



Complete Technical Guide to مقاومت Flame Propagation to Non- of Metallic and Composite Conduits

IEC 61386-1:2008 specifies general requirements for conduit systems used for cable management. Among its fire-hazard requirements, the standard establishes a specific test for determining whether **non-metallic and composite conduits** can be classified as **non-flame propagating**.

For conduits, compliance is evaluated by applying a standardized: **1 kW test flame**

in accordance with: [IEC 60695-11-2:2003](#)

The conduit is mounted vertically inside a specified steel enclosure, exposed to the flame for a duration determined by its and then evaluated according to defined extinction, dripping and charring criteria. This article covers only the ماده ضخامت, requirements related to the **flame propagation test** contained in IEC 61386-1:2008

1. هدف of the Flame Propagation Test

:The purpose of the test is to determine whether a conduit that may ignite when exposed to an external flame

- ;limits flame propagation
- ;extinguishes within a specified time after flame removal
- beneath the ماده does not ignite; نمونه آزمون;
- and does not allow burning or charring to propagate excessively toward the upper end of the نمونه آزمون.

A conduit classified as **non-flame propagating** may catch fire when an external flame is applied, but the flame shall not continue to propagate indefinitely and the conduit shall self-extinguish within the limits required by the standard.

2. Flame Propagation Classification

IEC 61386-1 classifies conduit systems according to flame propagation as مقاومت

Non-Flame Propagating

Classification: **1**

Flame Propagating

Classification: **2**

This characteristic forms the **eleventh digit** of the IEC 61386 conduit-system classification code.

3. Definition of a Non-Flame Propagating Conduit

A non-flame propagating conduit is a conduit that may catch fire as a result of an applied flame, but

- the flame does not continue to propagate
- and the conduit extinguishes itself within a limited time after removal of the external flame.

The test therefore evaluates **controlled self-extinguishing behaviour**, not complete immunity to ignition.

4. Products Subjected to the 1 kW Flame Test

The 1 kW flame test specified in Clause 13.1.3.2 applies to

non-metallic conduits and **composite conduits**

that are intended to be classified as: **non-flame propagating**.

The conduit itself is tested using the 1 kW flame.

Conduit اتصال s are assessed separately under the standard using the glow-wire method and are therefore not part of the 1 kW flame procedure described here.

5. Standardized Flame Source

The flame used for the test shall be the

1 kW Flame Specified in IEC 60695-11-2 1

IEC 61386-1 does not redefine the detailed burner construction, propane flow, air flow or flame calibration requirements.

:Those requirements are taken from

Test flames - 1 kW nominal pre-mixed flame - آزمون IEC 60695-11-2:2003 - Fire hazard

Therefore, a compliant IEC 61386-1 flame-propagation system requires a correctly established and confirmed IEC 60695-11-2 1 kW flame.

6. General Test Conditions

of: $20 \pm 5 \text{ }^{\circ}\text{C}$ دما Unless otherwise specified, tests under IEC 61386-1 are performed at an ambient

s, general conditioning is required for at least: 240 h نمونه For non-metallic and composite conduit

at: $23 \pm 2 \text{ }^{\circ}\text{C}$

with relative humidity between: 40 % and 60 %

is carried out immediately after this general conditioning. آزمون

نمونه should be s:

- clean;
- new;
- complete;
- representative of normal use.

7. Number of نمونه

The flame propagation procedure is performed on: Three نمونه s

The standard explicitly requires that: **all three** نمونه s shall pass.

Failure of one نمونه آزمون means the flame-propagation requirement has not been satisfied under the normal acceptance rule.

8. نمونه آزمون Length

Each conduit نمونه آزمون shall have a length of: 675 ± 10 mm

The نمونه آزمون is mounted: **vertically** inside the specified steel enclosure.

9. Test Enclosure

The test is performed inside a: **rectangular metal enclosure with one open face** and in an area that is: **substantially free from draughts**.

The purpose of the enclosure is to provide a repeatable flame environment while limiting uncontrolled air movement around the نمونه آزمون.

10. Steel Enclosure Dimensions

Figure 6 of IEC 61386-1 specifies the steel enclosure used for the flame propagation test.

The main dimensions shown are approximately

Height 1300 ± 25 mm

Width $300 +25 / 0$ mm

Depth $450 +25 / 0$ mm

The enclosure has: **one closed back face**

and: **one open front face**

The نمونه آزمون is mounted vertically inside the enclosure.

11. نمونه آزمون Position Inside the Enclosure

The نمونه آزمون assembly is positioned

vertically in the centre of the enclosure.

The general arrangement is defined in Figure 7.

The conduit is maintained in a straight vertical position by

- two metal clamps ;
- an internal steel rod.

12. Metal Clamps

Two metal clamps are used to support the نمونه آزمون.

Each clamp is approximately: 25 mm wide

The distance between the clamps is: 550 ± 10 mm

The clamps should be positioned approximately: **equidistant from the ends of the** نمونه آزمون.

13. Lower Clamp Height

The upper extremity of the lower clamp is positioned: 500 ± 10 mm

above the internal lower surface of the enclosure.

:This dimension establishes the vertical reference for

- نمونه آزمون ;positioning
- ;flame application point
- burner geometry.

14. Internal Steel Support Rod

A steel rod is passed through the conduit نمونه آزمون.

Its purpose is to keep the نمونه آزمون:

- ;straight
- ;vertical
- stable during flame exposure.

The rod is: **rigidly and independently mounted**

and clamped at its upper end.

Steel Rod Diameter - Conduit Sizes up to 12 mm .15

For conduit sizes up to: **12 mm**

the required steel rod diameter is: 2.0 ± 0.1 mm

Steel Rod Diameter - 16 mm to 25 mm Conduits .16

For conduit sizes from: **16 mm to 25 mm**

the steel rod diameter is: 6.0 ± 0.1 mm

Steel Rod Diameter - 32 mm and Larger Conduits .17

For conduit diameters: **32 mm and above**

the required steel rod diameter is: 16.0 ± 0.1 mm

Requirement for the Support Arrangement .18

The mounting arrangement shall therefore be **ماده**. The support system must not interfere with falling molten or burning
:designed so that

can fall freely onto the tissue paper below. نمونه آزمون

This is important because ignition of the tissue paper forms part of the acceptance criteria.

Pinewood Board .19

A suitable piece of: **white pinewood board**

is positioned on the lower surface of the test enclosure.

is: 10 mm **ضخامت** The approximate board

20. Tissue Paper

The pinewood board is covered with: one single layer of white tissue paper

The tissue paper serves as an indicator of whether

- flaming droplets
- molten particles
- burning fragments

Ignition of this tissue paper constitutes a failure. beneath the ماده from the conduit can ignite. آزمون.

21. Burner Orientation

The burner is mounted so that its axis is inclined at: $45 \pm 2^\circ$

to the vertical. This angle is a controlled part of the test geometry.

The burner shall remain in this position during flame application.

22. Burner-to- نمونه آزمون Distance

The distance from: **the top of the burner tube**

to: **the conduit** نمونه آزمون

measured along the axis of the flame shall be: 100 ± 10 mm

This dimension is measured along the burner/flame axis, not horizontally or vertically.

23. Flame کاربرد Point

The burner is positioned so that its flame axis intersects the surface of the conduit at a point: 100 ± 5 mm

above: **the upper extremity of the lower clamp.**

This establishes a precise and reproducible flame-application location.

24. Alignment of Flame and Conduit

The flame axis shall be arranged so that it: **interacts with the axis of the** نمونه آزمون
as defined by the test arrangement.

The نمونه آزمون is centrally located in the horizontal plane of the enclosure.
Correct alignment is critical because lateral displacement can alter

- ;heat exposure
- ;ignition behaviour
- ;flame spread
- charring distance.

25. Burner Position During the Test

Once the burner is correctly positioned: **the flame shall not be moved during application.**

The only permitted movement is: **removing the burner at the end of the specified exposure period.**

this procedure requires a fixed flame, نمونه آزمون Therefore, unlike some flame tests where the operator follows a deforming position during exposure.

26. Flame کاربرد Time Is Not Constant

One of the most important features of the IEC 61386-1 flame propagation test is that the flame exposure time is: **dependent on conduit ماده ضخامت.**

Thicker conduits receive a longer flame application time.

The exposure duration is selected from Table 9.

27. Determination of ماده ضخامت

Before selecting the flame application time, the **ماده ضخامت** of each **نمونه** must be determined.

IEC 61386-1 provides different **اندازه گیری** methods for:

- ;plain conduit
- ;corrugated conduit
- ;combined plain and corrugated conduit
- combined plain, corrugated and plain conduit.

:The procedures are specified in

Normative Annex B.

28. اندازه گیری of All Three نمونه آزمون

The ماده ضخامت test all three is measured on: نمونه.

For each نمونه آزمون:

1. Annex B the appropriate اندازه گیری method is used ;
2. the mean ماده ضخامت is calculated.

The three نمونه آزمون mean values are then compared.

29. ضخامت Used to Select Exposure Time

The standard requires use of: the highest mean ماده ضخامت

s. That value is used to determine the flame exposure time from Table 9. among the three نمونه آزمون

This means that three different flame times are not normally selected for the three نمونه آزمون.

:Instead

measure all three → calculate each mean → select the highest mean → use that value to establish the exposure time.

30. Complete Flame کاربرد Time Table

Mean Time کاربرد Flame ماده ضخامت

0.5 mm ≥	15 s
>0.5 to 1.0 mm	20 s

gt;1.0 to 1.5 mm&	25 s
gt;1.5 to 2.0 mm&	35 s
gt;2.0 to 2.5 mm&	45 s
gt;2.5 to 3.0 mm&	55 s
gt;3.0 to 3.5 mm&	65 s
gt;3.5 to 4.0 mm&	75 s
gt;4.0 to 4.5 mm&	85 s
gt;4.5 to 5.0 mm&	130 s
gt;5.0 to 5.5 mm&	200 s
gt;5.5 to 6.0 mm&	300 s
gt;6.0 mm&	500 s

The specified flame application times have a positive tolerance as indicated in Table 9 of the standard.

31. Plain Conduit ضخامت اندازه گیری

For a plain conduit , ضخامت اندازه گیری s are taken at: four locations
approximately equally spaced around: 360°

:of the conduit circumference. If the four measured values are

a_1, a_2, a_3, a_4

:is the mean

Mean ضخامت $= (a_1 + a_2 + a_3 + a_4) / 4$

32. Corrugated Conduit ضخامت اندازه گیری

:s are taken at both اندازه گیری, For a corrugated conduit

- the crest of the corrugation
- the root of the corrugation.

s are taken at four approximately equally spaced positions around the circumference. اندازه گیری

:This produces

- four crest اندازه گیری
- four root اندازه گیری.

values as defined in Annex B. The mean ضخامت is calculated from the eight resulting ضخامت

33. Combined Plain and Corrugated Conduit

:For conduit incorporating both

- ;plain sections
- ;corrugated sections

اندازه گیری at s are made

- ;corrugation crest
- ;corrugation root
- ;plain section

at four approximately equally spaced positions around 360°. The calculation method defined in Annex B accounts for both the corrugated and plain portions of the wall.

34. Combined Plain-Corrugated-Plain Construction

:For conduit incorporating

plain section → corrugated section → plain section

:of Annex B specifies اندازه گیری of

- ;root
- ;crest
- both plain-wall sections

formula at four positions approximately equally spaced around the conduit circumference. The appropriate mean shall be used before selecting the flame exposure duration.

35. Complete Test Setup Sequence

:A practical sequence based directly on IEC 61386-1 is

Step 1 - Select نمونه s

Prepare: **three new conduit** representative of the product. نمونه s

Step 2 - Condition the نمونه s

For non-metallic and composite conduits: **at least 240 h**

at: **23 ±2 °C**

and: **40-60 % RH**

Step 3 - Determine ماده ضخامت

Use Annex B according to conduit geometry.

Step 4 - Calculate the Mean of Each ضخامت نمونه

Calculate one mean value for each of the three نمونه s.

Step 5 - Select Highest Mean ضخامت

Use the highest of the three mean values.

Time کاربرد Step 6 - Determine Flame

Select the corresponding duration from Table 9.

Step 7 - Prepare the Enclosure

Install the steel enclosure in a substantially draught-free area.

Step 8 - Install the Pine Board and Tissue Paper

Place the approximately 10 mm white pine board on the bottom of the enclosure.

Cover it with one layer of white tissue paper.

Step 9 - Install the Steel Rod

Select the correct rod diameter according to conduit size.

Step 10 - Mount the Conduit

Install the: **675 ±10 mm**

vertically. نمونه

Step 11 - Install the Two Clamps

Use approximately: **25 mm wide**

clamps spaced: **550 ±10 mm**

apart.

Step 12 - Establish Lower Clamp Height

Set the upper edge of the lower clamp: **500 ±10 mm**

above the enclosure floor.

Step 13 - Set Burner Angle

Adjust burner axis to: **45 ±2° from vertical**

Step 14 - Set Burner Distance

distance along the flame axis to: **100 ±10 mm** Set burner tube-to-آزمون نمونه

Step 15 - Set Flame Impact Point

Align the flame to intersect the: آزمون نمونه

5 mm above the upper end of the lower clamp $\pm$ 100

Step 16 - Apply the 1 kW Flame

Apply the IEC 60695-11-2 flame for the duration obtained from Table 9.

Step 17 - Keep Burner Stationary

Do not move the flame during exposure.

Step 18 - Remove the Flame

Remove the burner immediately at the end of the specified exposure period.

Step 19 - Observe Post-Flame Behaviour

:Observe

- ;continued flaming
- ;sustained glowing
- ;falling burning particles
- ;tissue-paper ignition
- propagation of burning/charring.

Step 20 - Allow Burning to Cease

Wait until any burning of the sample has stopped.

Step 21 - Clean the sample

Wipe the sample surface with: **a cloth soaked with water** before evaluating the final char/burn limit.

36. Pass Criterion - No Ignition

The sample passes if: it does not ignite.
In this case, no further ignition-related acceptance criteria need to be invoked for that sample.

37. Pass Criterion When Ignition Occurs

Ignition itself does not automatically constitute failure. A sample that ignites can still pass if **all required post-ignition criteria are satisfied.**

38. Maximum Flaming / Glowing Duration

After removal of the test flame: **flaming or glowing shall extinguish within 30 seconds.**

Therefore: Post-Flame Burning/Glowing ≤ 30 s
is required.

52. Tissue Paper Acceptance Requirement

The white tissue paper underneath the sample shall: not ignite.

:Ignition caused by

- ;flaming drops
- ;glowing debris
- ;molten polymer
- burning fragments

therefore constitutes failure.

Upper Char / Burn Limit .53

:After all flaming and glowing have extinguished

there shall be: no evidence of burning or charring within 50 mm of the lower extremity of the upper clamp.

This requirement limits upward flame propagation along the conduit.

54. Why the 50 mm Criterion Is Important

eventually self-extinguishes. A conduit نمونه آزمون The purpose of the upper limit is not merely to determine whether the could theoretically extinguish but still allow the combustion zone to travel a substantial distance upward.

IEC 61386-1 therefore places an additional boundary on: **how far burning or charring may approach the upper clamp.**

The region within: **50 mm below the lower end of the upper clamp** must remain free from evidence of burning or charring after extinction.

55. Final Acceptance Conditions

Each نمونه آزمون :passes if

:Either

The نمونه آزمون does not ignite

:Or, if ignition occurs, all of the following are satisfied

1. Flaming/glowing extinguishes within **30 s** after flame removal.
2. The tissue paper underneath the **does not ignite** نمونه آزمون
3. After extinction, there is **no evidence of burning or charring within 50 mm of the lower end of the upper clamp**.

56. Three- نمونه Acceptance Rule

The standard requires: All Three نمونه Shall Pass s

:Therefore

نمونه 1 = PASS

نمونه 2 = PASS

نمونه 3 = PASS

is required for compliance. The result is not determined by

• averaging ;

- majority vote
- two out of three نمونه آزمون.

57. Post-Test Cleaning

After completion of the test and after all burning has ceased: the surface is cleaned by rubbing it with: **a piece of cloth soaked with water.** نمونه آزمون

This cleaning step is performed before the final visual assessment of burning/charring extent.

58. Test Enclosure - Technical Summary

The flame test enclosure includes

- rectangular steel construction
- open front
- closed rear face
- approximate height: **1300 ±25 mm**
- width: **300 +25/0 mm**

- ;depth: **450 +25/0 mm**
- vertically mounted conduit نمونه آزمون;
- ;lower white pinewood board
- ;white tissue paper
- inclined burner.

The enclosure drawing is given in Figure 6 and the complete test arrangement in Figure 7.

59. Complete Test Geometry - Quick Reference

Parameter	Requirement
نمونه آزمون length	10 mm± 675
نمونه آزمون orientation	Vertical
Clamp width	Approx. 25 mm
Clamp spacing	10 mm± 550
Lower-clamp upper edge above enclosure floor	10 mm± 500
Burner angle	from vertical ±2° 45
distance نمونه آزمون Burner tube to	10 mm± 100
Flame intersection point above lower clamp	5 mm± 100

Pinewood board ضخامت	Approx. 10 mm
Tissue paper	One layer, white
Flame source	IEC 60695-11-2, 1 kW
Number of نمونه آزمون	3

60. Steel Rod Selection - Quick Reference

Conduit Size	Steel Rod Diameter
Up to 12 mm	0.1 mm± 2.0
25 mm-16	0.1 mm± 6.0
32 mm and above	0.1 mm± 16.0

The rod must be independently secured and must maintain the conduit straight without obstructing falling debris.

61. Critical Variables Affecting Test Repeatability

:The most important controlled parameters include

- ;conformity of the 1 kW test flame
- نمونه آزمون ;conditioning
- نمونه آزمون ;length
- ماده ضخامت ;determination
- ;selected exposure time
- نمونه آزمون ;verticality
- ;burner angle
- burner-to-نمونه آزمون ;distance
- ;flame impact point
- ;clamp spacing
- ;steel-rod selection
- ;draught conditions
- tissue-paper position.

Small deviations in these variables can affect the apparent flame propagation behaviour.

62. Importance of ماده ضخامت

IEC 61386-1 intentionally changes flame exposure duration according to wall ضخامت.

The principle is

Thin wall → shorter flame application

Thick wall → longer flame application

:For example

- 0.5 mm → **15 s** ≥ •
- 2.5 mm → **45 s** - 2.0 •
- 5.0 mm → **130 s** - 4.5 •
- 6.0 mm → **500 s** •

This prevents the same fixed exposure time from being applied indiscriminately to conduit constructions with very different thermal mass.

Example of Exposure-Time Selection .63

Assume three conduit نمونه آزمون s have calculated mean ضحامت es of:

- نمونه 1: 2.18 mm •
- نمونه 2: 2.24 mm •
- نمونه 3: 2.31 mm •

The highest mean ضخامت is: **2.31 mm**
According to Table 9, the relevant range is: **over 2.0 mm up to 2.5 mm** ضخامت

Therefore, the flame application time for the test set is: **45 s**

This example illustrates application of the standard's selection logic.

64. Difference Between Flame مقاومت and Fire مقاومت

IEC 61386-1 distinguishes: **reaction to fire /** مقاومت **to flame propagation**

from: **مقاومت to fire.**

The 1 kW test described here assesses

flame propagation behaviour.

It does not demonstrate that the conduit can maintain electrical circuit integrity during a fire. The general standard states that **مقاومت** fire-resistance requirements are not applicable here, with fire-resistant conduits for survival circuits requiring separate consideration.

65. Difference Between Conduit and Conduit-اتصال Fire Tests

:Within IEC 61386-1

Conduit

Non-metallic and composite **conduits** are evaluated using: **1 kW flame according to IEC 60695-11-2**

Conduit اتصال

Conduit اتصال Non-metallic and composite **conduit** s are evaluated using: **750 °C glow-wire according to IEC 60695-2-11**

These two methods should not be confused when defining the capabilities of a test دستگاه.

66. Flame Propagation Classification Code

In Annex A , مقاومت Eleventh Digit to flame propagation appears as the: of the conduit-system classification code.

:The values are

Non-flame propagating = 1

Flame propagating = 2

This classification can form part of the product's declared technical characteristics.

67. Marking Related to Flame Propagation

IEC 61386-1 also contains colour-related requirements relevant to flame-propagation classification.

shall be: **orange** **Flame-propagating**

and shall not obtain the orange colour merely through superficial painting or a similar surface process.

may generally be another colour, subject to the marking provisions defined by the **A non-flame-propagating** standard.

This is a product-identification requirement rather than part of the flame-test procedure itself.

Pre-Test Checklist .68

:Before starting the test, verify

- ✓ Product is a non-metallic or composite conduit
- ✓ Three appropriate s available نمونه آزمون
- ✓ s conditioned for at least 240 h نمونه
- ✓ Conditioning $23 \pm 2^{\circ}\text{C}$ دما
- ✓ Conditioning RH = 40-60 %
- ✓ نمونه آزمون s clean and new
- ✓ Mean measured correctly ماده ضخامت
- ✓ Highest mean ضخامت identified
- ✓ Correct Table 9 exposure time selected
- ✓ IEC 60695-11-2 1 kW flame available
- ✓ Steel enclosure installed
- ✓ Test area substantially free from draughts
- ✓ White pinewood board installed
- ✓ Single layer of white tissue paper installed
- ✓ Correct steel rod selected
- ✓ Correct clamps installed

✓ نمونه آزمون vertical and straight

69. Geometry Checklist

:Before ignition verify

✓ نمونه آزمون length = **675 ±10 mm**

✓ Clamp spacing = **550 ±10 mm**

✓ Clamp width ≈ **25 mm**

✓ Lower clamp reference height = **500 ±10 mm**

✓ Burner angle = **45 ±2°**

✓ distance = **100 ±10 mm** Burner-to-نمونه آزمون

✓ Flame application point = **100 ±5 mm above lower clamp**

✓ Flame axis correctly aligned with نمونه آزمون

Falling debris path to tissue paper unobstructed ✓

Test Execution Checklist .70

:During the test

Apply standardized **1 kW flame** ✓

Start exposure timer at correct point ✓

Apply flame for Table 9 duration ✓

Do not move burner during exposure ✓

Remove burner at end of required time ✓

Observe continuing flames ✓

Observe sustained glowing ✓

Observe falling particles ✓

Observe tissue paper ✓

Record extinction behaviour ✓

Acceptance Checklist .71

For every نمونه آزمون verify:

✓ نمونه آزمون did not ignite

:OR, if ignition occurred

✓ Flame/glow extinguished within **30 s**

✓ Tissue paper did **not ignite**

✓ No burning/charring within **50 mm of lower end of upper clamp**

:Final result

✓ نمونه 1 PASS

✓ نمونه 2 PASS

✓ نمونه 3 PASS

Only then can the test set satisfy the flame-propagation requirement.

72. Recommended Test Report Data

:A detailed flame-propagation test report should record

- ;standard: IEC 61386-1:2008
- ;flame-source standard: IEC 60695-11-2:2003
- ;product identification
- ;conduit type
- ;nominal conduit size
- ;plain/corrugated/combined construction
- ;نمونه آزمون identification
- ;conditioning duration
- ;دما conditioning
- ;conditioning humidity
- ;individual wall- ضخامت اندازه گیری
- ;نمونه آزمون of each calculated mean ضخامت
- ;highest mean ضخامت

- ;selected flame application time
- ;steel rod diameter
- ;نمونه آزمون length
- ;clamp spacing
- ;burner angle
- ;burner distance
- ;flame application point
- ;ignition occurrence
- ;duration of post-flame flaming/glowing
- ;tissue-paper ignition
- ;burning/charring extent
- ;result for each نمونه آزمون
- overall PASS/FAIL result.

Complete Test Logic .75

:The complete procedure can be summarized as

Condition three نمونه آزمون s



Measure ماده ضخامت



Calculate mean ضخامت for each نمونه آزمون



Select highest mean ضخامت



Determine exposure time from Table 9



Mount 675 ± 10 mm conduit vertically



Install correct internal steel rod



Set clamps 550 ± 10 mm apart



Position lower clamp at 500 ± 10 mm



Position burner at $45 \pm 2^\circ$



Set burner distance to 100 ± 10 mm



Set impact point 100 ± 5 mm above lower clamp



Apply IEC 60695-11-2 1 kW flame



Maintain flame for specified exposure time



Remove flame



Observe extinction and falling ماده



Verify extinction within 30 s



Verify tissue paper does not ignite



Verify no burn/char within 50 mm of upper clamp



Repeat for all three نمونه آزمون s



All three must pass

<https://ahp-makina.com/iec-60695-11-2-2003-complete-technical-guide-to-1-kw-nominal-pre-mixed-flame-apparatus-calibration-and-test-procedure--equipment/>