed load directions for the system configuration

- the minimum characteristic moment resistances around the assessed load directions for the system configuration

2.2.2.10.5   Resistance at elevated temperatures

The performance of the angle connector at elevated temperatures shall be assessed in the scope of the trapeze frame assessment for elevated temperatures in accordance with section 2.2.2.14.4.

2.2.2.11   End cap

2.2.2.11.1   Shape

Exemplary drawings and illustrations of the shape shall be given in the ETA.

2.2.2.11.2   Dimensions

The relevant dimensions of the end cap shall be determined. The dimensions shall conform to the end cap's specification.

2.2.2.11.3   Material

Material characteristics of the end cap shall be determined according to the reference specification as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference specification.

2.2.2.11.4   Resistance at ambient temperature

The objective of this test is to assess the pull-out resistance of an end cap pulled out of a channel. The following provisions shall be considered for each combination of end cap and channel: The end cap shall be fixed to the channel according to the manufacturer's instructions. The specimen shall be installed in a tensile testing machine and shall be subjected to continuous displacement-controlled loading (10 mm/minute) in the center of the endcap until the pullout occurs. The test is complete once the end cap has been pulled out from the channel. The specimen is replaced with a new one of same type and size and testing resumed until a total of at least five tests have been completed. The average of the test values is describing the pull-out resistance of the end cap from the channel. Furthermore the ETA shall state and contain for the channel the essential characteristics in accordance with the chapters 2.2.2.2.1 – 2.2.2.2.3.
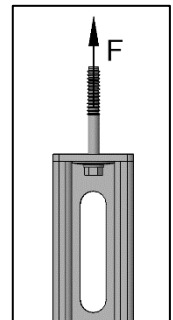
2.2.2.12   Head rail

2.2.2.12.1   Shape

Exemplary drawings and illustrations of the head rail configuration and associated components shall be given in the ETA.

2.2.2.12.2   Dimensions

The relevant dimensions of the head rail and the associated components shall be determined. The dimensions shall conform to the specifications.

2.2.2.12.3   Material

Material characteristics of the headrail shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards.

2.2.2.12.4   Resistance and deformation at elevated temperatures determined for headrail kits without pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.1 and Annex K.2.

Method 2 (Assessment of the kit without using FEM analysis for the channel):
The requirements described in Annex D must be observed. The head rail and the saddle nuts shall be mounted in accordance with the manufacturer's instructions. See Annex E.10 for details of exemplary testing setups. Any other testing setup not shown in Annex E.10 with different load numbers, load positions and load sizes may be assessed and documented with its performance according to this EAD. The systems shall be loaded by centrically arranged test loads connected to the specimen via tension rods. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the applicable loads and deformations.

-   $F_{Rk,t}$ shall be evaluated in accordance with Annex F,
-   $F_{Rk,30}(\delta)$ shall be evaluated in accordance with Annex G
-   $\delta_{max,t}$ shall be evaluated in accordance with Annex H

Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined with a specific number of evenly distributed loads may be transferred to the same kit with equal number of evenly distributed loads but having a shorter span.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying one or multiple evenly distributed single loads to the system, may be transferred to identical systems with higher number of multiple, evenly distributed single loads, in which the total sum of the evenly distributed loads shall not exceed the total sum of loads of the tested system.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying multiple evenly distributed single loads to the system, may be transferred to identical systems with lower number of evenly distributed single loads, in which each individual load shall not exceed the value of the lowest value of tested single load.

2.2.2.12.5   Resistance and deformation at elevated temperatures determined for headrail kits with pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.1 and Annex K.2.

Method 2 (Assessment of the kit without using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.8 and Annex K.9.

2.2.2.13   Trapeze rod

2.2.2.13.1   Shape

Exemplary drawings and illustrations of the trapeze rod configuration and the associated components shall be stated in the ETA.

2.2.2.13.2   Dimensions

The relevant dimensions of the trapeze rod and the associated components shall be determined. The dimensions shall conform to the specifications.

2.2.2.13.3   Material

Material characteristics of the trapeze rod shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards.

2.2.2.13.4 Resistance and deformation at elevated temperatures determined for trapeze rod kits without pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.3 and Annex K.4.

Method 2 (Assessment of the kit without using FEM analysis for the channel):
The requirements described in Annex D must be observed. The trapeze rod shall be mounted in accordance with the manufacturer's instructions. See Annex E.11 for details of exemplary testing setups. Any other testing setup not shown in Annex E.11 with different load numbers, load positions, load sizes and suspension height of the channel may be assessed and documented with its performance according to this EAD. The systems shall be loaded by centrically arranged test loads connected to the specimen via tension rods. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the loads and deformations.
- $F_{Rk,t}$ shall be evaluated in accordance with Annex F,
- $F_{Rk,30}(\delta)$ shall be evaluated in accordance with Annex G
- $\delta_{max,t}$ shall be evaluated in accordance with Annex H

Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined with a specific number of evenly distributed loads and a specific suspension height may be transferred to the same kit with equal number of evenly distributed loads and equal suspension height but having a shorter span.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying one or multiple evenly distributed single loads to the system, may be transferred to identical systems with higher number of multiple, evenly distributed single loads, in which the total sum of the evenly distributed loads shall not exceed the total sum of loads of the tested system.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying multiple evenly distributed single loads to the system, may be transferred to identical systems with lower number of evenly distributed single loads, in which each individual load shall not exceed the value of the lowest value of tested single load.

2.2.2.13.5 Resistance and deformation at elevated temperatures determined for trapeze rod kits with pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.3 and Annex K.4.

Method 2 (Assessment of the kit without using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.8 and Annex K.9.

2.2.2.14 Trapeze frame

2.2.2.14.1 Shape

Exemplary drawings and illustrations of the trapeze frame configuration and associated components shall be given in the ETA.

2.2.2.14.2 Dimensions

The relevant dimensions of the trapeze frame and the associated components shall be determined. The dimensions shall conform to the specifications.

2.2.2.14.3   Material

Material characteristics of the trapeze frame shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards.

2.2.2.14.4   Resistance and deformation at elevated temperatures determined for trapeze frame kits without pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.5 and Annex K.6.

Method 2 (Assessment of the kit without using FEM analysis for the channel):
The requirements described in Annex D must be observed. The trapeze frame shall be mounted in accordance with the manufacturer's instructions. See Annex E.12 for details of exemplary testing setups. Any other testing setup not shown in Annex E.12 with different load numbers, load positions, load sizes and suspension height of the channel may be assessed and documented with its performance according to this EAD. The systems shall be loaded by centrically arranged test loads connected to the specimen via tension rods. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. A record is to be kept of the loads and deformations.

-   $F_{Rk,t}$ shall be evaluated in accordance with Annex F,
-   $F_{Rk,30}(\delta)$ shall be evaluated in accordance with Annex G
-   $\delta_{max,t}$ shall be evaluated in accordance with Annex H

Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined with a specific number of evenly distributed loads and a specific suspension height may be transferred to the same kit with equal number of evenly distributed loads and equal suspension height but having a shorter span.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying one or multiple evenly distributed single loads to the system, may be transferred to identical systems with higher number of multiple, evenly distributed single loads, in which the total sum of the evenly distributed loads shall not exceed the total sum of loads of the tested system.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying multiple evenly distributed single loads to the system, may be transferred to identical systems with lower number of evenly distributed single loads, in which each individual load shall not exceed the value of the lowest value of tested single load.

2.2.2.14.5   Resistance and deformation at elevated temperatures determined for trapeze frame kits with pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.5 and Annex K.6.

Method 2 (Assessment of the kit without using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.8 and Annex K.9.

2.2.2.15   Suspended and non-suspended cantilever

2.2.2.15.1   Shape

Exemplary drawings and illustrations of the suspended and non-suspended cantilever configuration and associated components shall be given in the ETA.

2.2.2.15.2　Dimensions

The relevant dimensions of the suspended and non-suspended cantilever and the associated components shall be determined. The dimensions shall conform to the specifications.

2.2.2.15.3　Material

Material characteristics of the suspended and non-suspended cantilever shall be determined according to the reference standards as layed down in the applicable control plan according to chapter 3.2. Acceptance criteria shall conform to the respective reference standards.

2.2.2.15.4　Resistance and deformation at elevated temperatures determined for suspended and non-suspended cantilevers without pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation of the suspended cantilever only shall follow the procedures described in Annex K.7 and Annex K.4.

Method 2 (Assessment of the kit without using FEM analysis for the channel):
The requirements described in Annex D must be observed. The cantilever with or without suspension shall be mounted in accordance with the manufacturer's instructions. To assess the performance of the joint between base plate and channel the resistance shall be evaluated for a suspended cantilever with the maximum applicable span. See Annex E.13 and Annex E.14 for details of exemplary testing setups. Any other testing setup not shown in Annex E.13 with different load numbers, load positions, load sizes and suspension height of the channel and Annex E.14 with different load numbers, load positions and load sizes may be assessed and documented with its performance according to this EAD. The systems shall be loaded by centrically arranged test loads connected to the specimen via tension rods. The specimens are then subjected to the temperatures as described in Annex D until failure occurs. For the non-suspended cantilever failure is considered to occur as soon as deformation at the end of the cantilever arm reaches the value l/15 (l is the cantilever arm length). A record is to be kept of the loads and deformations.
-　$F_{Rk,t}$ shall be evaluated in accordance with Annex F,
-　$F_{Rk,30}(\delta)$ shall be evaluated in accordance with Annex G
-　$\delta_{max,t}$ shall be evaluated in accordance with Annex H

Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined with a specific number of evenly distributed loads and a specific suspension height may be transferred to the same kit with equal number of evenly distributed loads and equal suspension height but having a shorter span.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying one or multiple evenly distributed single loads to the system, may be transferred to identical systems with higher number of multiple, evenly distributed single loads, in which the total sum of the evenly distributed loads shall not exceed the total sum of loads of the tested system.
Performance levels ($F_{Rk,t}$; $F_{Rk,30}(\delta)$; $\delta_{max,t}$) for kits, which have been determined by applying multiple evenly distributed single loads to the system, may be transferred to identical systems with lower number of evenly distributed single loads, in which each individual load shall not exceed the value of the lowest value of tested single load.

2.2.2.15.5　Resistance and deformation at elevated temperatures determined for suspended and non-suspended cantilevers with pipe clamps

Method 1 (Assessment of the kit using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation of the suspended cantilever only shall follow the procedures described in Annex K.7 and Annex K.4.

Method 2 (Assessment of the kits without using FEM analysis for the channel):
In order to assess the essential characteristics $F_{Rk,t}$ and δ_t the evaluation shall follow the procedures described in Annex K.8 and Annex K.9.

3   ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1   System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal acts are:

Decision 1996/577/EC for products used in sprinkler installations. The system is: **1**

Decision 1999/472/EC for products not in contact with water intended for human consumption: The system is **3**

Reaction to fire: **1, 3 or 4**

3.2   Tasks of the manufacturer

The cornerstones of the action to be undertaken by the manufacturer of the Installation System products in the procedure of assessment and verification of constancy and performance are laid down in the Tables 3.2.1 through 3.2.10 for the products according to table 1.1 and in the Tables 3.2.11 through 3.2.14 for the kits according to table 1.2. The detailed control plan depends on the manufacturing process and must be established for each product/kit. The manufacturer of a product with weld shall demonstrate that the plant can perform the selected welding process in accordance with the applicable standards.

Table 3.2.1 Control Plan for the manufacturer, cornerstones for pipe clamps

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]
Pipe clamp
1	Material and material properties of the metal	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Material and material properties of the pipe clamp rubber inlay	In accordance with the ETA	Control plan	1	Each manufacturing lot
3	Check of the functional dimensions	Gauge	Control plan	1	per manufacturing lot or every 7500 pcs
4	Tension resistance	2.2.2.1.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.2 Control Plan for the manufacturer, cornerstones for channels

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Channel					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	1	Every 2500 meters
3	Pull-through resistance	2.2.2.2.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.3 Control Plan for the manufacturer, cornerstones for threaded rods

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Threaded rod					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	3	Each manufacturing lot
3	Tension test	ISO 898-1, chapter 9.2	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.4 Control Plan for the manufacturer, cornerstones for hexagon nuts

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Hexagon nut					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204 and hardness test	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	5	Each manufacturing lot
3	Tension test	2.2.2.4.3	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.5 Control Plan for the manufacturer, cornerstones for drilled plates

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Drilled plate					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimension	Gauge	Control plan	3	Each manufacturing lot or every hour
3	Pull-through resistance	2.2.2.5.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.6 Control Plan for the manufacturer, cornerstones for saddle nuts

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Saddle nut					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	1	Each manufacturing lot or every 5000 pcs
3	Pull-out resistance	2.2.2.6.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.7 Control Plan for the manufacturer, cornerstones for channel connectors

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Channel connector					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	1	Each manufacturing lot
3	Pull-out resistance	2.2.2.7.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
4	Shear resistance	2.2.2.7.5	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.8 Control Plan for the manufacturer, cornerstones for cantilevers

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Cantilever					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	1	Each manufacturing lot or every 1000 pcs

Table 3.2.9 Control Plan for the manufacturer, cornerstones for base connectors

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Base Connector					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	1	Every 300 pcs or every 4 hours
3	Tension test if characteristic resistance is assessed by tests	2.2.2.9.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.10 Control Plan for the manufacturer, cornerstones for angle connectors

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
Angle Connector					
1	Material and material properties	Inspection certificate 3.1 according to EN 10204	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	1	Each manufacturing lot or every hour
3	Tension test if characteristic resistance is assessed by tests	2.2.2.10.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.11 Control Plan for the manufacturer, cornerstones for end caps

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test plan]					
End cap					
1	Material and material properties	Inspection of documents	Control plan	1	Each manufacturing lot
2	Check of the functional dimensions	Gauge	Control plan	1	Each manufacturing lot
3	Tension test	2.2.2.11.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.12 Control Plan for the manufacturer, cornerstones for headrails

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test pan]					
Headrail					
1	Material and material properties of the kit components	Inspection certificate 3.1 according to EN 10204	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
2	Check of the functional dimensions of the kit components	Gauge	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
3	Tension resistance of the pipe clamp	2.2.2.1.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
4	Pull-through resistance of the channel back hole	2.2.2.2.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
5	Pull-through resistance of the drilled plate	2.2.2.5.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
6	Pull-out resistance of the saddle nut	2.2.2.6.4	Control plan	1	every 5 years

Table 3.2.13 Control Plan for the manufacturer, cornerstones for trapeze rods

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test pan]				
	Trapeze rod				
1	Material and material properties of the kit components	Inspection certificate 3.1 according to EN 10204	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
2	Check of the functional dimensions of the kit components	Gauge	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
3	Tension resistance of the pipe clamp	2.2.2.1.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
4	Pull-through resistance of the drilled plate	2.2.2.5.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
5	Pull-out resistance of saddle nut	2.2.2.6.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.14 Control Plan for the manufacturer, cornerstones for trapeze frames

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test pan]					
Trapeze frame					
1	Material and material properties of the kit components	Inspection certificate 3.1 according to EN 10204	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
2	Check of the functional dimensions of the kit components	Gauge	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
3	Tension resistance of the pipe clamp	2.2.2.1.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
4	Pull-through resistance of the drilled plate	2.2.2.5.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
5	Pull-out resistance of saddle nut	2.2.2.6.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

Table 3.2.15 Control Plan for the manufacturer, cornerstones for suspended and non-suspended cantilevers

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with the prescribed test pan]					
Suspended / non-suspended cantilever					
1	Material and material properties of the steel of the kit components	Inspection certificate 3.1 according to EN 10204	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
2	Check of the functional dimensions of the kit components	Gauge	Control plan	See Tables 3.2.1 - 3.2.11	See Tables 3.2.1 - 3.2.11
3	Tension resistance of the pipe clamp	2.2.2.1.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
4	Pull-through resistance of drilled plate	2.2.2.5.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery
5	Pull-out resistance of the saddle nut	2.2.2.6.4	Control plan	1	every 5 years or after any change of the manufacturing process or machinery

3.3 Tasks of the notified body

The intervention of the notified body is only necessary if the products/kits are intended to be used in sprinkler installations or in so far as the conditions for the applicability of system 1 as defined in Decision 1999/472/EC are fulfilled.

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.

Table 3.3.1 Control plan for the notified body, cornerstones

No.	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
	Initial inspection of the manufacturing plant and of factory production control *(for system 1)*				
1	Ascertain that the factory production control with the stuff and equipment are suitable to ensure a continuous and orderly manufacturing of the product	-	Laid down in control plan	-	1
	Continuous inspection of the manufacturing plant and of factory production control (for system 1)				
2	Subsequent continuous surveillance of factory production control to ensure continuing conformity with the performance stated in the ETA.	-	Laid down in control plan	-	1/year

4   REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment is of relevance.

DIN 582	Lifting eye nuts
DIN 976-1	Metric thread stud bolts
EN 1363-1	Fire resistance tests - Part 1: General Requirements
EN 1990	Eurocode – Basis of structural design
EN 1993-1-1	Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings
EN 1993-1-2	Eurocode 3: Design of steel structures – Part 1-2: General rules - Structural fire design
EN 1993-1-3	Eurocode 3: Design of steel structures – Part 1-3: General rules - Supplementary rules for cold-formed members and sheeting
EN 1993-1-4	Eurocode 3: Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels
EN 1993-1-5	Eurocode 3: Design of steel structures - Part 1-5: Plated structural elements
EN 1993-1-8	Eurocode 3: Design of steel structures - Part 1-8: Design of joints
EN 10204	Metallic products – Types of inspection documents
EN 13501-1	Fire classification of construction products and building elements – Part 1: classification using data from reaction to fire tests
EN ISO 4014	Hexagon head bolts – Product grades A and B
EN ISO 4032	Hexagon regular nuts (style 1) – Product grades A and B
EN ISO 7089	Plain washers – Normal series, Product grade A
ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread
ISO 898-2	Mechanical properties of fasteners made of carbon steel and alloy steel Part 2: Nuts with specified property classes
ISO 6892-2	Metallic materials – Tensile testing – Part 2: Method of test at elevated temperature
TR 021	Reaction to fire requirements for small components

ANNEX A
TESTING SETUPS AT AMBIENT TEMPERATURE
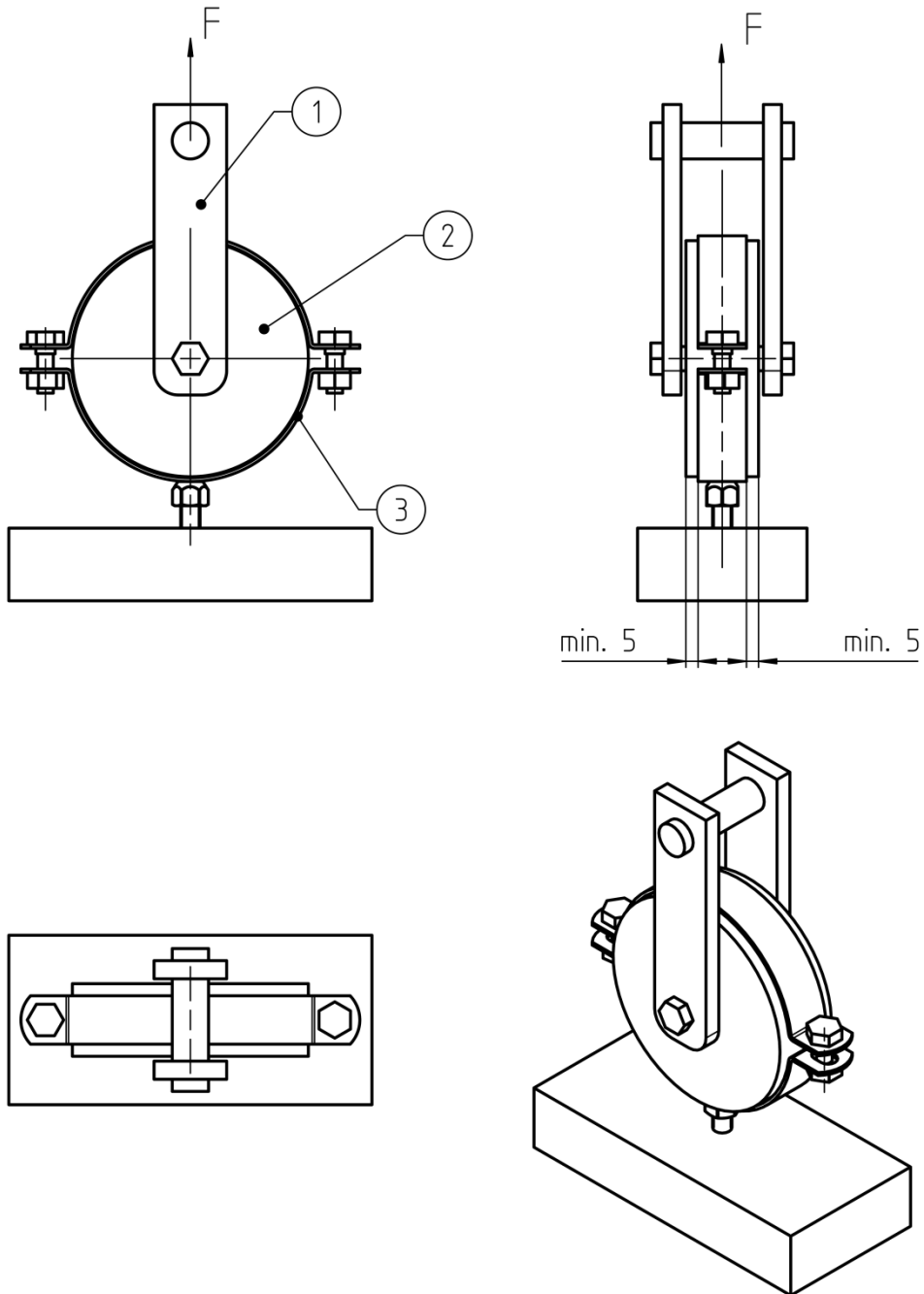
Legend
1 Force transducer
2 Pipe dummy
3 Pipe clamp

Dimensions in mm

| **Tension tests on pipe clamps** | **Annex A.1** |

F

1

2

4

3

5

l/2

l = max. 250

Legend
1 Threaded rod
2 Adapter
3 Channel
4 Hexagon head bolt
5 Flat washer

Dimensions in mm

| **Channel back hole pull-throug test** | **Annex A.2** |

Legend
1 Channel
2 Drilled plate
3 Threaded rod
4 Load distribution element

Dimensions in mm

| **Drilled plate pull-through test** | **Annex A.3** |

Legend
1 Channel
2 Saddle nut
3 Threaded rod

Dimensions in mm

| **Saddle nut pull-out test in channel center** | **Annex A.4** |

Legend
1 Threaded rod
2 Saddle nut
3 Channel
4 Retaining device

Dimensions in mm

| **Saddle nut pull-out test at channel end** | **Annex A.5** |

F

②

L/2

④

③

①

250

Legend
1 Channel
2 Channel connector
3 Threaded rod
4 Adapter

Dimensions in mm

Channel connector pull-out test in channel center	**Annex A.6**

L ≥ 250

Legend
1 Adapter
2 Channel connector
3 Channel
4 Retaining device

Dimensions in mm

| Channel connector pull-out test at channel end | Annex A.7 |

Legend
1 Channel
2 Channel connector
3 Angle connector

Channel connector shear test	Annex A.8

Legend
1 Force Transducer
2 Channel
3 Base connector
4 Channel connector

Test setup for tension test on base connector at ambient temperature	**Annex A.9**

Legend
1 Channel
2 Load distribution element
3 Angle connector
4 Base connector

| Tension test on angle connectors below horizontal channel in trapeze frame | Annex A.10 |

Legend
1 Channel
2 Load distribution element
3 Angle connector
4 Base connector

Tension test on angle connectors below horizontal channel in trapeze frame	**Figure A.11**

ANNEX B
DESIGN ASSISTED BY TESTING ACCORDING TO EN 1990

ANNEX B.1
Determination of the characteristic resistance F_{Rk} assisted by tests according to EN 1990

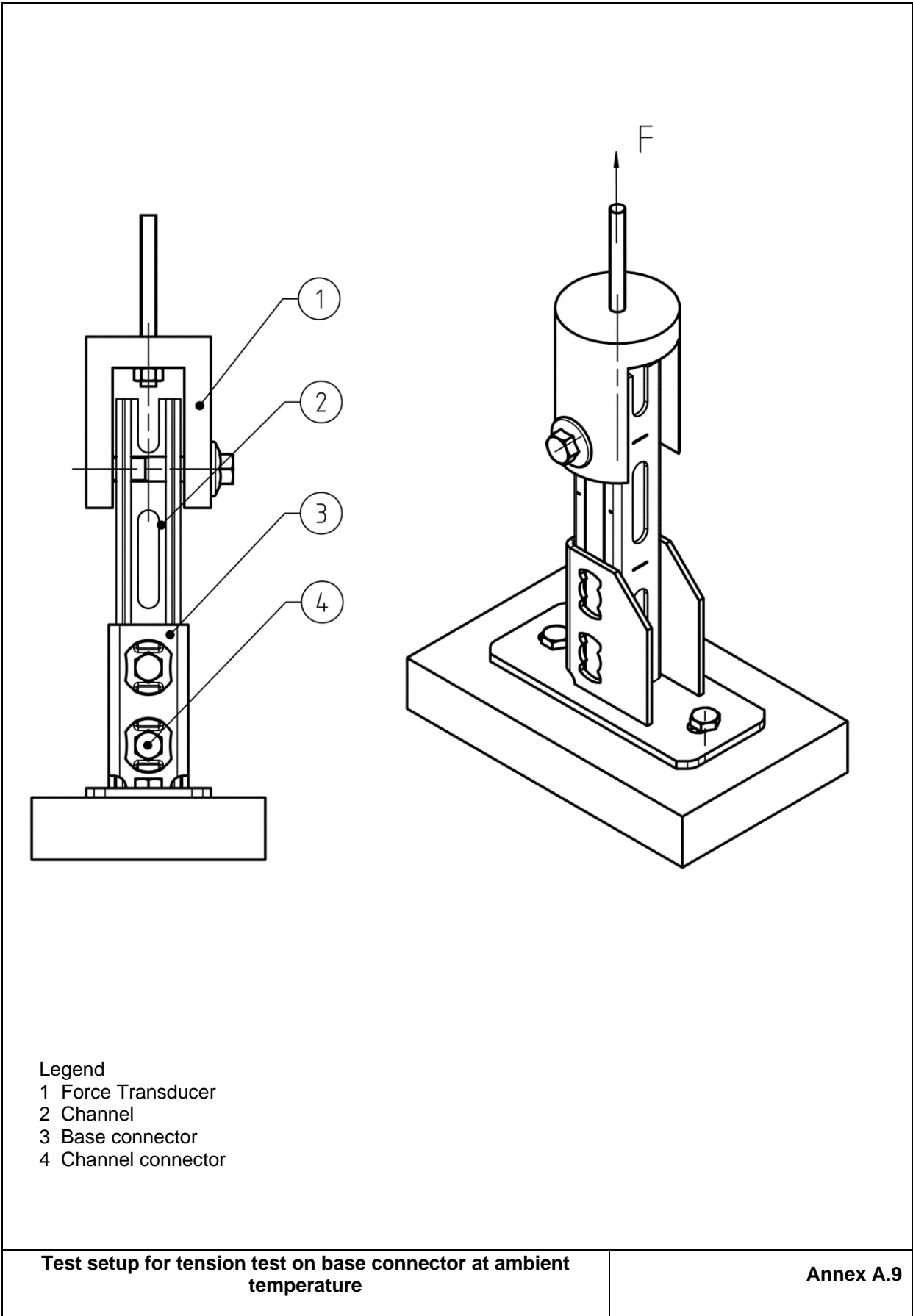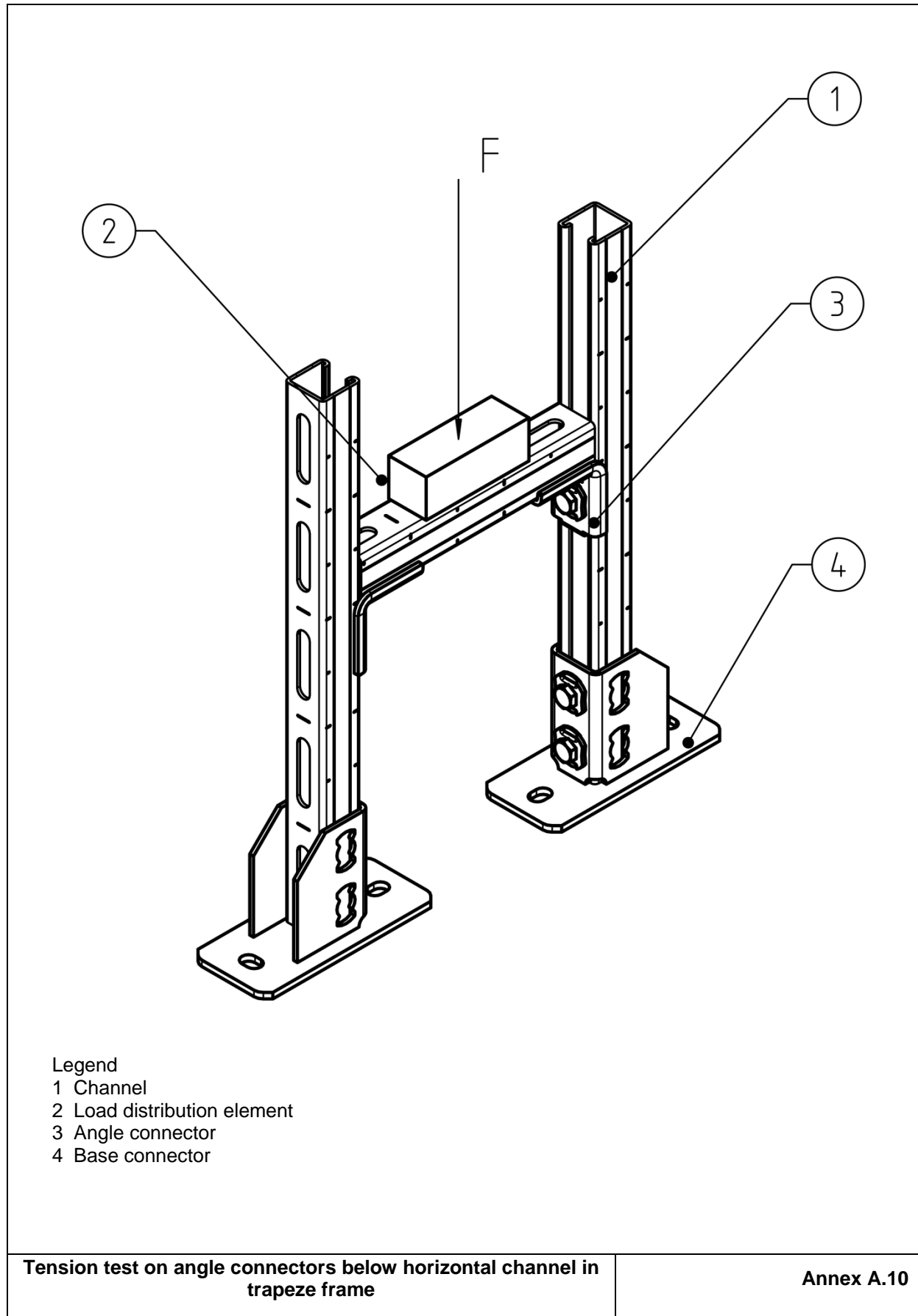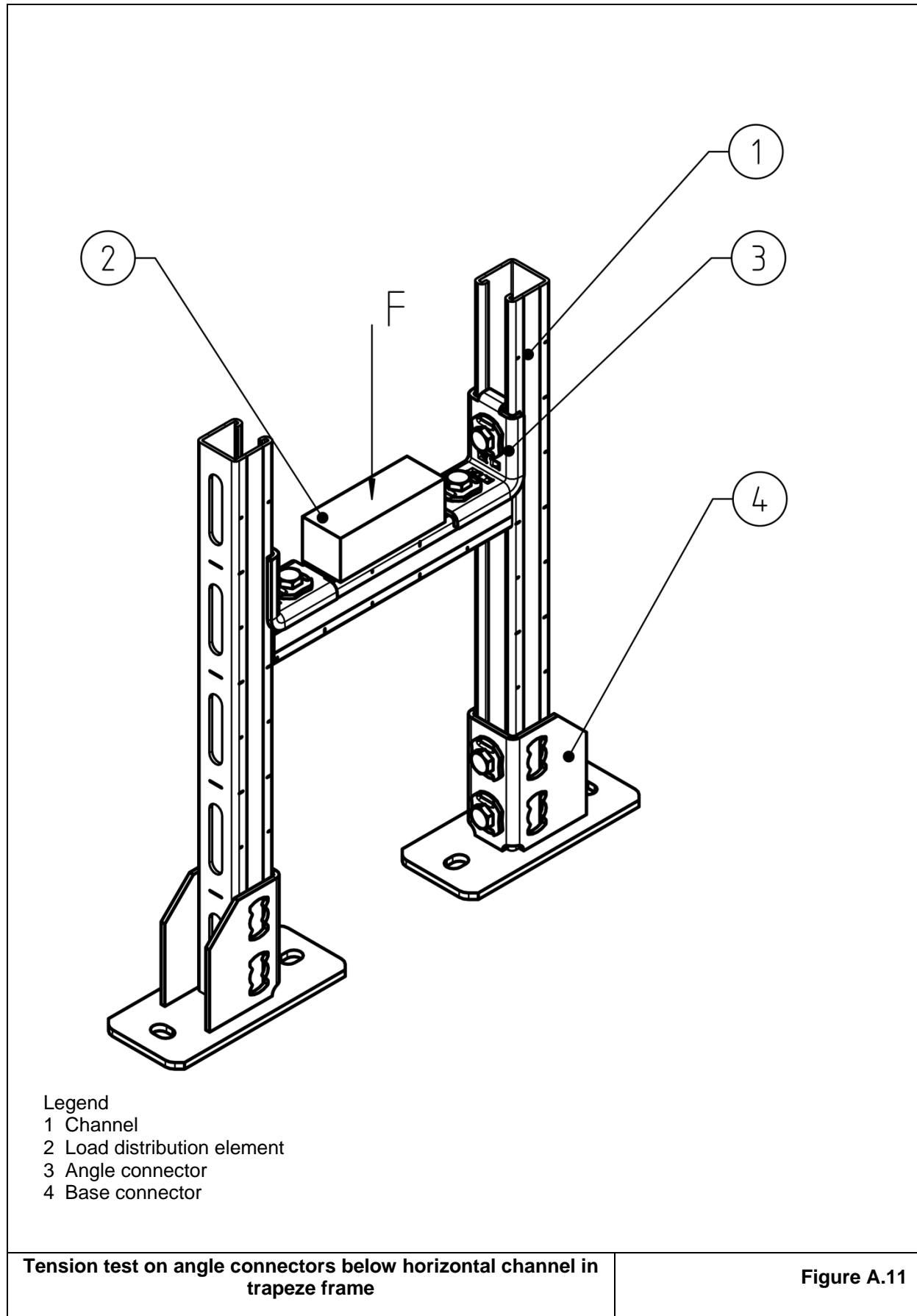The test assemblies must take possible deviations from the installation conditions given by the manufacturer into account. Possible deviations from the installation conditions given by the manufacturer can be neglected if installers can show that they are competent and have been trained by participating in manufacturer-specific training courses.

The load-displacement curves and the respective failure modes as well as the material properties (yield strength, tensile strength), dimensions and geometry of the components used for the tests shall be documented in the test report. The material properties of the initial material of the components used in the test shall be documented on the basis of 3.1 certificates according to EN 10204. The results must correspond to the material specifications given by the manufacturer. The test results (failure loads) shall be multiplied by a correction factor which takes account of nominal tensile/effective tensile strength resp. nominal yield strength/effective yield strength of the components used in the tests. The ratio resulting in a smaller correction factor is relevant. If fracture occurs as a failure mode the tensile strength shall be used in order to determine the correction factor. The corrected test results shall be evaluated statistically (determination of 5% fractiles, confidence level of 75%) according to EN 1990. For the statistically evaluation k_n shall be taken from EN 1990, Table D.1. A normal distribution can generally be assumed. The corrected and statistically evaluated test results (5% fractiles) represent the characteristic resistance.

ANNEX B.2
Determination of the design resistance F_{Rd} assisted by tests according to EN 1990

The load-displacement curves and the respective failure modes as well as the material properties (yield strength, tensile strength), dimensions and geometry of the components used for the tests shall be documented in the test report. The material properties of the initial material of the components used in the test shall be documented on the basis of 3.1 certificates according to EN 10204. The results must correspond to the material specifications given by the manufacturer. The test results (failure loads) shall be multiplied by a correction factor which takes account of nominal tensile/effective tensile strength resp. nominal yield strength/effective yield strength of the components used in the tests. The ratio resulting in a smaller correction factor is relevant. If fracture occurs as a failure mode the tensile strength shall be used in order to determine the correction factor. The corrected test results shall be evaluated statistically according to EN 1990. For the statistically evaluation k_n shall be taken from EN 1990, Table D.2. A normal distribution generally can be assumed. The corrected and statistically evaluated test results represent the design resistance F_{Rd}.

ANNEX C
REQUIREMENTS FOR DETERMINING THE SERVICEABILTY LIMIT STATE F_{SLS} ASSISTED BY TESTS

The test assemblies must correspond to the installation conditions given by the manufacturer. The limiting displacement criteria for the service limit state shall be given by the manufacturer and shall be stated in the ETA. For pipe clamps, unless otherwise specified by the manufacturer, the maximum allowable deformation for determining F_{SLS} should be max. (1.5 mm; 2% of the largest pipe clamp diameter). A preload is applied to the pipe clamp in accordance with Tables C.1 and C.2. In this way, a pipe clamp is assigned to the preload group that is closest to it in terms of its dimensions and intended application. In case of doubt, the lower preload is to be selected. If the deformation that occurs when the initial load is applied reaches the level of the permissible deformation, the preload may not be further increased up to the value given in the table. In this case, the test is to be carried out with a reduced preload. After the preload has been applied for 30 seconds, the position transducer is set to zero. A continuous displacement-controlled load is then applied to the pipe clamp until the displacement criteria is reached. The load speed is 10 mm/minute. In general, the specimen selection and the number of tests the same provisions apply as for the determination of the characteristic resistance. Max. F_{SLS} shall be determined as the mean value of the test series. The load-displacement curves and the material properties (yield strength, tensile strength), dimensions and geometry of the components used for the tests shall be documented in the test report. The material properties of the initial material of the components used in the test shall be documented by means of 3.1 certificates according to EN 10204. The results must correspond to the material specifications given by the manufacturer. Examples of test setups are shown in Annex A.

Table C.1 Preloads for plumbing, heating and sprinkler applications

Test dummy diameter [mm]	Preload [N]
17.2	80
21.3	80
26.9	80
33.7	80
44.5	100
48.3	125
51.0	135
57.0	180
60.3	200
63.5	200
76.1	290
82.5	360
88.9	400
101.6	520
108.0	560
114.3	590
127.0	730
133.0	760
139.7	800
152.4	970
159.0	1030
168.3	1090
177.8	1280
193.7	1560
219.1	1990
244.5	2220
273.0	2490
323.9	3330
355.6	4120
406.4	5180
508.0	8100

Table C.2 Preloads for ventilation and air conditioning applications

Test dummy diameter [mm]	Preload [N]
71	80
80	
90	
100	
112	100
125	
140	
150	
160	
180	
200	
224	180
250	
280	
300	
315	300
355	
400	
450	
500	
560	
600	
630	
710	
800	
900	
1000	
1120	
1250	
1400	
1600	
1800	
2000	

ANNEX D
GENERAL REQUIREMENTS FOR TESTS AT ELEVATED TEMPERATURES

- As a rule, experimental setup and performance of the test shall comply with EN 1363-1

- A pressure of 0 ± 2 Pa in the area of the center axis of the test specimens shall apply.

- The furnace shall be covered at the top by means of proper ceiling elements (preferably with a thickness of 150-240 mm).

- With respect to the possible drop height, in the furnace, even in the case of maximum deformation of the specimens, the test loads must have sufficient drop height so that failure of the specimen can be detected.

- The furnace shall have suitable windows to allow proper observation and documentation of the behavior or failure of the test specimens during the fire.

- The specimens shall be exposed to elevated temperatures in accordance with the standard temperature curve according to EN 1363-1.

- The individual burners shall be controlled via thermal elements according to EN 1363-1.

- The thermal elements shall be so arranged to allow temperature recording at a level close to critical areas of the specimens where failure is expected to happen first, e.g. close to saddle nuts or close to the middle of a horizontal channel with a central load. Thermal elements should be arranged in such a way that they can follow the deformation of the specimen.

- Displacement measurement ± 1 mm, measured continuously or as a minimum every 5 minutes.

- The relevant dimensions and material characteristics of the installation system shall be documented.

- The test specimen shall be fastened by means of threaded rods / threaded pipes running across the ceiling and secured by the corresponding hexagonal nuts. The strength class of the threaded rods / threaded pipes shall be defined and documented in the test report. The smallest desired thread diameter shall be selected.

- The specimen shall be mounted in accordance with the manufacturer's installation instructions.

- The specimen shall be loaded by centrically arranged test loads which are connected to the specimen or the pipe dummy via tension rods.

- With test specimens that are fastened exclusively to the ceiling of the furnace, their distance from the adjacent walls, or from the next adjacent test specimen, must be at least 200 mm in order to rule out any influences.

- The test specimens must be positioned at least 500 mm away from the burners.

ANNEX E
SETUPS FOR TESTING AT ELEVATED TEMPERATURES

Legend
1 Threaded rod
2 Pipe clamp dummy
3 Force transducer
4 Pipe clamp
5 Furnace ceiling

Dimensions in mm

| **Tension tests on pipe clamps at elevated temperatures** | Annex E.1 |

Legend
1 Channel
2 Flat washer
3 Hexagon nut
4 Adapter
5 Threaded rod
6 Furnace ceiling

Dimensions in mm

| Channel back hole pull-through test at elevated temperatures | Annex E.2 |
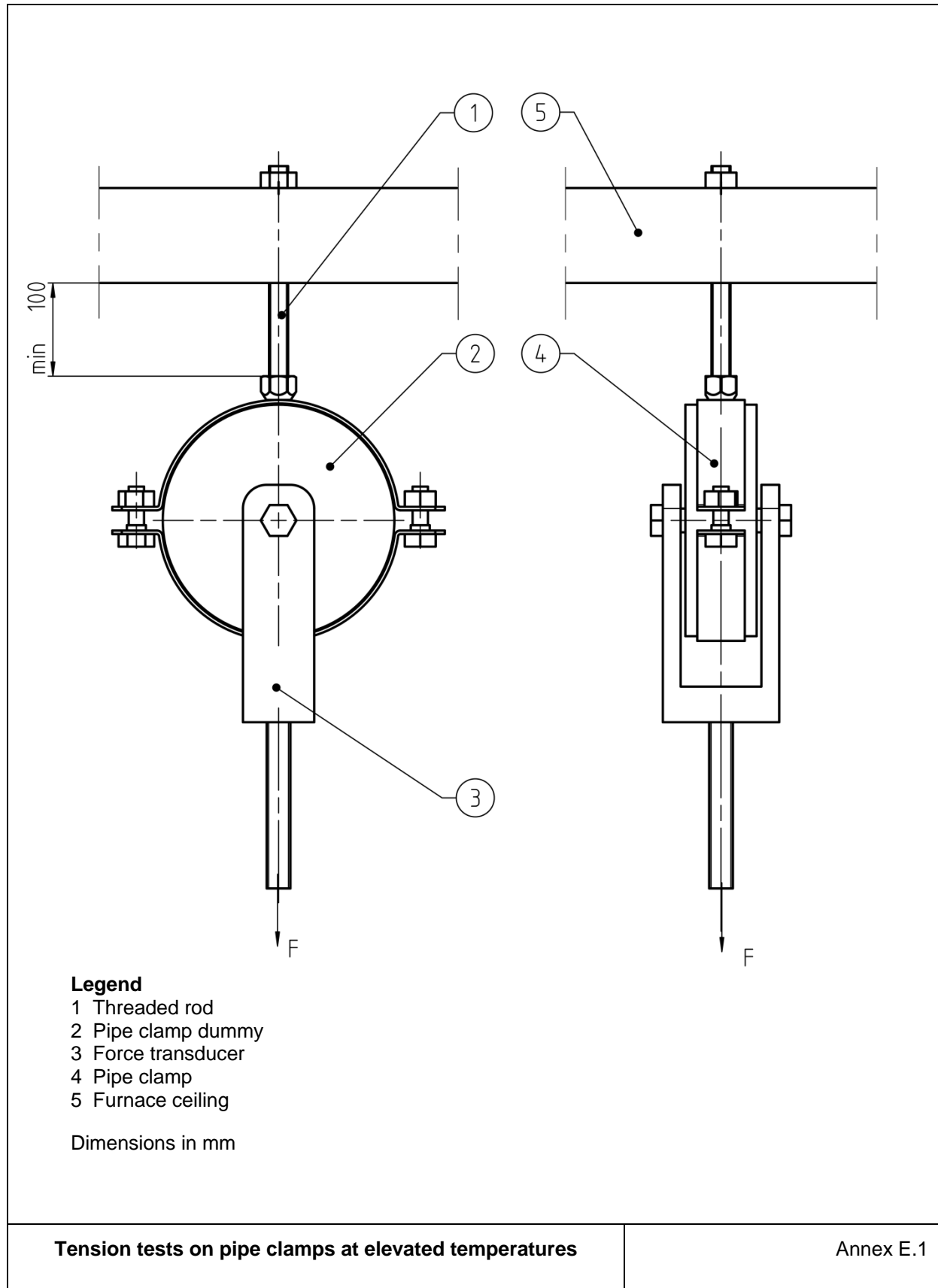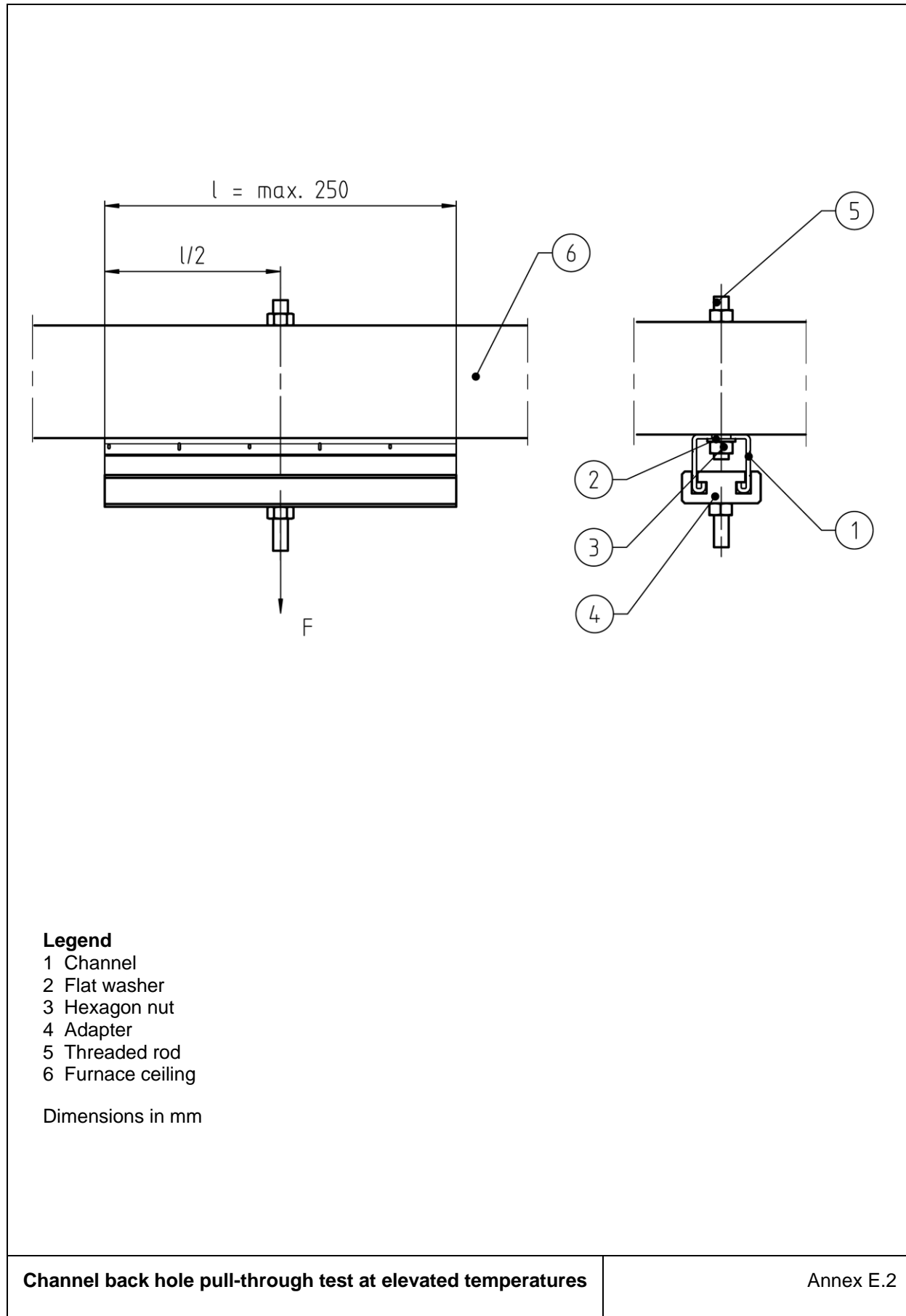
$\sigma_B = 20$ N/mm^2

$\sigma_B = 25$ N/mm^2
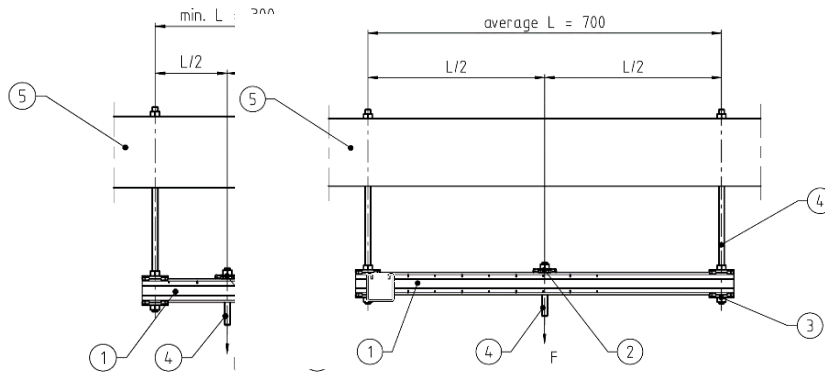
$\sigma_B = 10$ N/mm^2

$\sigma_B = 15$ N/mm^2
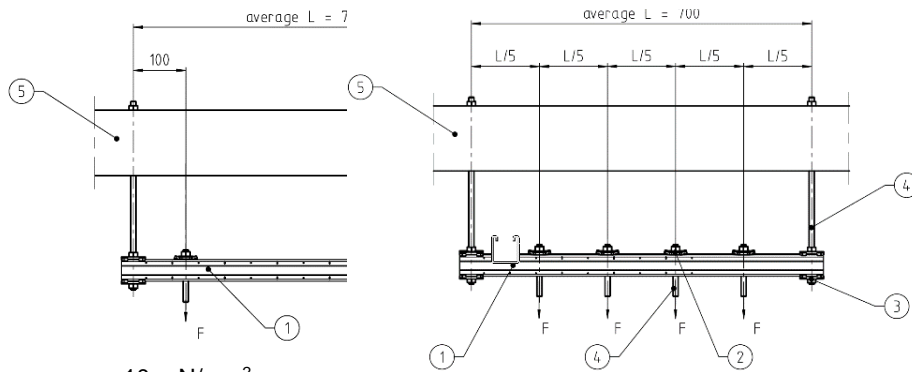
$\sigma_B = 10$ N/mm^2
$\sigma_B = 15$ N/mm^2
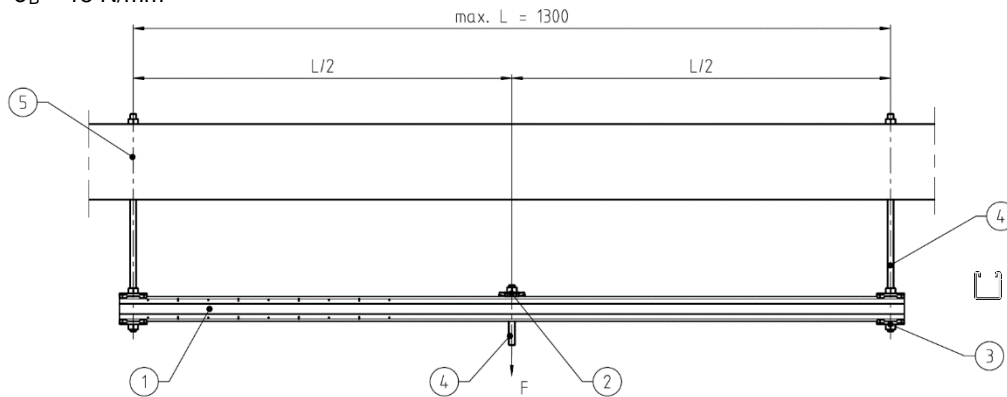
Legend
1 Channel
2 Saddle nut
3 Drilled plate
4 Threaded rod
5 Furnace ceiling

Dimensions in mm

Validation test-setups for FEM calculations	Annex E.3

Legend
1 Steel profile
2 Threaded rod
3 Furnace ceiling

Dimensions in mm

Test setup for bending and tension loads on threaded rods at elevated temperatures	Annex E.4

200–300

F

≤ 300

Legend
1　Channel
2　Drilled plate
3　Load distribution plate
4　Threaded rod
5　Furnace ceiling

Dimensions in mm

Drilled plate pull-through test at elevated temperatures	**Annex E.5**

100   100   100

50

200–300

F
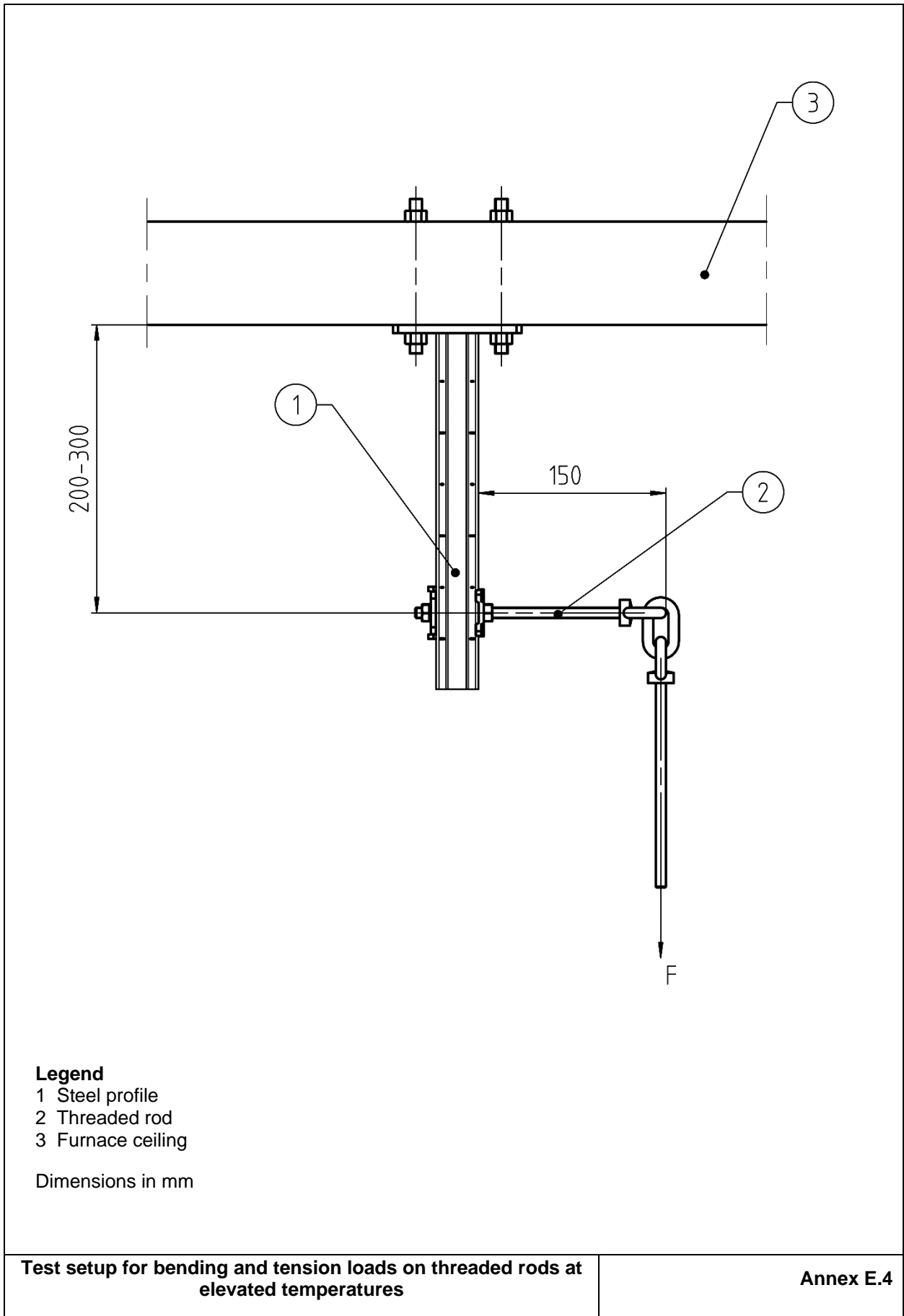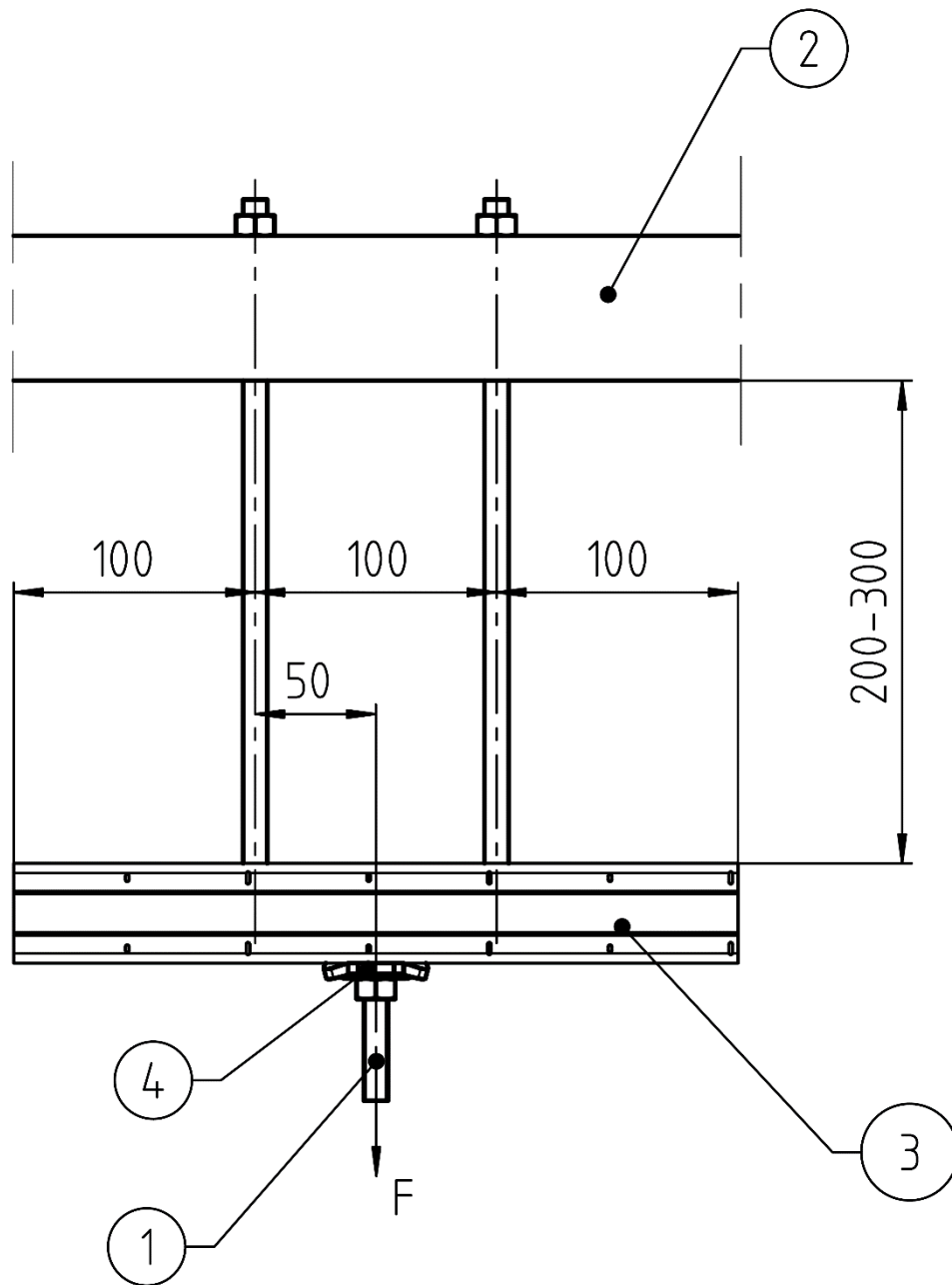
Legend
1 Threaded rod
2 Furnace ceiling
3 Channel
4 Saddle nut

Dimensions in mm

Saddle nut pull-out test from horizontal channel at elevated temperatures	Annex E.6

100xcos45°

45°

150–200

100

100

150

300

F

2

1

4

3

Legend
1 Threaded rod
2 Furnace ceiling
3 Channel
4 Saddle nut

Dimensions in mm

Saddle nut pull-out test from channel inclined at 45° at elevated temperatures	Annex E.7

Legend
1 Channel connector
2 Furnace ceiling
3 Channel
4 Adapter

Dimensions in mm

Channel connector pull-out test at elevated temperatures	Annex E.8
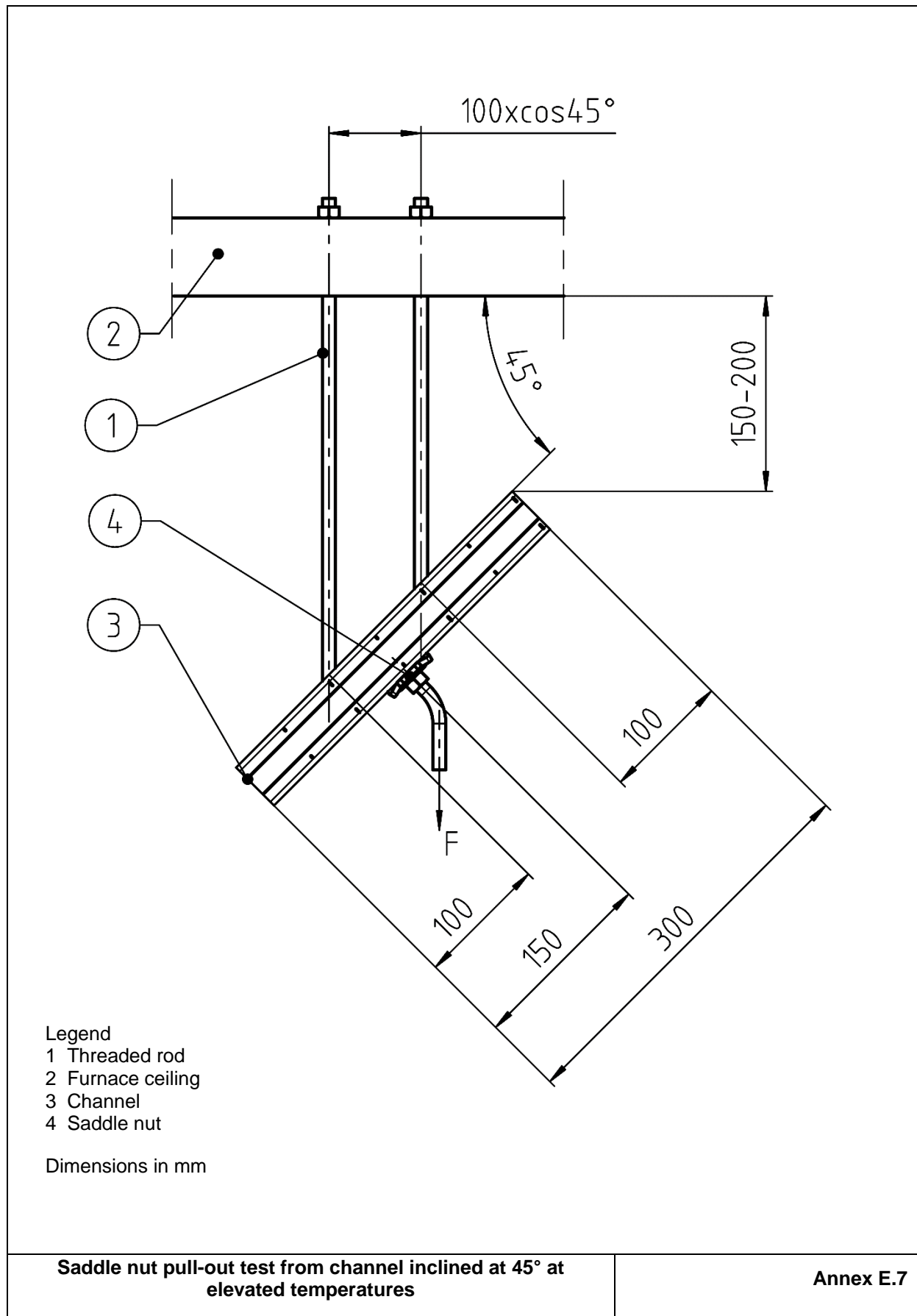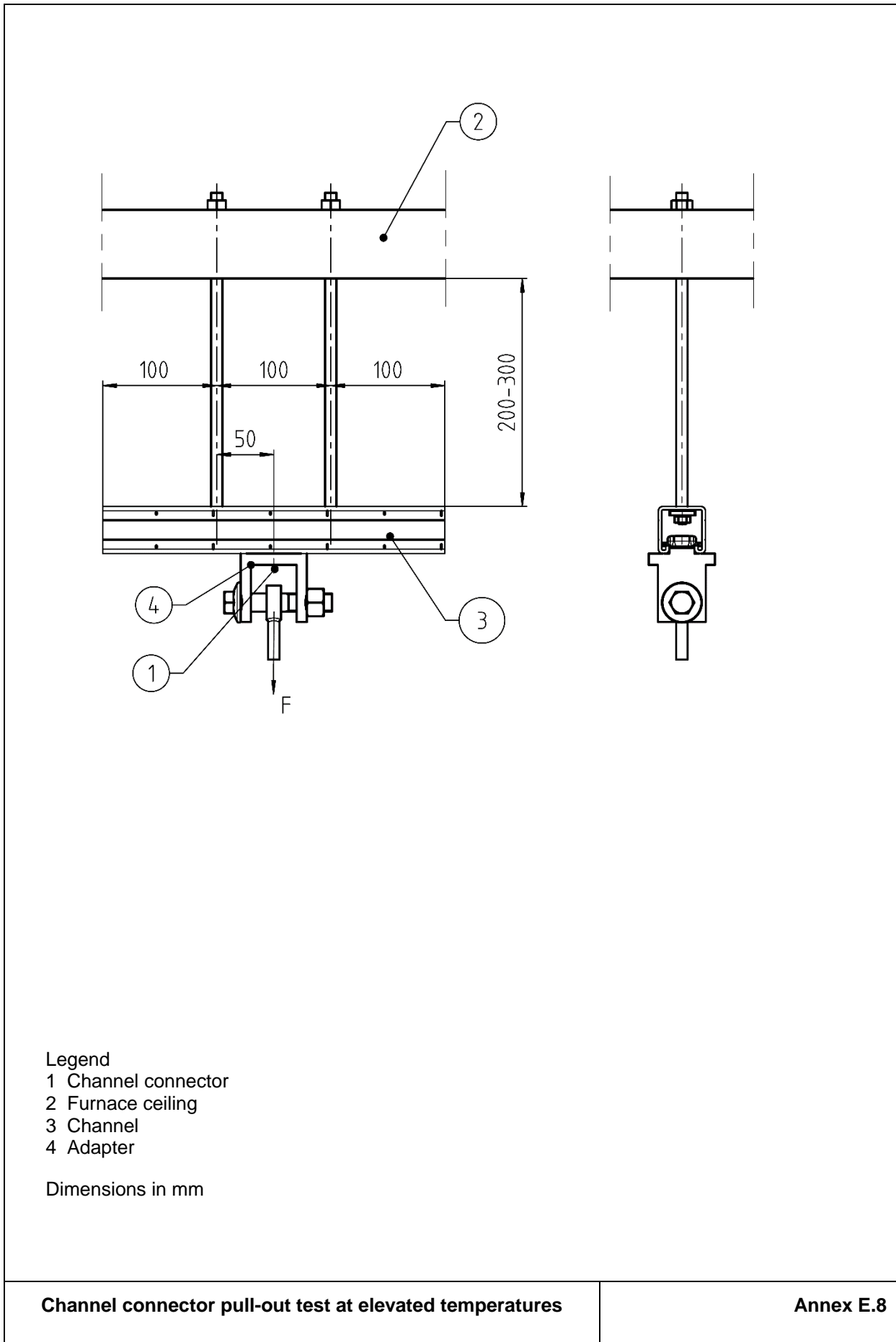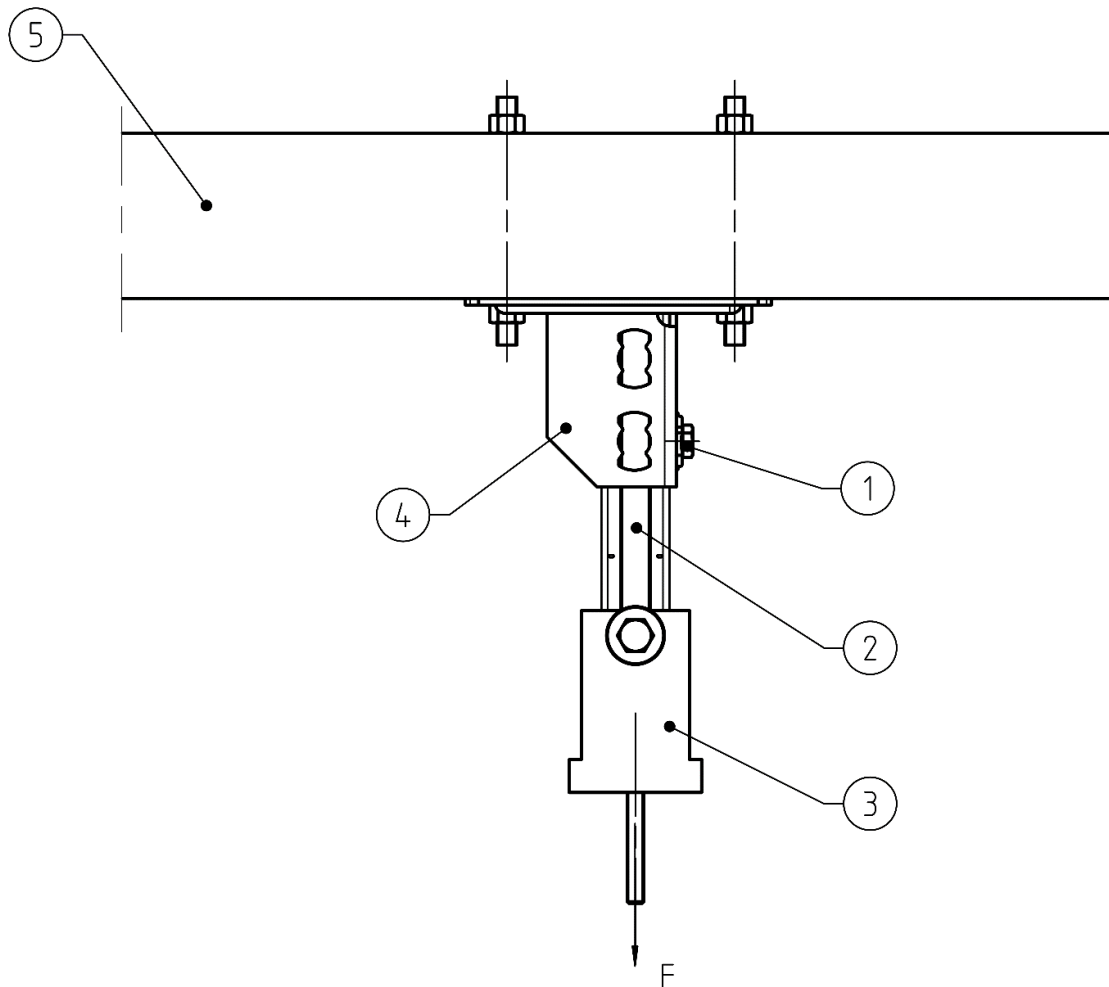
Legend
1 Channel connector
2 Channel
3 Adapter for load introduction
4 Base connector
5 Furnace ceiling

Channel connector shear test at elevated temperatures	Annex E.9
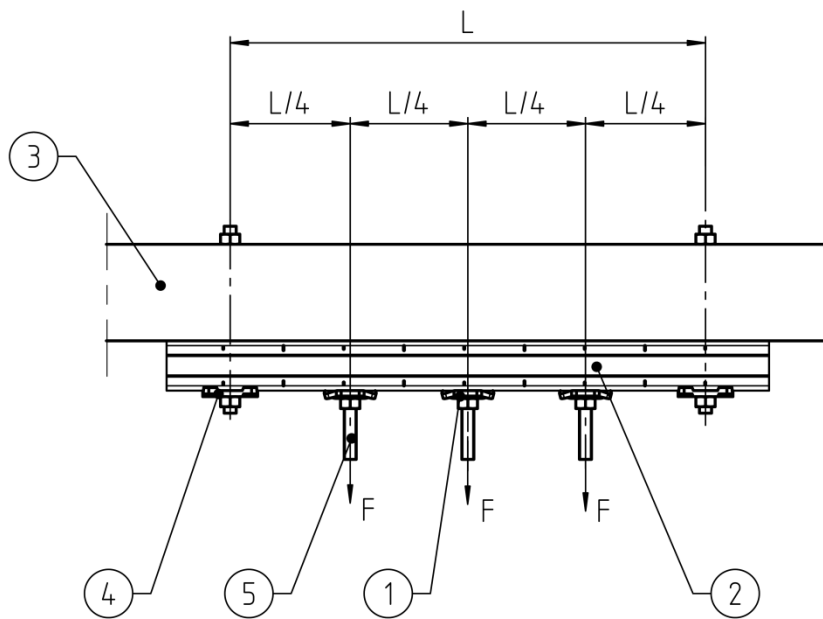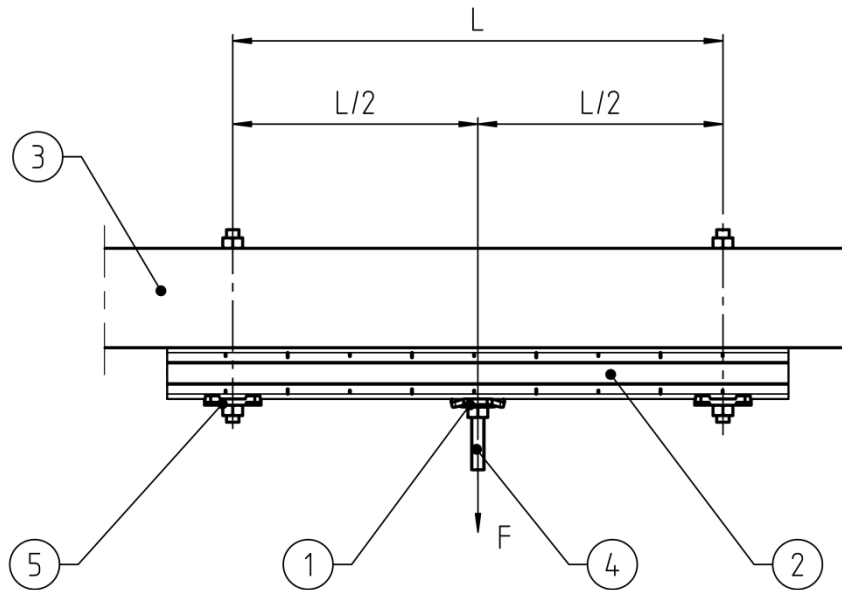
Legend
1 Saddle nut
2 Channel
3 Furnace ceiling
4 Drilled plate
5 Threaded rod

Test setup for partially assembled headrail systems with one and three loads at elevated temperatures	Annex E.10

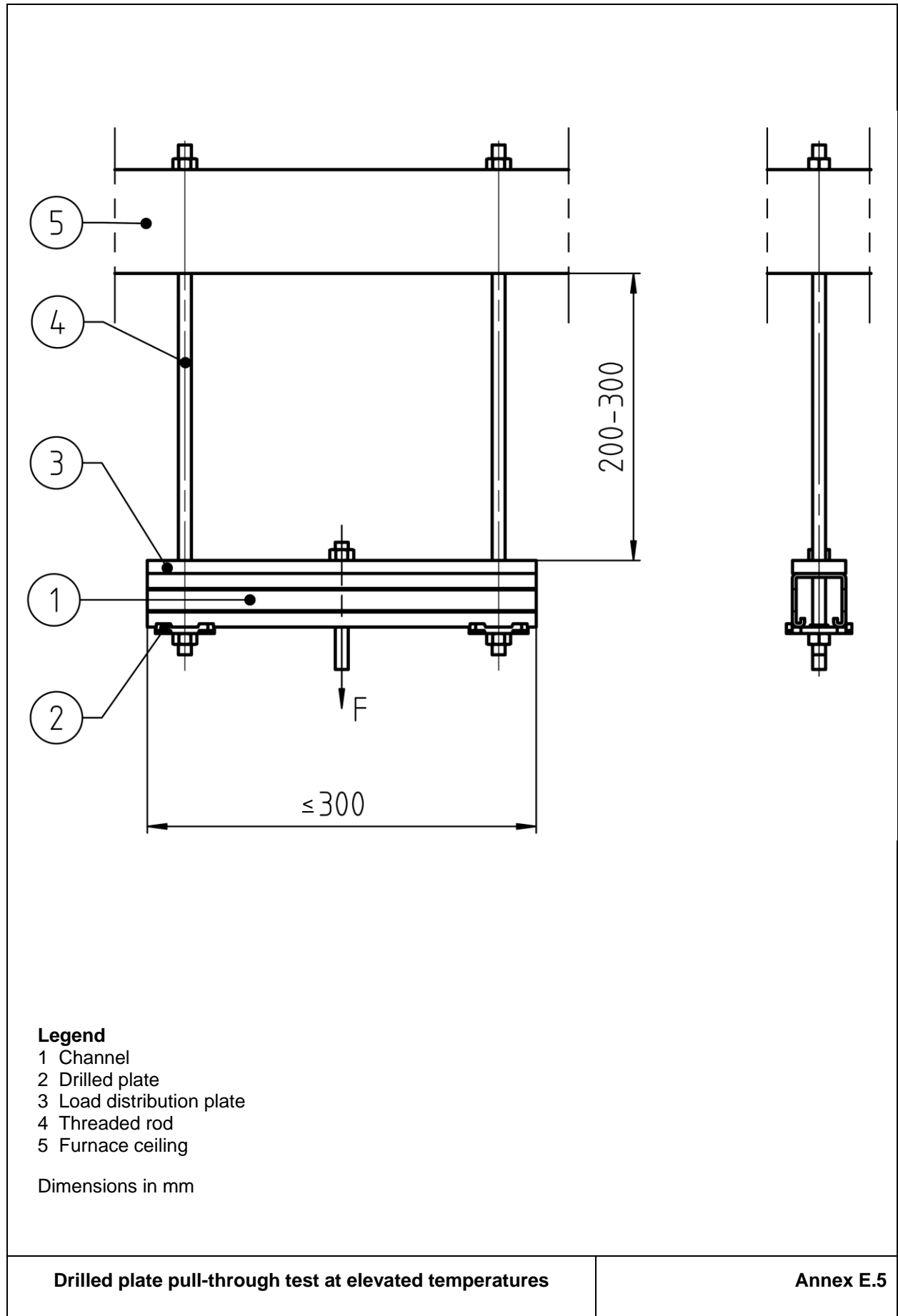**Test setups for partially assembled trapeze rod systems with one and three loads at elevated temperatures**

Annex E.11

Legend
1 Channel
2 Saddle nut
3 Drilled plate
4 Threaded rod
5 Furnace ceiling
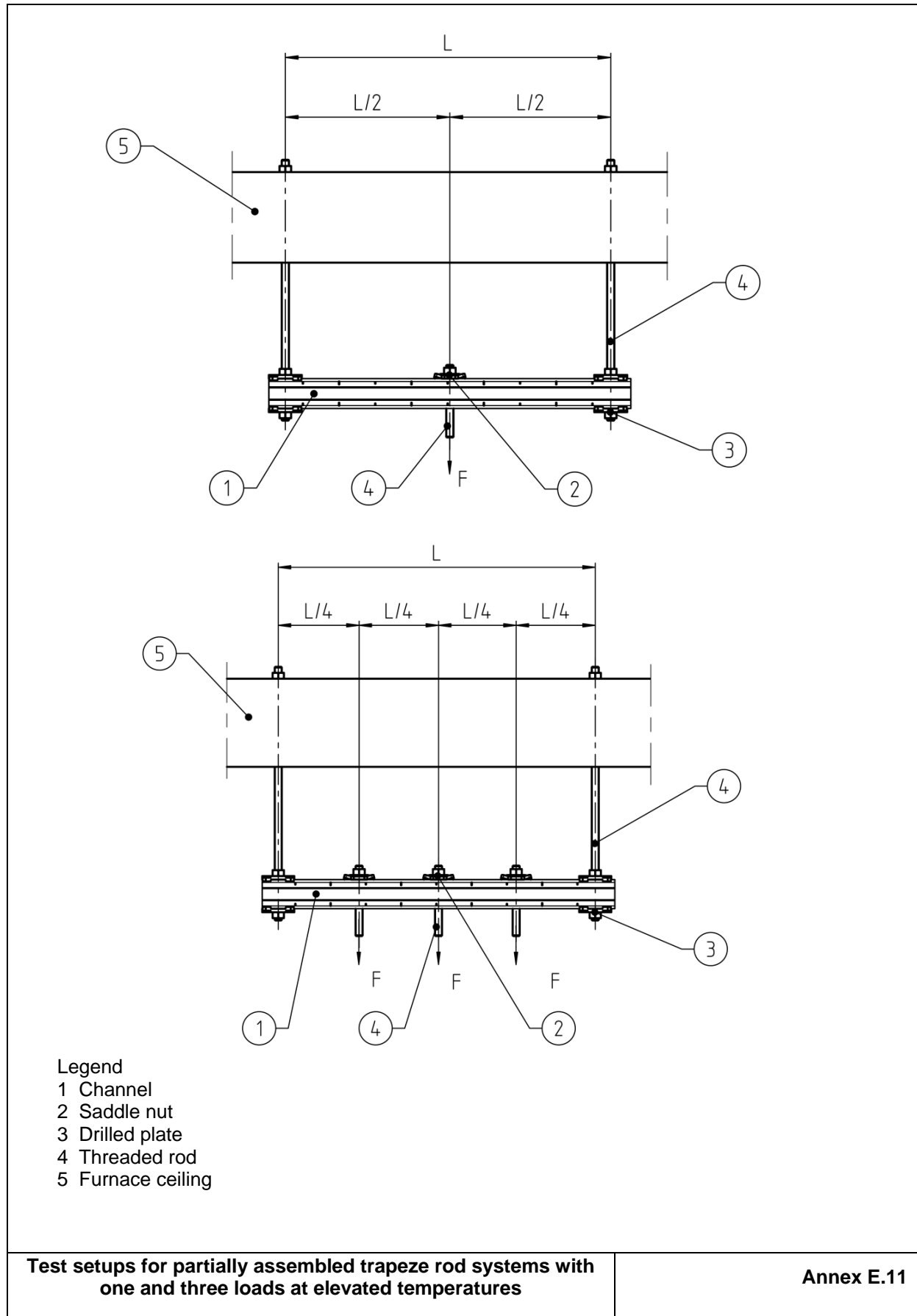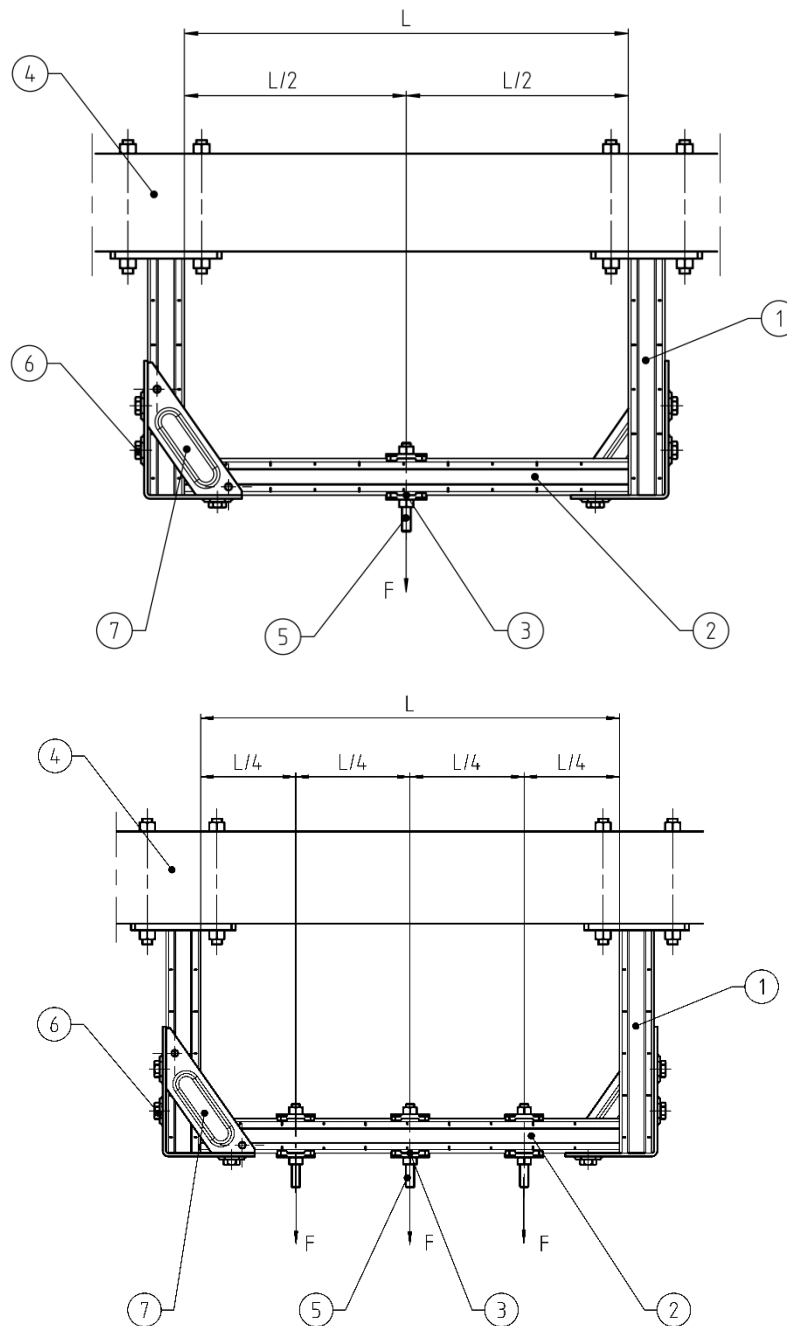
Legend
1 Vertical channel
2 Horizontal channel
3 Drilled plate
4 Furnace ceiling
5 Threaded rod
6 Channel connector
7 Angle connector

Test setup for partially assembled trapeze frame systems with one and three loads at elevated temperatures	Annex E.12
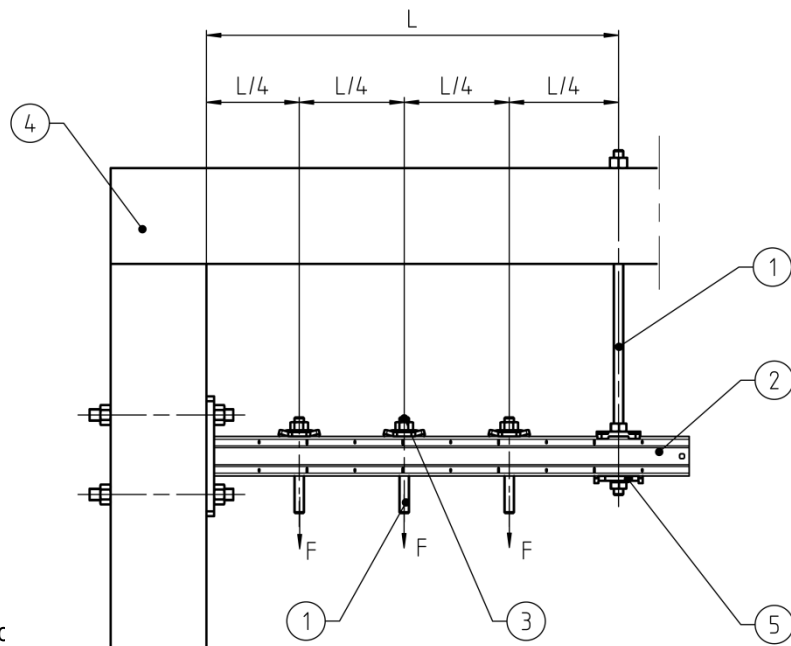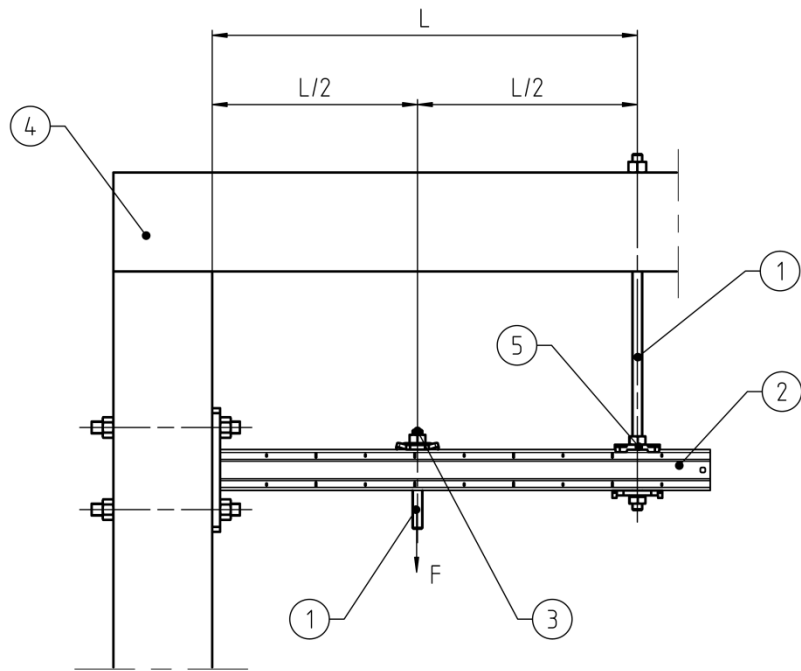
Legend
1 Threaded rod
2 Cantilever
3 Saddle nut
4 Furnace ceiling
5 Drilled plate

| Test setups for partially assembled suspended cantilever systems with one and three loads at elevated temperatures | Annex E.13 |
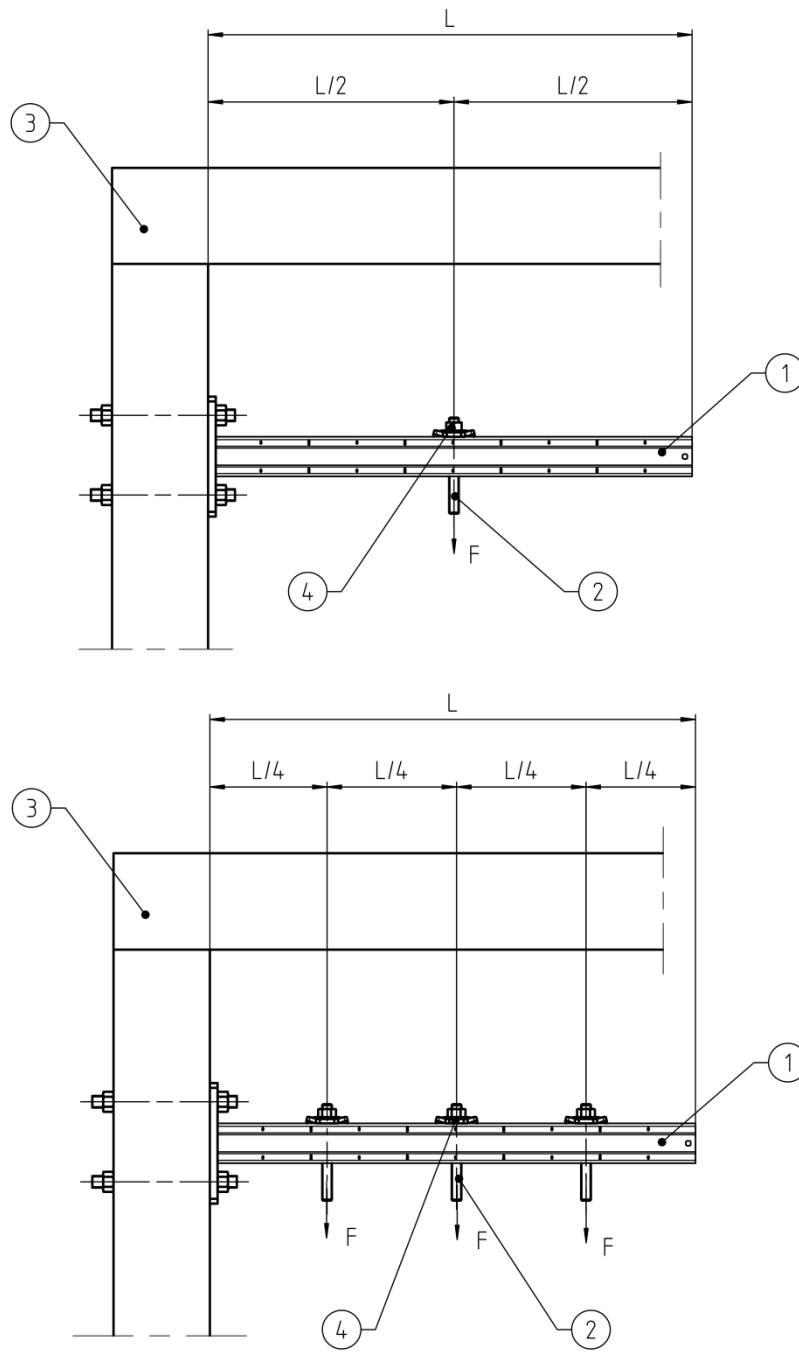
Legend
1 Cantilever
2 Threaded rod
3 Furnace ceiling
4 Saddle nut
5 Drilled plate

Test setups for partially assembled non-suspended cantilever systems with one and three loads at elevated temperatures	Annex E.14

ANNEX F
DETERMINATION OF THE RESISTANCE AT ELEVATED TEMPERATURES ASSISTED BY TESTS

For assessment of the resistance for the time interval n, the testing shall be conducted at least until the time interval n+1. The test loads $F_{T,i}$ shall be selected according to the following table:

Table F.1

No. of time interval n	Duration of test at elevated temperatures [minutes]	Number of products with test loads $F_{T,i}$ that collapse during the time interval
1	0-30	1
2	31-60	2
3	61-90	1
4	91-120	1
5	121-150	1
6	151-180	1
7	181-210	1
8	211-240	1
9	241-300	1
10	301-360	1
11	361-420	1

Pairs of variates [test load $F_{T,i}$ / exposure time to elevated temperatures when failure occurs $t_{u,i}$] are to be determined from the tests. A one-time shifting of a load/time/deformation data point to the immediately preceding interval shall be permissible to replace a failure time.

The test loads $F_{T,i}$ shall be illustrated in a diagram according to the determined resistance duration against elevated temperatures $t_{u,i}$ (see Figure F.1).

The formula (mean value curve) according to Eq. F.1 shall be determined by regression of m pairs of variates ($F_{T,i}$ / $t_{u,i}$).

Eq. F.1 $R1_{F,tu} = c_1 + c_2 / t_u$

Where c_1 and c_2 are the coefficients

$$c_2 = \frac{m\sum\frac{F_{T,i}}{t_{u,i}}-\sum\frac{1}{t_{u,i}}\sum F_{T,i}}{m\sum\frac{1}{t_{u,i}^2}-(\sum\frac{1}{t_{u,i}})^2}$$

$$c_1 = \frac{1}{m}\sum F_{T,i} - \frac{c_2}{m}\sum\frac{1}{t_{u,i}}$$

The mean value curve according to Eq. C1 shall be reduced by an additional factor $c_3 < 1$ in such a way that the curve runs through the pair of variates for the most unfavorable test result. The lower limit curve according to Eq. F.2 is thus obtained as a result, describing the characteristic resistance.

Eq. F.2 $F_{Rk}(t) = c_3 (c_1 + c_2 / t)$

The resistance after an exposure time to elevated temperatures t of 30 min, 60 min, 90 min, 120 min, 150 min, 180 min, 210 min, 240 min, 300 min, and 360 min can be calculated by Eq. F.2 as follows:

$$F_{Rk,30} = c_3 (c_1 + c_2 / 30 \text{ min})$$
$$F_{Rk,60} = c_3 (c_1 + c_2 / 60 \text{ min})$$
$$F_{Rk,90} = c_3 (c_1 + c_2 / 90 \text{ min})$$
$$F_{Rk,120} = c_3 (c_1 + c_2 / 120 \text{ min})$$
$$F_{Rk,150} = c_3 (c_1 + c_2 / 150 \text{ min})$$
$$F_{Rk,180} = c_3 (c_1 + c_2 / 180 \text{ min})$$
$$F_{Rk,210} = c_3 (c_1 + c_2 / 210 \text{ min})$$
$$F_{Rk,240} = c_3 (c_1 + c_2 / 240 \text{ min})$$
$$F_{Rk,300} = c_3 (c_1 + c_2 / 300 \text{ min})$$
$$F_{Rk,360} = c_3 (c_1 + c_2 / 360 \text{ min})$$

$F_{Rk,t}$ shall be not greater than F_{Rk} and min $t_{u,i} < t_u <$ max $t_{u,i}$
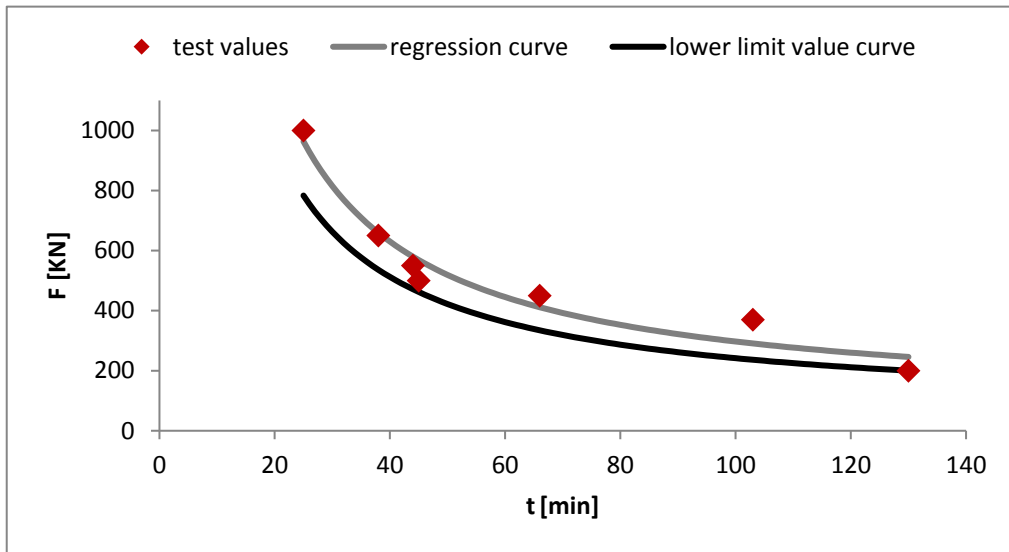
Figure F.1 Determination of the resistance time function for elevated temperatures

ANNEX G
DETERMINATION OF THE LOAD DISPLACEMENT FUNCTION $F_{Rk,30}(\delta)$

Only test specimens with a collapse time exceeding 30 minutes according to Annex F shall be taken into account in the evaluation. Pairs of variates $[F_{T,i} / \delta_{T,i,30}]$ shall be determined from these tests:
[test load / vertical displacement after 30 min exposure to elevated temperatures under the test load]. The displacement shall be measured at the position where the highest displacement of the tested system is expected. The test loads $F_{T,i}$ shall be illustrated in a diagram depending on the determined deflection $\delta_{T,i,30}$ (see Figure G.1). The formula (mean value curve) according to Eq. G.1 shall be determined by regression of m pairs of variates $[F_{T,i} / \delta_{T,i,30}]$.

Eq. G.1 $\qquad\qquad\qquad R_{F,\delta} = a_1 * \delta^{a2}$

Where a_1 and a_2 are

$$a_2 = \frac{m \sum(\ln(\delta_{T,i,30}) \cdot \ln(F_{T,i})) - \sum \ln(\delta_{T,i,30}) \cdot \sum \ln(F_{T,i})}{m \sum ln^2 (\delta_{T,i,30}) - \left(\sum \ln(\delta_{T,i,30})\right)^2}$$

$$a_1 = \exp(\frac{1}{m}\sum ln(F_{T,i}) - \frac{a_2}{m}\sum ln(\delta_{T,i,30}))$$

The mean value curve according to Eq. G.1 shall be reduced by an additional factor $a_3 < 1$ in such a way that the curve runs through the pair of variates for the most unfavorable test result. The lower limit curve according to Eq. G.2 is obtained as a result, describing the resistance after exposure to elevated temperatures for 30 minutes with the displacement δ.

Eq. G.2 $\qquad\qquad\qquad F_{Rk,30}(\delta) = a_3 (a_1 * \delta^{a2})$ with

$$\min(\delta_{F(T,i),30}) \le \delta \le \max(\delta_{F(T,i),30})$$

Figure G.1 Determination of the load displacement function for t= 30 min under elevated temperatures
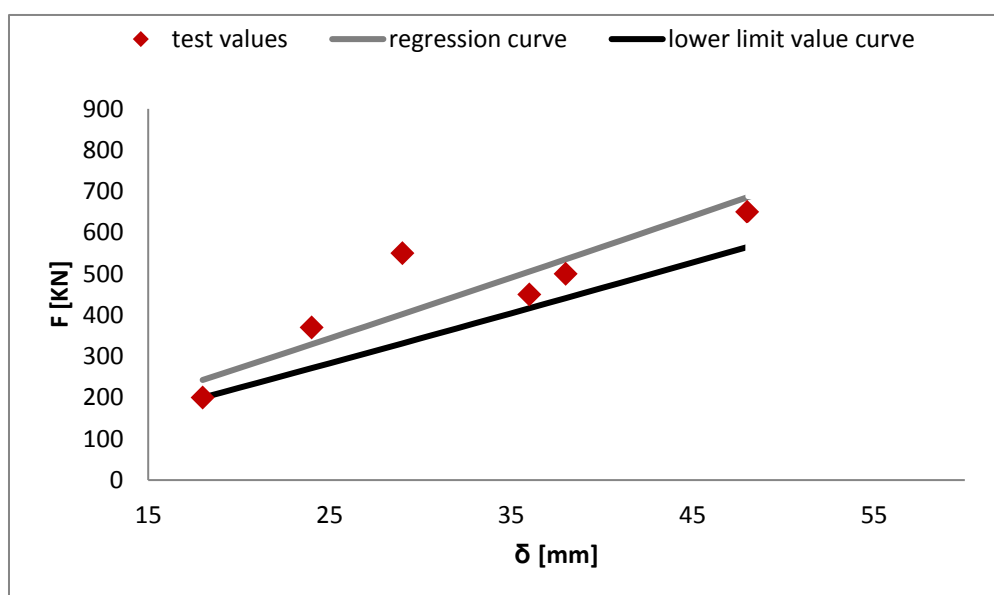
ANNEX H
MAXIMUM DEFORMATION ON REACHING THE LOAD-BEARING CAPACITY FOR t > 30 MIN
EXPOSURE TO ELEVATED TEMPERATURES

The maximum displacement at any time t > 30 within the time interval n in accordance with Table F.1, Annex F is given by the maximum displacement measured during the series of tests at elevated temperatures and the data recorded at the end of the interval n which is immediately following the point of time t. For this purpose, the load/time displacement data point with the maximum displacement is selected from all the load/time displacement point data recorded at the end of the interval n immediately following the point of time t.

$$\delta_{max,t} = \max(\delta_{F(T,i);t}) \text{ with}$$

$$t > 30 \text{ min}$$

ANNEX I
DETERMINATION OF CHANNEL CHARACTERISTICS AT ELEVATED TEMPERATURES

1 General points
The deformations and time until failure may be determined, as described in the following sections, by carrying out experimental tests or by calculation.

2 Determination of the bending deformation characteristics by experimental testing
The performance figures may be determined by carrying out full-scale tests on the "trapeze rod". The stipulations made in section 2.2.2.13.4 are applicable. The thermal expansion of the threaded rods, in accordance with the relationship between the thermal expansion of steel and the temperature, as shown in EN 1993-1-2, must be taken into account.

3 Calculation of the bending deformation characteristics
As an alternative to the full-scale tests carried out, the performance figures given may be determined by calculation using a validated numerical FE model, so long as the following prerequisites and constraints are complied with:
- Thermo-mechanically coupled and / or mechanical model preceded by thermal analysis employing the temperature-dependent, non-linear material parameters in accordance with Annex J,
- Discretization using 3D shell elements or continuum elements,
- Geometric non-linear FE calculation using local and global imperfections in accordance with EN 1993-1-1 (theory of 2nd order with imperfections),
- Thermal mapping of the standard temperature / time curve (STTC),
- The deformation behavior over the applicable time period is phenomenologically correctly illustrated.

It is necessary to validate the numerical model by carrying out at least 6 fire bending tests. If the performance figures deviate from the test results by more than 10% on the unsafe side, a suitable global correction factor must be determined. The fire bending tests must take into account the different span widths, load distribution and level of stresses. When carrying out the validation tests attention must be paid to the following:
- The channels must be suspended from the ceiling using threaded rods or a similar system (not supported by walls or similar).
- The temperature of the furnace in the area of the channel, and the temperature of the channel itself, must be measured.
- The bending deflection in the middle section must be measured (the measured value can be corrected by the theoretical elongation of the suspension- and measuring system due to thermal expansion).

See Annex E.3 for details of the exemplary test setup. At the end of the fire exposure time it is necessary to check whether any of the suspension systems have been tearing, to check for breakage of the channels and to determine whether the deformation pattern corresponds to a kinematic chain. So long as the tested structures show no signs of channel breakage or the anchors being tearing, the limiting value for bending deflection may be determined by making use of the kinematic chain approach. When it is determined that none of the anchors have been torn down and no channels are broken on the structures tested, this fact must be recorded in order to permit or rule out the possible use of the kinematic chain approach in subsequent calculations. The dependence of the bending deflection on the theoretical point in time, calculated from the measured component temperature by way of the functional relationship with the STTC, is to be used for the purpose of validation. For the assessed stress level σ_B, the ETA shall state and contain the corresponding system and load configuration and the performance levels $\delta_{tmax;B}$, $t_{max,B}$, δ_{30} , δ_{60} , δ_{90} , δ_{120} .

4 Further use of results by interpolation

4.1 General

The performance criteria referred to above allow planners to design mounting systems for technical building services while also taking into account the behavior of the mounting systems when assessing support structures and other functional structures. This includes the deformation prognosis for the mounting system for any load and system configuration parameters that lie within the limits of the parameter array (see below). The parameter array to be examined is based on the intended scope of the evaluation. In reality, the geometric boundary conditions and loads will often deviate from the initial selected parameters. A prime example in which the supporting span and the load type and regime deviate from the boundary conditions of the declared performance criteria is shown in Figure I.1 below.

Figure I.1: Application example in which the span, load type and regime deviate from the defined parameter array.

Provided that

- the minimum value and the maximum value of the support span, a span of 700 mm as well as other intermediate values with a span increment of $\Delta L \leq 200$ mm,
- the minimum value and the maximum value of the load on the notified scope of application in accordance with technical bending theory ($\sigma = M/W$), a load of 10 N/mm² and additional intermediate values with a load interval of $\Delta\sigma \leq 5$ N/mm²,
- 3 moments (usually approximate parabolic (uniformly distributed load), triangular (central single load) and trapezoidal (4-point bending load with single loads near supports)

have been examined and verified and the stress direction/installation situation of the channel corresponds to one of the two variants, the deformation prognosis may be determined for all spans and stress situations, as described in Annex I, Section 4.2, through interpolation with regard to

- span,
- load type, defined by the moment coefficient and
- stress level.

4.2 General description of the procedure using interpolation

For a given static system with the span length $\underline{L}$, the moment distribution $\underline{M}_y(x)$ over the length x of the beam axis is determined using technical bending theory. The maximum moment is denoted as $\underline{M}_{max}$. The moment coefficient $\underline{V}$ is calculated using the equation:

$$\underline{V} = \frac{1}{\underline{L} \cdot \underline{M}_{max}} \int_0^{\underline{L}} \underline{M}_y(x)dx$$

The maximum bending stress is calculated using the equation $\underline{\sigma}_{max} = \underline{M}_{max}/W_y$.

The moment coefficient $\underline{V}$ and the span length $\underline{L}$ are read from the bending parameters δ_i in the Declaration of Performance as infimum and supremum values for the maximum stress level $\underline{\sigma}_{max}$:

δ_i (V_{inf}, $\sigma_{b,inf}$, L_{inf})
δ_i (V_{inf}, $\sigma_{b,inf}$, L_{sub})

δ_i (V_{inf}, $\sigma_{b,sub}$, L_{inf})
δ_i (V_{inf}, $\sigma_{b,sub}$, L_{sub})
δ_i (V_{sub}, $\sigma_{b,inf}$, L_{inf})
δ_i (V_{sub}, $\sigma_{b,inf}$, L_{sub})
δ_i (V_{sub}, $\sigma_{b,sub}$, L_{inf})
δ_i (V_{sub}, $\sigma_{b,sub}$, L_{sub}),

these can be interpreted as key points (coordinates) in a 3-dimensional parameter space. If these key points are now transformed into an isoparametric coordinate system with the coordinates r, s, t ($-1 \le r \le 1$), ($-1 \le s \le 1$), ($-1 \le t \le 1$), the following isoparametric coordinates are produced for the span length $\underline{L}$, the maximum stress level $\underline{\sigma}_{max}$ and the moment coefficient $\underline{V}$:

$\underline{L}$: $\quad r = (\underline{L} - 0{,}5^*(L_{sub} + L_{inf})) / (0{,}5^*(L_{sub} - L_{inf}))$

σ_{max}: $\quad s = (\sigma_{max} - 0{,}5^*(\sigma_{b,sub} + \sigma_{b,inf})) / (0{,}5^*(\sigma_{b,sub} - \sigma_{b,inf}))$

$\underline{V}$: $\quad t = (\underline{V} - 0{,}5^*(V_{sub} + V_{inf})) / (0{,}5^*(V_{sub} - V_{inf}))$

These isoparametric coordinates can be used to generate the interpolation vector M on the basis of linear ansatz functions in the isoparametric coordinate space

$$M = \begin{bmatrix} 0.125 \cdot (1-r) \cdot (1-s) \cdot (1-t) \\ 0.125 \cdot (1+r) \cdot (1-s) \cdot (1-t) \\ 0.125 \cdot (1-r) \cdot (1+s) \cdot (1-t) \\ 0.125 \cdot (1+r) \cdot (1+s) \cdot (1-t) \\ 0.125 \cdot (1-r) \cdot (1-s) \cdot (1+t) \\ 0.125 \cdot (1+r) \cdot (1-s) \cdot (1+t) \\ 0.125 \cdot (1-r) \cdot (1+s) \cdot (1+t) \\ 0.125 \cdot (1+r) \cdot (1+s) \cdot (1+t) \end{bmatrix},$$

which can then be multiplied scalarly with the vector N reading for the deformation value δ_i to produce the interpolated displacement size $\delta_{interpol}$.

$$N = \begin{bmatrix} \delta_i(V_{inf}, \sigma_{b,inf}, L_{inf}) \\ \delta_i(V_{inf}, \sigma_{b,inf}, L_{sub}) \\ \delta_i(V_{inf}, \sigma_{b,sub}, L_{inf}) \\ \delta_i(V_{inf}, \sigma_{b,sub}, L_{sub}) \\ \delta_i(V_{sub}, \sigma_{b,inf}, L_{inf}) \\ \delta_i(V_{sub}, \sigma_{b,inf}, L_{sub}) \\ \delta_i(V_{sub}, \sigma_{b,sub}, L_{inf}) \\ \delta_i(V_{sub}, \sigma_{b,sub}, L_{sub}) \end{bmatrix}$$

$$\delta_{interpol} = M \cdot N$$

With this interpolation method, the coefficients $\delta_{tmax;B}$, $t_{max,B}$, δ_{30}, δ_{60}, δ_{90}, δ_{120} can be determined as performance values for specific applications whose load and system configurations deviate from the selected parameter array with regard to moment distribution, maximum stress and channel length.

ANNEX J
DETERMINATION OF STRESS-STRAIN CHARACTERISTICS AT ELEVATED
TEMPERATURES OF THE CHANNEL MATERIAL

1. Unsteady thermal creep tests at a constant mechanical load

1.1. Test specimens

The test specimens are to be cut out of the installation channels following a specimen shape in line with the requirements of ISO 6892-2. Three tensile testing specimens are to be manufactured for each stress level 5 N/mm², 10 N/mm², 15 N/mm², 20 N/mm², 25 N/mm², and 30 N/mm². The free length of each tensile testing specimen must reach at least 25 mm beyond the clamping points on each side of the elongation measurement area in order to minimize the influence of the heavy clamping devices on temperature development in the elongation measurement area.

1.2. Test rig

See fig. J.1 for details of the test setup. The unsteady thermal creep tests must be carried out using a tensile testing machine in a high-temperature furnace. This furnace must fully enclose the specimen and the specimen mounting fixtures. The specimen mounting fixtures are to be connected to the cross-beams of the tensile testing machine by way of tension rods which pass through sealed openings in the lower and upper shell of the furnace. An electronically controllable load cell is to be mounted between these parts for the purpose of monitoring the tensile stress taken up by the test specimens. The elongation of the test specimens is measured by a high-temperature attachable extensometer. The extensometer is equipped with two ceramic measurement probes that project into the furnace and which trace the elongation $\Delta u_{VK}(t)$ of the measured length L_0 directly on the test specimen in the furnace and pass this information to the displacement gauge located outside the shell of the furnace, where the data is continuously recorded. The furnace must reach a nominal air heating rate of at least 20°C/min within the 20°C-700°C temperature range, which may drop down to 0°C/min in the subsequent 700°C-1100°C temperature range, but it must be capable of reproducing the course followed by the STTC in accordance with EN 1363-1. The furnace heating system should be controlled by an air temperature sensor positioned at the middle of the test specimen at a distance of 1 to 2 mm from the surface of the test specimen. In the case of thick-walled test specimens, t > 5 mm, the temperature of the test specimen should also be measured in the areas above and below the elongation measurement length. In order to minimize the falsifying influence that the temperature differences over the length of the test specimen have on the relationship between steel temperature and the elongation to be determined in the tests, the distance to be measured by the extensometer L_0 should be set to the lowest possible value and should be a maximum of 20 mm.

Non-stationary heat creep test with specimen cut out of the channel — Figure J.1

Legend
1 Load cell
2 Electric furnace
3 Test specimen
4 Cross member
5 Extensometer

Dimensions in mm
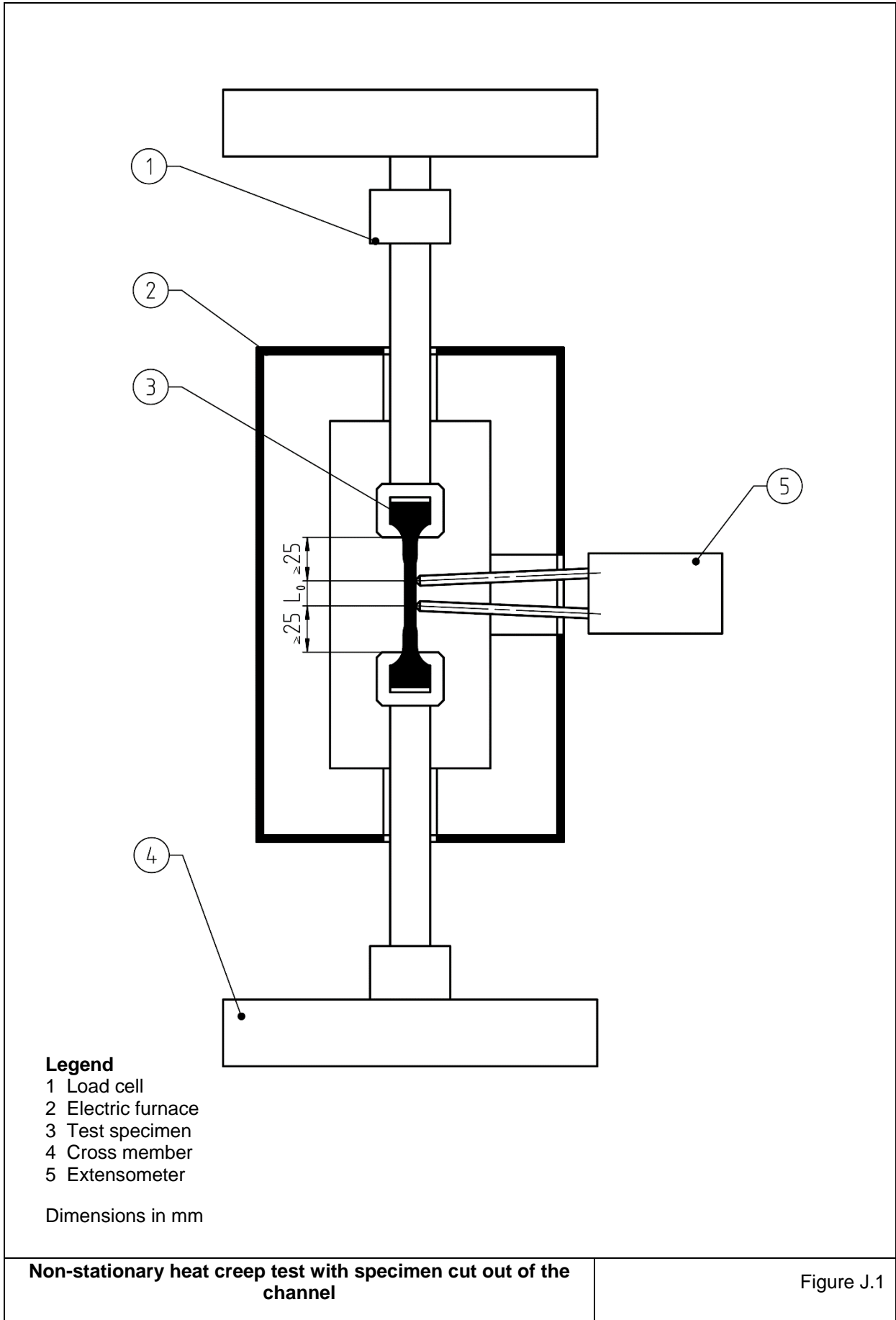
1.3. Test procedure

For the transient thermal creep test the test specimen is mounted in the gripping mechanism centrally in a way that avoids slippage. The test specimen is then subjected to an elongation-controlled load until the given peak load or, respectively, until the required stress level σ_0, in accordance with the test program, is reached. The test specimen is subsequently heated while the required stress level σ_0 remains constant. The elongation of the distance to be measured L_0 on the test specimen is then continuously recorded. Depending on the height of the peak load, the test is stopped either when the test specimen fails or when the maximum furnace operating temperature is reached. During the test, the air within the furnace is to be heated in accordance with the STTC as per EN 1363-1. Non-critical deviations up to a temperature of 700°C on the STTC are permissible. Below 700°C the time factor for the STTC has to be shifted until the shifted curve begins to touch the maximum achievable linear heating ramp of at least 20°C/min of the furnace system. The target air temperature for controlling the furnace heat output therefore consists of two sections: In the first section a linear ramp with an increase of at least 20°C/min is specified and the section ends at the point in time at which the gradient of the ramp corresponds exactly with the tangential gradient of the time-shifted STTC (tangent point). In the second section the shifted STTC is specified as the target air temperature which, from this point in time onwards, shows a tangential gradient (increase) of less than the maximum achievable ramp by the furnace. See fig. J.2.

Fig. J.2: Nominal temperature curve (heating ramp of 50°C/min and shifted standard temperature / time curve (STTC)) for the unsteady thermal creep test

--- STTC   – – Heating ramp 50°C/min up to 500°C   Shifted STTC
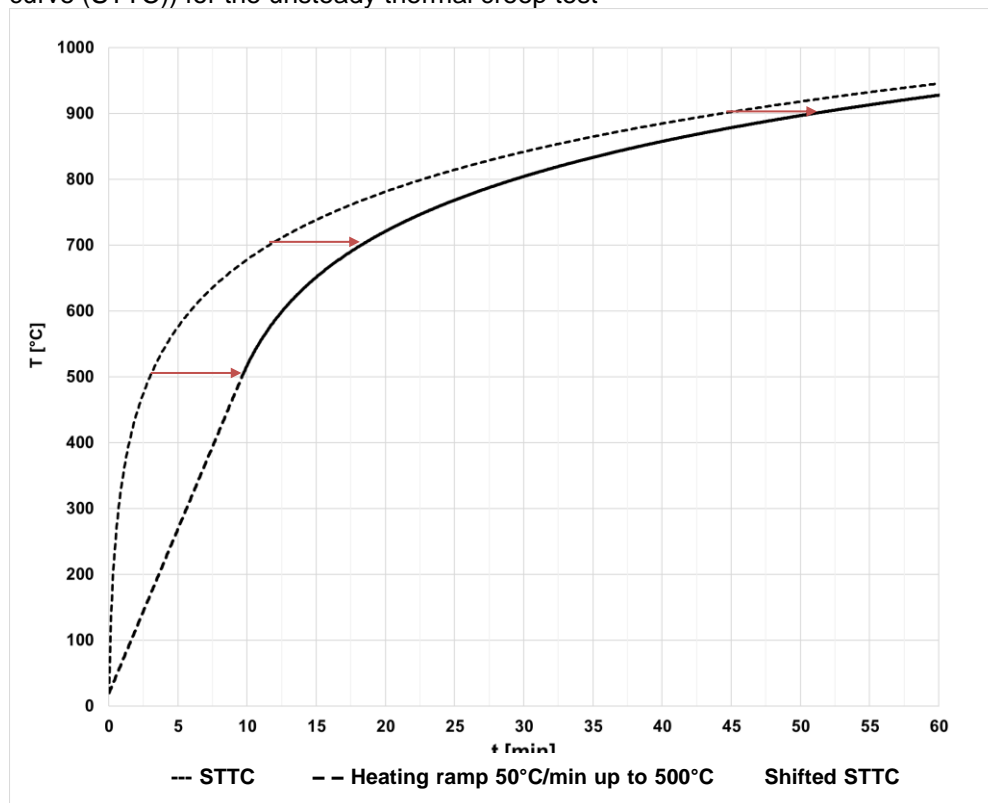
1.4 Evaluation

The results of the high-temperature tensile load tests under a constant mechanical load for the nominal stress levels of 5 N/mm², 10 N/mm², 15 N/mm², 20 N/mm², 25 N/mm² and 30 N/mm² are each presented in three results tables (triple testing). The results tables contain information about the time since the beginning of the test (measurements usually at an interval of ≤ 0.5 s), mechanical stress σ as the quotient of the measured force and the original cross-sectional area, the measured total elongation ε as well as the temperature in the furnace T_f. In the case of profiles with a thickness of more than 5 mm, in addition to this the temperature of the test specimen in the area at which the length measurement is taken is also to be measured at each time interval.

First of all, for each test **i** and above 700 °C at the latest, it is necessary to check that following conditions are fulfilled: that the horizontal deviation or, respectively, the difference between the standard temperature / time curve (STTC) as per EN 1363-1, shifted in accordance with Annex J, section 1.3, and the measured dependency of the furnace temperature on the time factor is always less than 3 minutes. In addition to this, above 700°C, the corresponding temperature of the shifted STTC may not, at any point in time, be higher than the measured temperature of the furnace. In the case of profiles with a thickness of greater than 5 mm, these conditions must be fulfilled in the area at which the elongation is measured. If these conditions are not fulfilled then the test must be repeated.

Subsequently (provided that the measuring interval is constant), the arithmetical mean value $\sigma_{m,i}$ for the measured stress in each test **i** is to be determined. It is then necessary to check that the highest and lowest individual values for the measured stress never deviate by more than 5% from the mean value for the measured stress. If the deviation is greater, the test must be repeated. Likewise, if an arithmetical mean value $\sigma_{m,i}$ deviates from the nominal stress level by more than 15%, the test must also be repeated.

On the basis of the relationship between temperature and the thermal expansion of steel, as stated in EN 1993-1-2, section 3.4, the theoretical thermal expansion (elongation) ε_{th} at the measured furnace temperature is determined for each test **i** and each point in time **t**. The mechanical elongation ε_σ for each measured value results from the difference between the measured elongation ε and the theoretical thermal elongation ε_{th} ; ($\varepsilon_\sigma = \varepsilon - \varepsilon_{th}$).

Subsequently, the value triplet {T_e; $\sigma_{m,i}$; $\varepsilon_\sigma(T_e)$) is compiled from the **n** valid results matrices for the tests **i** for the discrete temperatures T_e = [800; 850; 900; 950; 1000; 1050; 1100; 1150]°C n and, for the purpose of better illustration, a diagram is prepared for each of the various temperature points T_e. An example is shown in fig. J.3.

From the n value triplets, m groups are then generated by grouping together the value triplets with the same nominal stress level by forming the arithmetical mean values {T_e; $\bar{\sigma}_{m,i}$; $\bar{\varepsilon}_\sigma(T_e)$}.

The stress-elongation relationship σ=f(ε,T) to be applied to a certain temperature T_e in the FE model is the result of linear connections between the adjacent mean values {T_e; $\bar{\sigma}_{m,i}$; $\bar{\varepsilon}_\sigma(T_e)$}.

The progression must not contain any negative secant gradients. Otherwise the tests **i** that belong to this value triplet {T_e; $\sigma_{m,i}$; $\varepsilon_\sigma(T_e)$} must be repeated, at least in part. The progression is valid up to an elongation of $\varepsilon_{t,\theta}$ = 0.15 in accordance with EN 1993-1-2, fig. 3.1. From this elongation limit onwards, a linear weakening stress-elongation pattern down to the point ($\varepsilon_{u,\theta}$, 0), following the example of EN 1993-1-2, fig. 3.1, is assumed.

In the elastic range where elongation is small, the temperature-dependent gradient is based on $k_{E,\theta} \cdot E$, in accordance with EN 1993-1-2. This applies to the elongation range $\varepsilon_{t,\theta}$ = 0 up to the intersection of the stress-elongation curve in accordance with EN 1993-1-2, with the extended secant, which results from the value triplet for the nominal stresses of 5 N/mm and 10 N/mm^2.

For all temperatures equal to or less than 750°C the stress-elongation relationships from in EN 1993-1-2 are to be used. Linear interpolation may be used to determine the stress-elongation relationships for other temperatures that lie between the discrete temperature points. The ETA shall state and contain the stress-strain (elongation) relationship in accordance with this annex.

Fig. J.3: Example to illustrate the evaluation of test results to determine stress-elongation dependency
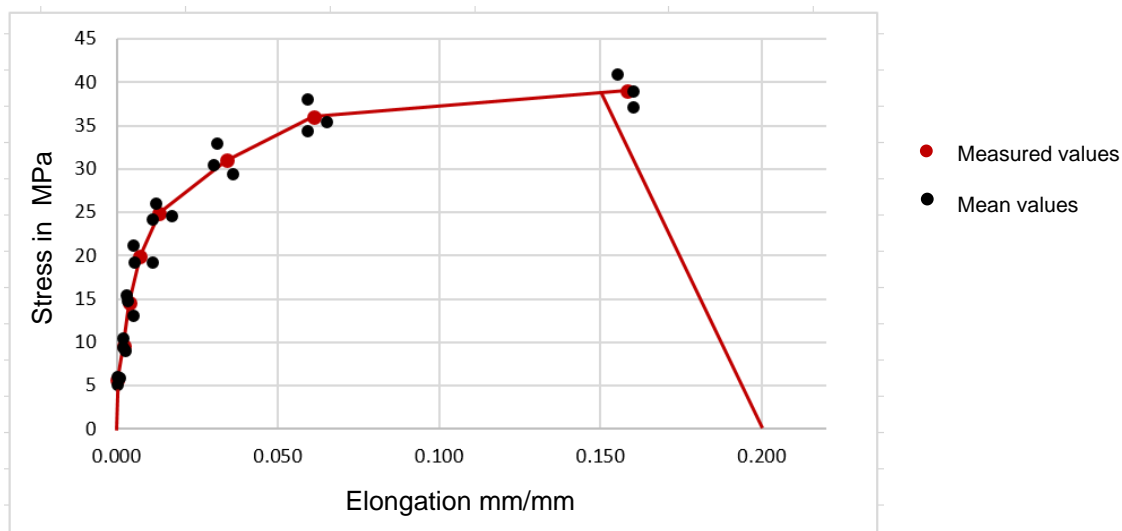
ANNEX K
DETERMINATION OF $F_{Rk,t}$ AND δ_t FOR KITS AT ELEVATED TEMPERATURES
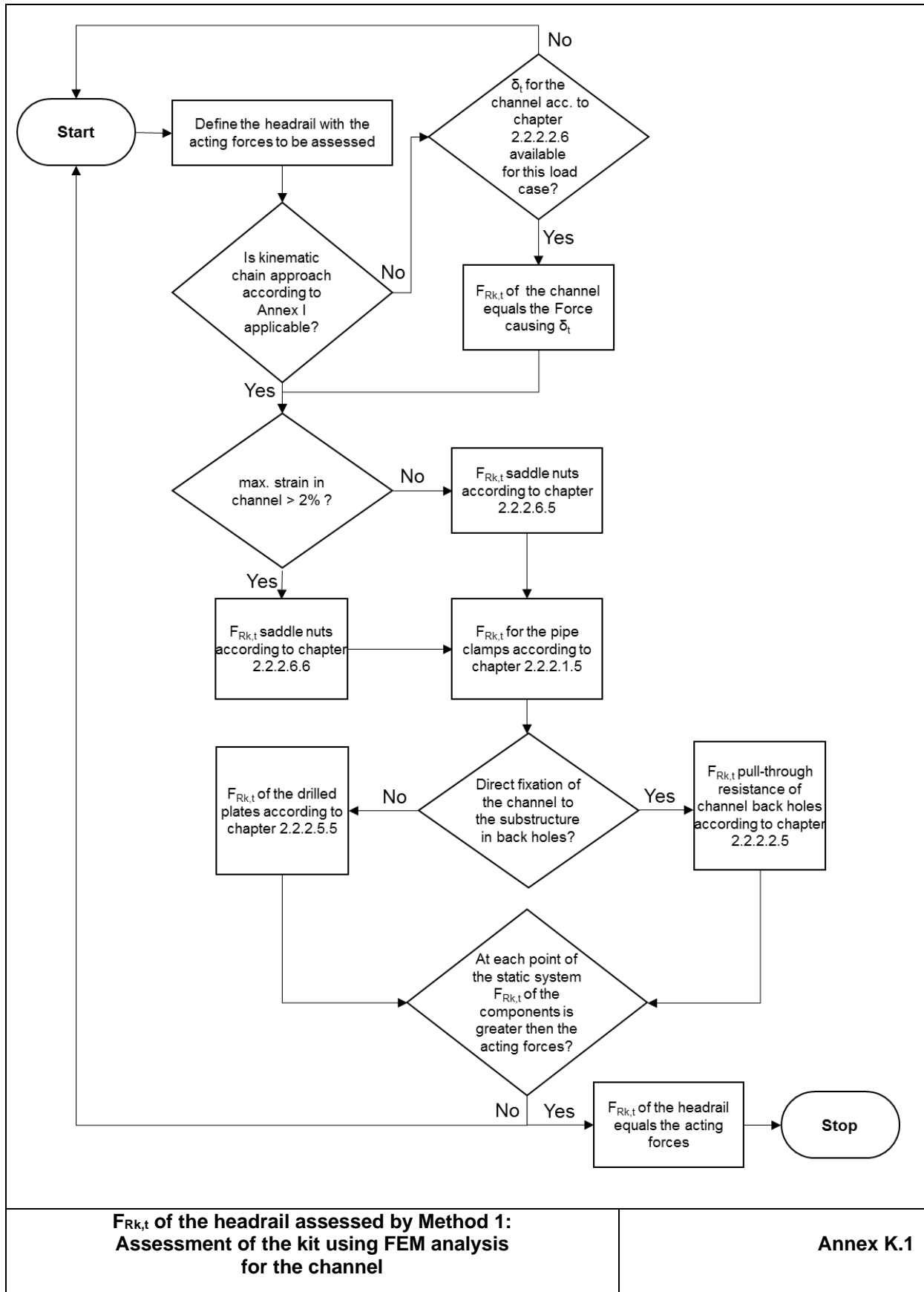
$F_{Rk,t}$ **of the headrail assessed by Method 1:** Assessment of the kit using FEM analysis for the channel	**Annex K.1**

δt of the headrail assessed by Method 1:
Assessment of the kit using FEM analysis
for the channel

Annex K.2

```
                                                                    No
           ┌──────────┐        ╱╲                        ╱╲
           │          │       ╱  ╲  Is kinematic        ╱  ╲  δt for the
 ╭──────╮  │ Define the│     ╱    ╲ chain approach  No ╱    ╲ channel
 │ Start├─▶│ trapeze   ├────▶   according to ────────▶  according to
 ╰──────╯  │ rod with  │     ╲    ╱ Annex I            ╲    ╱ chapter 2.2.2.2.6
           │ the acting│      ╲  ╱  applicable?         ╲  ╱  available for
           │ forces to │       ╲╱                        ╲╱   this load case?
           │ be        │        │                         │
           │ assessed  │       Yes                       Yes
           └──────────┘         │            ┌──────────────┐
                                │            │ FRk,t of the │
                                │            │ channel      │
                                │            │ equals the   │
                                │            │ Force causing│
                                │            │ δt           │
                                │            └──────────────┘
```

Define the trapeze rod with the acting forces to be assessed

Is kinematic chain approach according to Annex I applicable?

δ_t for the channel according to chapter 2.2.2.2.6 available for this load case?

No

Yes

Yes

$F_{Rk,t}$ of the channel equals the Force causing δ_t

Compression resistance of the threaded rods according to 2.2.2.3.5

Yes

Saddle nuts positioned above the channel?

No

Saddle nuts positioned below the channel?

Yes

No

Max δ_t of the channel > l/20?

max. strain in channel > 2% ?

Yes   No

$F_{Rk,t}$ of the channel suspension threaded rod according to chapter 2.2.2.3.3

$F_{Rk,t}$ of the channel suspensions with drilled plate connections according to chapter 2.2.2.5.5

No   Yes

$F_{Rk,t}$ saddle nut according to chapter 2.2.2.6.5

$F_{Rk,t}$ saddle nut according to chapter 2.2.2.6.6

$F_{Rk,t}$ for the pipe clamps according to chapter 2.2.2.1.5

$F_{Rk,t}$ of the pipe clamp suspensions with drilled plates according to chapter 2.2.2.5.5

At each point of the static system $F_{Rk,t}$ of the components is greater then the acting forces?

No

Yes

$F_{Rk,t}$ of the trapeze rod equals the acting forces

Stop

$F_{Rk,t}$ of the trapeze rod assessed by Method 1: **Assessment of the kit using FEM analysis** **for the channel**	**Annex K.3**

| δ_t of the trapeze rod or suspended cantilever assessed by Method 1: Assessment of the kit using FEM analysis for the channel | Annex K.4 |

```
                                                                                    No
                                                            δ_t for the
                              Is kinematic                   channel
                              chain approach                according to
          Define the trapeze   according to       No       chapter 2.2.2.2.6
  Start    frame to be         Annex I                      available for this
           assessed            applicable?                  load case?

                                             Yes                        Yes

                                                            F_{Rk,t} of the channel
                                                            equals the Force
                                                            causing δ_t

                         Compression
                         resistance of the    Yes    Saddle nuts     No    Saddle nuts    Yes
                         threaded rods               positioned            positioned
                         according to                above the              below the
                         2.2.2.3.5                    channel?               channel?

                                                                                No

  F_{Rk,t} of the pipe clamp      F_{Rk,t} for the pipe clamps                 max. strain in
  suspensions with drilled plates  according to chapter                        channel
  according to chapter 2.2.2.5.5   2.2.2.1.5                                    > 2% ?

                                                                       No           Yes

  F_{Rk,t} for the base connectors                          F_{Rk,t} saddle nuts    F_{Rk,t} saddle nuts
  according to chapter 2.2.2.9.5                             according to chapter    according to chapter
                                                             2.2.2.6.5              2.2.2.6.6

  F_{Rk,t} for the angle connectors
  according to chapter 2.2.2.10.5

                 At each point of
                 the static system
          No     F_{Rk,t} of the          F_{Rk,t} of the trapeze
                 components is             frame equals the        Stop
                 greater then the          acting forces
                 acting forces?
```
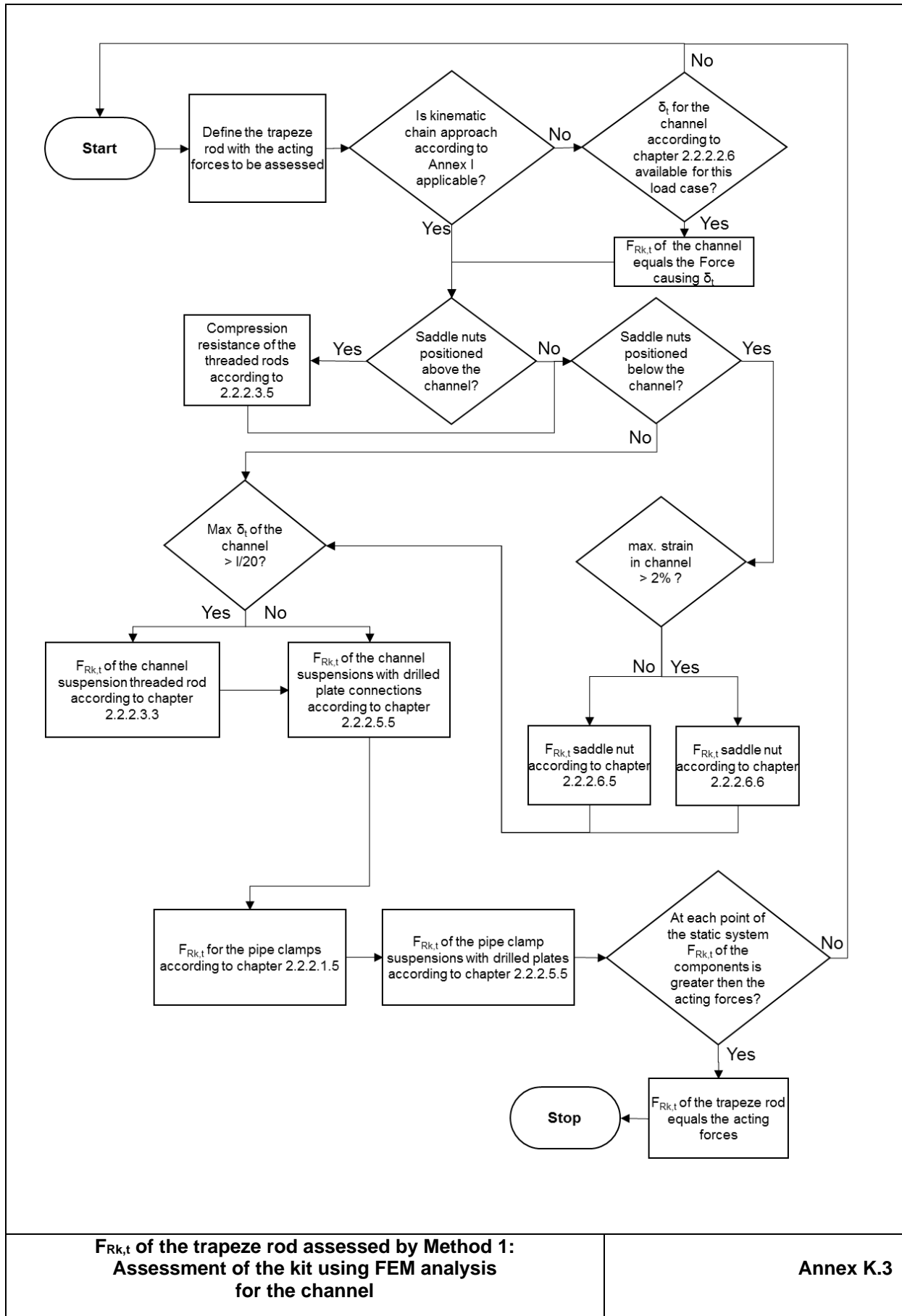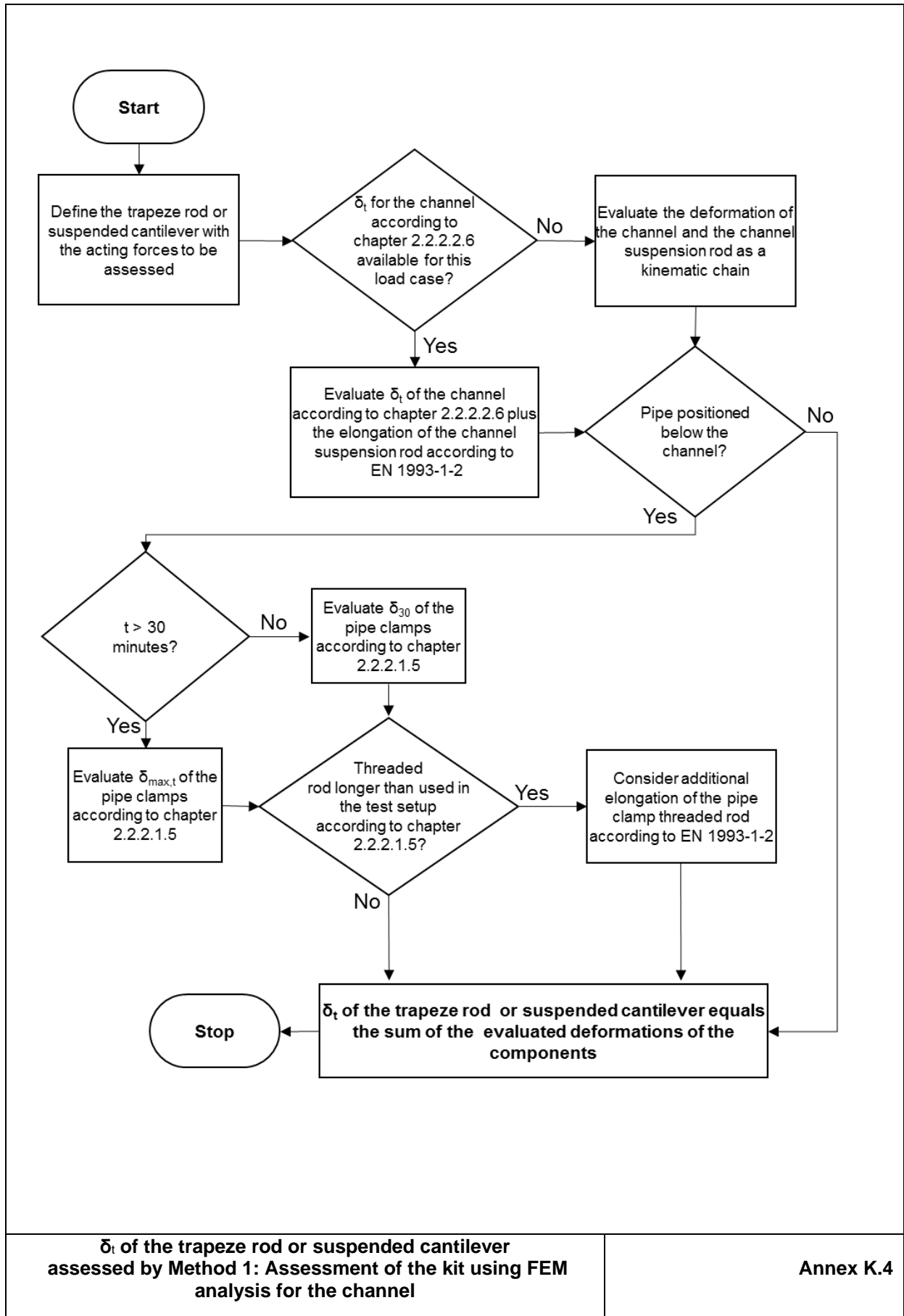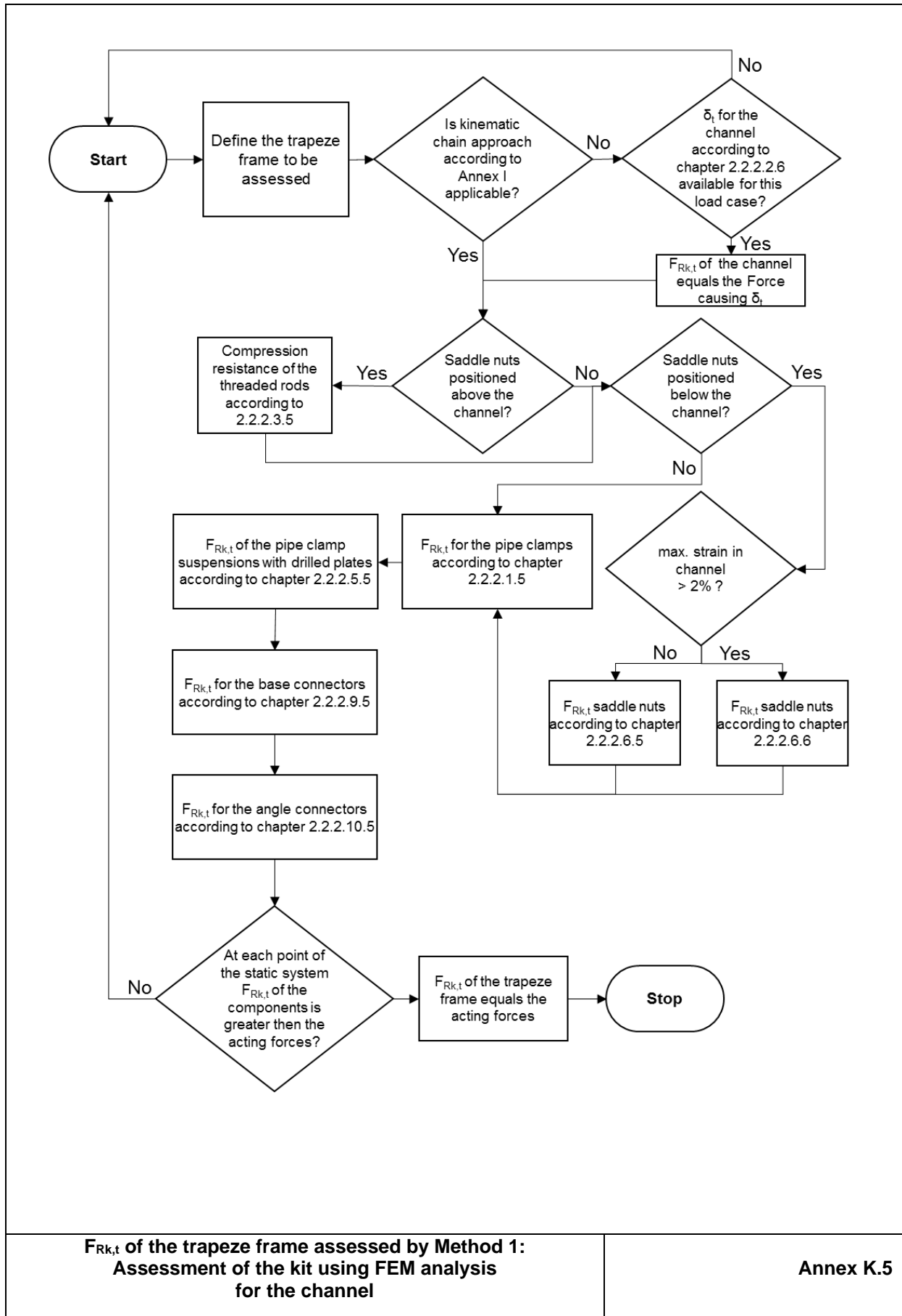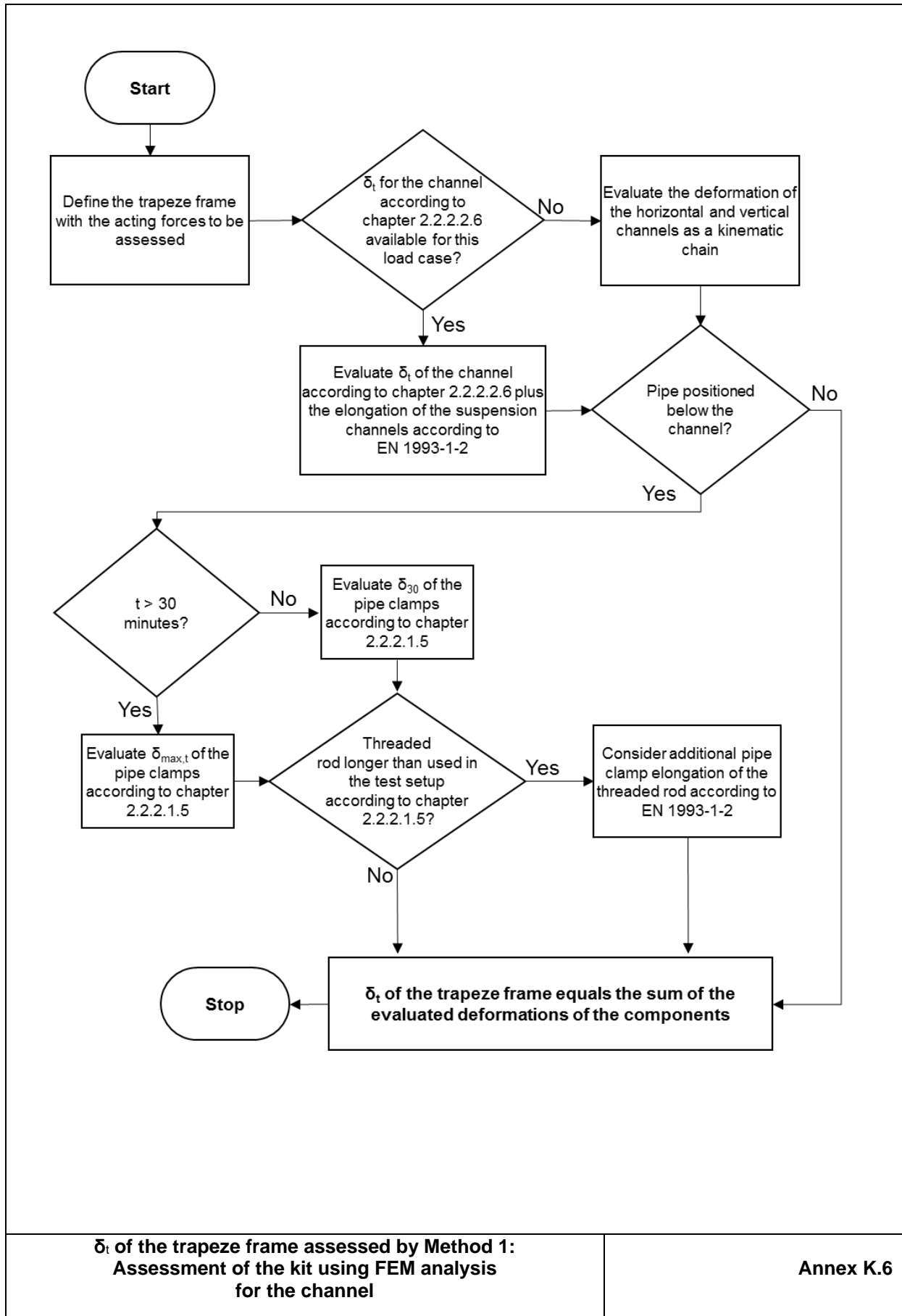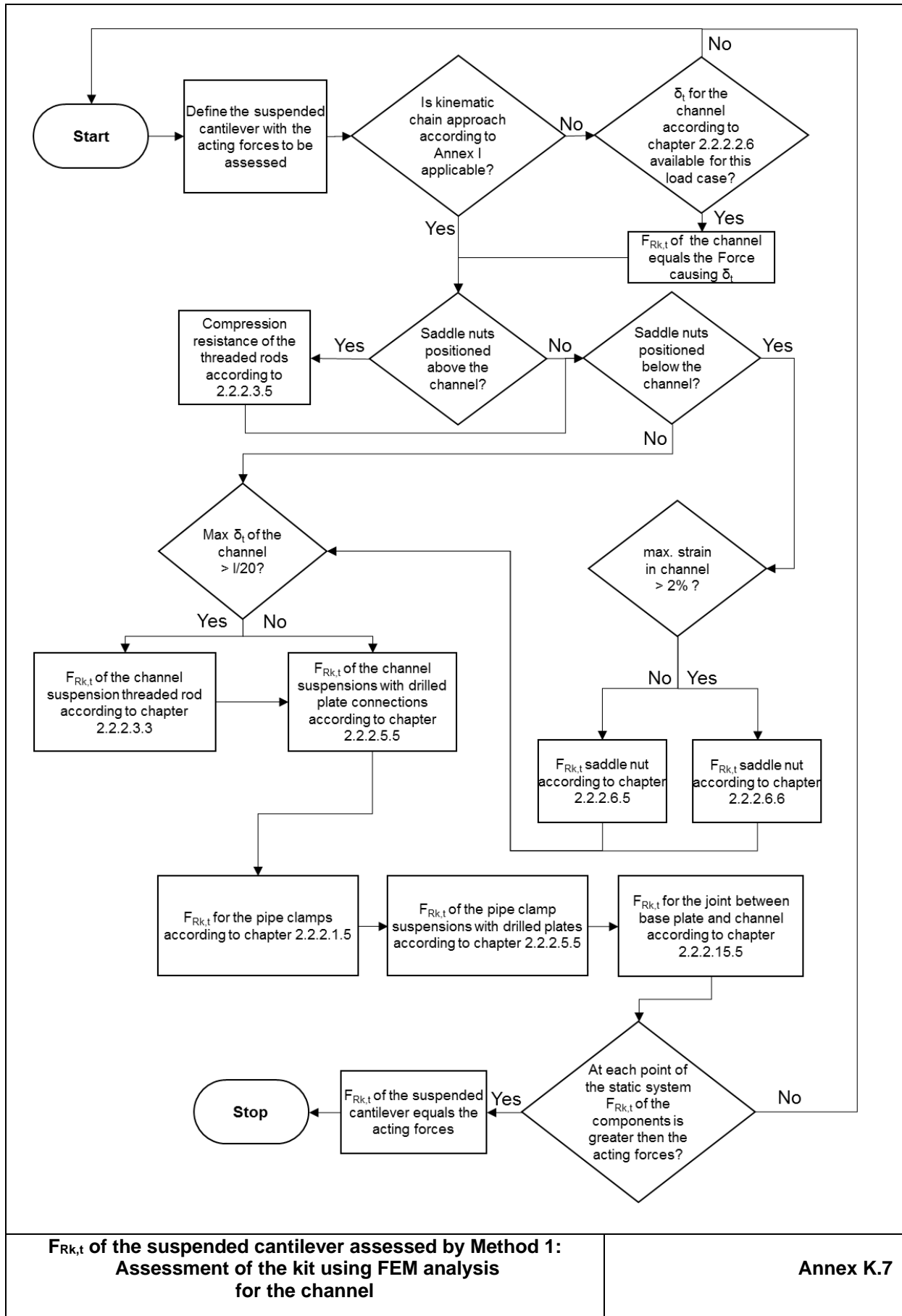
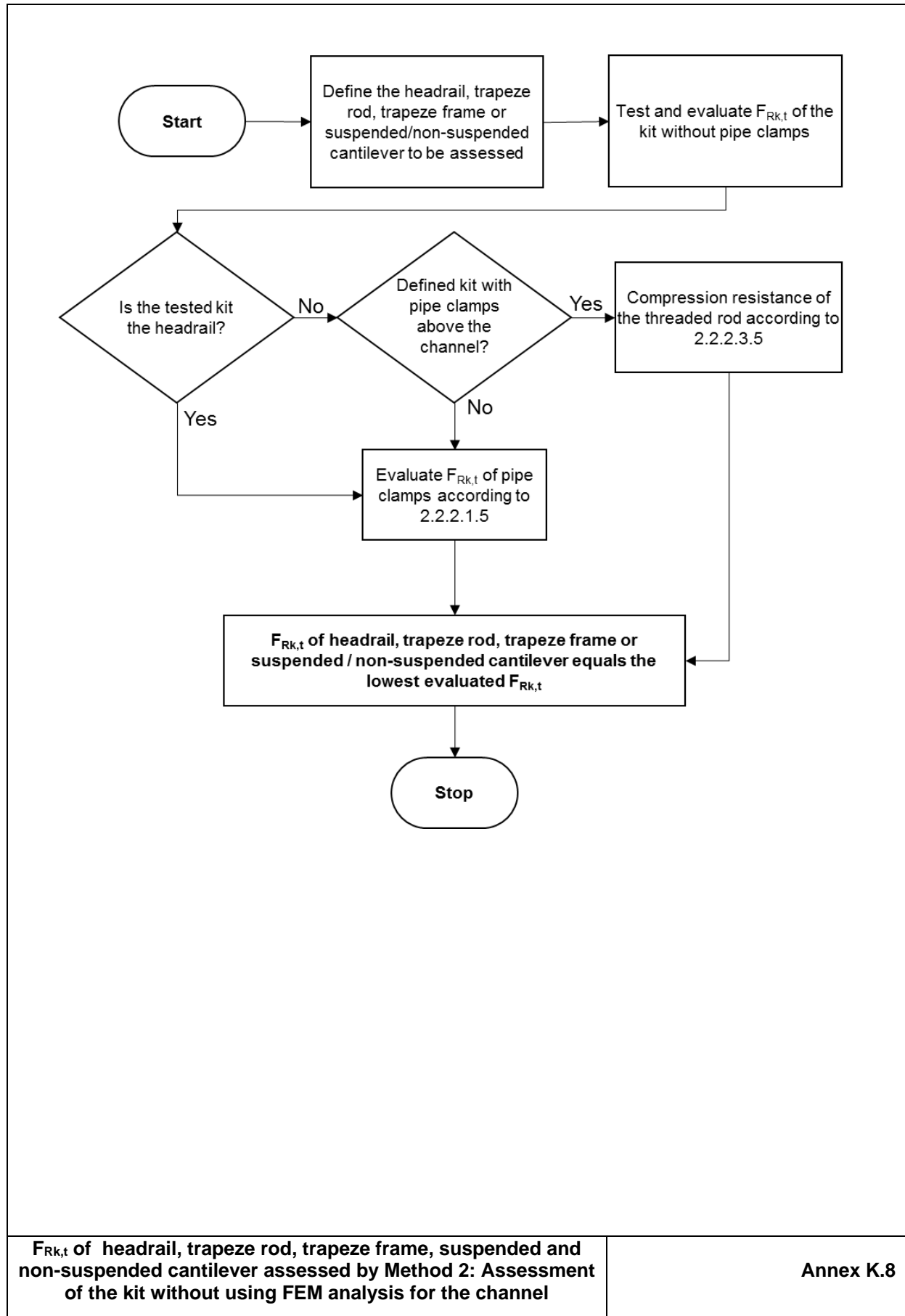| **F_{Rk,t} of the trapeze frame assessed by Method 1: Assessment of the kit using FEM analysis for the channel**	**Annex K.5**

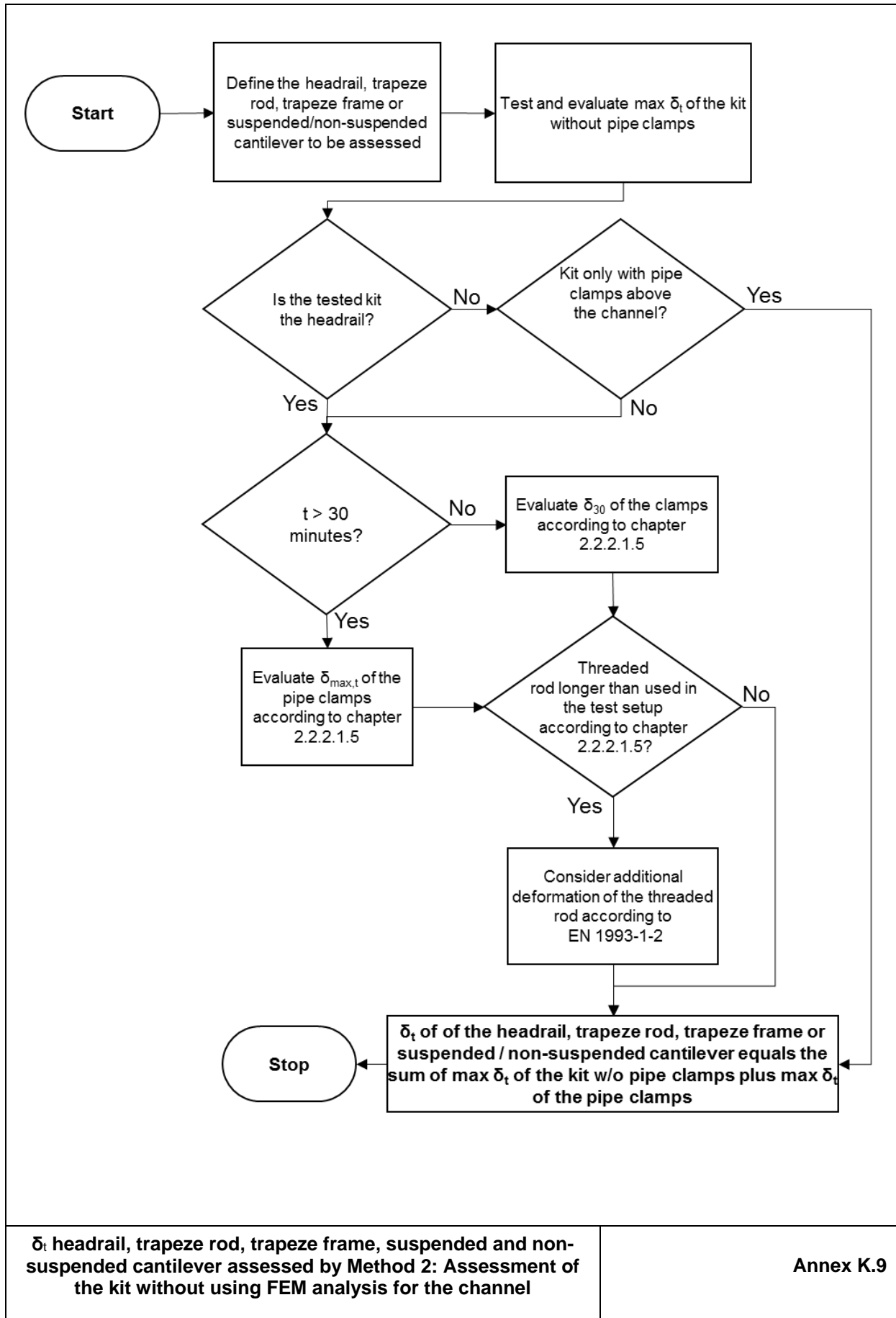| δ_t of the trapeze frame assessed by Method 1: Assessment of the kit using FEM analysis for the channel | Annex K.6 |

$F_{Rk,t}$ of the suspended cantilever assessed by Method 1: Assessment of the kit using FEM analysis for the channel	Annex K.7

| $F_{Rk,t}$ of headrail, trapeze rod, trapeze frame, suspended and non-suspended cantilever assessed by Method 2: Assessment of the kit without using FEM analysis for the channel | Annex K.8 |

δ_t **headrail, trapeze rod, trapeze frame, suspended and non-suspended cantilever assessed by Method 2: Assessment of the kit without using FEM analysis for the channel**	**Annex K.9**