EVALUATION OF FIRE SEPARATION CHANGES FROM 2012 IRC TO 2015 AND RECOMMENDATIONS FOR A COST EFFECTIVE METHOD OF ALTERNATIVE CONSTRUCTION

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Interim Report

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REPORT COMPILED WITH KOFFEL ASSOCIATES, INC

1. EXECUTIVE SUMMARY

The University of Florida has contracted Koffel Associates, Inc., on behalf of the Florida Building Commission, to evaluate the fire separation requirement changes from the 2012 Edition of the International Residential Code (IRC) as amended by Florida under the 5th Edition, 2014 Florida Building Code and the 2015 Edition of the IRC. This evaluation will focus on the applicable code requirements, and alternative methods of protection.

This version of the report is for a draft submission on December 15, 2015.

2. PROJECT SCOPE

The scope of this project is to evaluate the requirements for fire separations in the 'Florida Building Code: Residential," 5th Edition and the changes to them in the 2015 IRC. There is a concern that these requirements have become more stringent, especially in relation to exterior walls and projections.

Fire separation distance is defined by the 2015 IRC as: "The distance measured from the building face to one of the following:

1. To the closest interior *lot line*.
2. To the centerline of a street, an alley or public way.
3. To an imaginary line between two buildings on the *lot.*

The distance shall be measured at a right angle from the face of the wall."

Based on the fire separation distance, a building's exterior walls, projections and openings have fire-resistance requirements. The primary focus of this evaluation will be on exterior wall and projection requirements for single family homes and townhouses, i.e. an attached single family dwelling with a zero lot line.

The evaluation will consist of a literary review of four (4) concepts related to fire-rated construction and fire separation distances. These concepts include a review of 2015 code requirement changes, code history, prescriptive and performance based approaches, and cost effective alternative construction.

The scope was limited strictly to reviewing the fire separation provisions of the codes. However, other code requirements will be discussed, as necessary, such as sprinkler protection, opening protection, and penetration protection.

3. CODE REFERENCES

The following codes and standards are used for this analysis:

- International Residential Code (IRC), 2015 Edition
- Florida Building Code Residential (FBC-R), 5th Edition (2014)

The primary reference of this evaluation will be the IRC, 2015 Edition, as Florida will use this code as the basis for the next edition of their building code. Note that the IRC and FBC-R are very similar. Any differences between the codes related to the code requirements addressed herein will be noted.

All terminology used in this report will be as defined by the IRC. For example, draftstopping can also be referred to as "draft stop," "fire block," or "fire stop." These other terms may be common in the field, but the code has different definitions for this terminology. In addition, this terminology has changed over time and is present in the legacy codes.

4. LITERATURE REVIEW

The literature review includes an analysis of the 2015 code requirement changes, code history, prescriptive and performance based approaches, and cost effective alternative construction. Each item is discussed in the sections below.

4.1 2015 Code Requirements

The current code requirements for exterior walls and fire separation distance are in IRC Section R302.1. Fire separation distance is used to determine the fire-resistance needed for exterior walls, projections and openings. Per §302.1, "Construction, projections, openings, and penetrations of exterior walls of dwellings and accessory buildings shall comply with Table R302.1 (1); or dwellings equipped throughout with an automatic sprinkler system installed in accordance with Section P2904 shall comply with Table R302.1 (2).

Exceptions:

1. Walls, projections and openings or penetrations in walls perpendicular to the line used to determine the *fire separation distance*.
2. Walls of dwellings and accessory structures located on the same lot.
3. Detached tool sheds and storage sheds, playhouses, and similar structures exempted from permits are not required to provide wall protection based on location on the *lot*. Projections beyond the *exterior wall* shall not extend over the *lot line*.
4. Detached garages accessory to a dwelling located within 2 ft of a *lot line* are permitted to have roof eave projections not exceeding 4 in.
5. Foundation vents installed in compliance with the codes are permitted."

Table R302.1 (2) EXTERIOR WALLS

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE (feet)
Walls	Fire-resistance Rated	1-hr tested in accordance with ASTM E 119 or UL 263 with exposure from the outside.	< 5
	Not Fire-resistance Rated	0 hrs	≥ 5
Projections	Not Allowed	N/A	< 2
	Fire-resistance Rated	1-hr on the underside [a, b]	≥ 2 to < 5
	Not Fire-resistance Rated	0 hrs	≥ 5
Openings in Walls	Not Allowed	N/A	< 3
	25% Maximum of Wall Area	0 hrs	3
	Unlimited	0 hrs	5
Penetrations	All	Comply with Section R302.4	< 3
		None	3

a. Roof eave fire-resistance rating shall be permitted to be reduced to 0 hrs on the underside of the eave if fire blocking is provided from the wall top plate to the underside of the roof sheathing.
b. Roof eave fire-resistance rating shall be permitted to be reduced to 0 hrs on the underside of the eave provided that gable vent openings are not installed.

Table R302.1 (2) EXTERIOR WALLS- DWELLINGS WITH FIRE SPRINKLERS

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE (feet)
Walls	Fire-resistance Rated	1-hr tested in accordance with ASTM E 119 or UL 263 with exposure from the outside.	0
	Not Fire-resistance Rated	0 hrs	3[a]
Projections	Not Allowed	N/A	< 2
	Fire-resistance Rated	1-hr on the underside [b, c]	2[a]
	Not Fire-resistance Rated	0 hrs	3
Openings in walls	Not Allowed	N/A	< 3
	25% Maximum of Wall Area	0 hrs	3[a]
	Unlimited	0 hrs	5
Penetrations	All	Comply with Section R302.4	< 3
		None	3[a]

a. For residential subdivisions where all dwellings are equipped throughout with an automatic sprinkler system installed in accordance with Section P2904, the fire separation distance for nonrated exterior walls and rated projections shall be permitted to be reduced to 0 ft, and unlimited unprotected openings and penetrations shall be permitted, where the adjoining lot provides an open setback yard that is 6 ft or more in width on the opposite side of the property line.
b. Roof eave fire-resistance rating shall be permitted to be reduced to 0 hrs on the underside of the eave if fire blocking is provided from the wall top plate to the underside of the roof sheathing.
c. Roof eave fire-resistance rating shall be permitted to be reduced to 0 hrs on the underside of the eave provided that gable vent openings are not installed.

The code that is highlighted in yellow are the changes made from the 2012 to the 2015 Edition of the IRC. This language was added to address the construction problem of providing fire-resistive eave projections in addition to adequate roof ventilation vents. The 2015 IRC Revision History comments explain that the new language provides builders with an option to "mitigate this situation by providing for the installation of a top-side roof vent in lieu of fire-resistance treatments of the eave projection" [1].

Though fire blocking is normally only appropriate for approximately 10-15 minutes of fire-resistance, by providing this alternative the building code addresses the larger issue of roof ventilation. Roof ventilation is usually provided using "bird block" vents under roof eaves, which provide a direct path for fire, fire embers, and smoke to enter an unsprinklered attic. By changing the location of the vent and adding fire blocking under the projection, the attic space is effectively protected and the projection is simply considered expendable with no required rating.

4.2 Code History

The requirement for 1-hr underside rating for projections dates back to before there was the International Code Council (ICC), when there were three (3) major building code councils: SBCCI, BOCA, and UBC. Before the ICC, these three building councils jointly sponsored the CABO One and Two Family Dwelling Code. This code was one of the first steps in creating uniformity between the code councils to eliminate conflict and repetition. The CABO One and Two Family Dwelling Code began to be referenced by the Uniform Building Code (UBC) in 1982. Exterior wall projection requirements were added to the CABO code in 1995. The following timeline table shows the transformation of the One and Two Family Building Code and its requirements for projections and exterior walls based on fire separation.

The Florida Building Code did not incorporate a separate Residential Code until 2004. In 2004, the Florida Building Code required exterior walls separated by less than six ft to have a 1-hr fire-resistance rating on both sides. It also required that projections not extend to a point closer than 4 ft from an adjacent protection or wall unless they were protected by a 1-hr or more fire-resistance rated construction on the underside. It was not until the 2007 Edition of the Florida Building Code that code sections from the IRC were adopted, as indicated in the table below.

Table 1. History of the Projection Code.

Code and Edition	Florida Building Code Adoption	Section	Requirement
CABO 1992	Not Adopted	§R-202.1	Required exterior walls less than 3 ft from the property line to have a 1-hr fire-resistance rating. Projections are not mentioned.
CABO 1995	Not Adopted	§302.1	Required exterior walls less than 3 ft from the property line to have a 1-hr fire-resistance rating. Projections were forbidden from extending more than 12 in. into areas where openings were prohibited.

International One- and Two – Family Dwelling Code 1998	Not Adopted	§302.1	Same requirements as CABO 1995.
IRC 2000	FBC 2007 §R302.1	§R302.1	Required exterior walls less than 3 ft from the property line to have a 1-hr fire-resistance rating. Projections could not extend more than 1/3 the distance to the property line from where protected openings were required or more than 12 in. into areas where opening were prohibited, whichever was smaller. If they extended past that smaller measurement, a 1-hr fire-resistance rating was required on the underside. FBC 2007: did not mention projection allowance extending more than 1/3 the distance to property line from where protected openings are required. Did however include 12-in. limitation where openings were prohibited.
IRC 2003	FBC 2007 §R302.1	§R302.1	Required exterior walls less than 3 ft from the property line to have a 1-hr fire-resistance rating. Projections could not extend to be closer than 2 ft from the lot line. If they extended into this 2 ft space then a 1-hr fire-resistance rating was required on the underside.
IRC 2006	FBC 2007 §R302.1	§R302.1	This edition of the code was the beginning of using a single table to classify the construction rating required based on the fire separation distance for exterior walls, projections, openings, and penetration. Projections were still forbidden from extending more than 12 in. into areas where openings were prohibited.
IRC 2009		§R302.1	Same requirements as IRC 2006, FBC 2010 remained the same as 2007.
IRC 2012	FBC 2014 §R302.1	§R302.1	This edition of the code was the beginning of using two tables to classify the construction rating required, based on the fire separation distance and provided suppression, for exterior walls, projections, openings, and penetration. 12-in. projection provision was removed.
IRC 2015		§R302.1	See Section 4.1 of this report.

Adjustments for sprinkler protected buildings begin in the 2004 Edition of the FBC. Specifically, §R317, which allowed ½-hr fire-resistance rating, instead of a 1 hr, between dwelling units in two family dwellings when equipped throughout with an automatic sprinkler system in accordance with NFPA 13. This provision is carried through the 2007, 2010 and 2014 Editions of the FBC. Allowances for exterior wall separation and projections in sprinkler protected buildings is not incorporated until the 2014 Edition of the FBC. Therefore, prior to the 2014 FBC, allowances could still be taken even when buildings were not sprinkler protected.

In this edition, two tables are presented; Table R302.1(1) Exterior Walls gives requirements for non-sprinkler protected buildings and Table R302.1(2) Exterior Walls-Dwellings with Fire Sprinklers gives requirements for buildings equipped throughout with a NFPA 13D sprinkler system installed in accordance with Section P2904.

4.3 Prescriptive Assemblies

Prescriptive assemblies are those that are generic and do not require certain brands of products. Section 721 of the International Building Code (IBC), provides multiple tables where one can choose the type of structural member to be protected, the type of insulating material to be used, and it will provide how thick the insulating material must be to provide 1, 2, 3, or 4 hrs of fire-resistance. Table 2 is a collection of all the permitted 1-hr construction types given in Section 721 of the IBC.

Table 2: 1-hr Fire-resistance Rated Construction

Roof Construction	Ceiling Construction	Thickness of floor slab (-es)	Minimum Thickness of ceiling (inches)
Siliceous Aggregate Concrete	Slab (no ceiling required) minimum cover over nonprestressed reinforcement shall not be less than 3/4".	3.5	N/A
Carbonate Aggregate Concrete	Slab (no ceiling required) minimum cover over nonprestressed reinforcement shall not be less than 3/4".	3.2	N/A
Sand-lightweight Concrete	Slab (no ceiling required) minimum cover over nonprestressed reinforcement shall not be less than 3/4".	2.7	N/A
Lightweight Concrete	Slab (no ceiling required) minimum cover over nonprestressed reinforcement shall not be less than 3/4".	2.5	N/A
Steel joists constructed with a poured reinforced conrete slab on metal lath forms or steel form units	Gypsum plaster on metal lath attached to the bottom cord with single No. 16 gauge or doubled No. 18 gauge wire ties spaced 6" on center.	2 1/4	5/8
Steel joists constructed with a poured reinforced conrete slab on metal lath forms or steel form units	Cement plaster over metal lath attached to the bottom chord of joists with single No. 16 gauge or doubled .049" (No.18 B.W. gauge) wire ties 6" on center.	2	5/8

	Plaster mixed 1:2 for scratch coat and 1:3 for brown coat for 1-hr system.		
Reinforced concrete slabs and joists with hollow clay tile fillers laid end to end in rows 2 1/2" or more apart; reinforcement placed between rows and conrete cast around and over tile	None	5 1/2	N/A
1 1/2" deep steel roof deck on steel framing. Insulation board, 30 pcf density, composed of wood fibers with cement binders of thickness shown bonded to deck with unified asphault adhesive. Covered with a Class A or B roof covering.	Ceiling of gypsum plaster on metal lath. Lath attached to 3/4" furring channels with .049" (No. 18 B.W. gauge) wire ties spaced 6" on center. 3/4" channel saddle tied to 2" channels with doubled .065" (No. 16 B. W. gauge) wire ties. 2" channels spaced 36" on center suspended 2" below steel framing and saddle tied with .165" (No. 8 B.W. gauge) wire. Plaster mixed 1:2 by weight, gypsum-to-sand aggregate.	1	3/4
1 1/2 " deep steel roof deck on steel framing wood fiber insulation board, 17.5 pcf density on top applied over a 15-lb asphault-saturated felt. Class A or B roof covering	Ceiling of gypsum plaster on metal lath. Lath attached to 3/4" furring channels with .049" (No. 18 B.W. gauge) wire ties spaced 6" on center. 3/4" channel saddle tied to 2" channels with doubled .065" (No. 16 B. W. gauge) wire ties. 2" channels spaced 36" on center suspended 2" below steel framing and saddle tied with .165" (No. 8 B.W. gauge) wire. Plaster mixed 1:2 for scratch coat and 1:3 for brown coat, by weight for 1-hr system.	1	3/4
Vermiculite concrete slab proportioned 1:4 (Portland cement to vermiculite aggregate) on a 1 1/2" deep steel deck supported on individually protected steel framing. Maximum span of deck 6'-10" where deck is less than .019” (No. 26 carbon steel sheet gauge) or greater. Slab reinforced with 4" x 8" .109/.083" (No. 12/14 B.W. gauge) welded wire mesh.	None	3	

Perlite concrete slab proportioned 1:6 (Portland cement roperlite aggregate) on a 1 1/4" deep steel deck supported on indivudally protected steel framing. Slab reinforced with 4" x 8" .109/.083" (No. 12/14 B.W. gauge) welded wire mesh.	None	3 1/2	
Wood joists, wood I-joists, floor trusses and flat or pitched roof trusses spaced a maximum 24" o.c. with 1/2" wood structural panels with exterior glue applied at right angles to top of joist or top chord of trusses with 8d nails. The wood structural panel thickness shall not be less than nominal 1/2" nor less than required by Chapter 23.	Base layer 5/8" Type X gypsum wallboard applied at right angles to joist or truss 24: o.c. with 1 1/4" Type S or Type W drywall screws 24" o.c. Face Layer 5/8" Type X gypsum wallboard or veneer base applied at right angles to joist or truss through base layer with 1 7/8" Type S or Type W drywall screws 12" o.c. at joints and intermediate joist or truss. Face layer Type G drywall screws placed 2" back on either side of face layer end joints, 12" o.c.	Varies	1 1/4
Steel joists, floor trusses and flat or pitched roof trusses spaced a maximum 24" o.c. with 1/2" wood structural panels with exterior glue applied at right angles to top of joist or top chord of trusses with No. 8 screws. The wood strucutral panel thickness shall not be less than nominal 1/2" nor less than required by Chapter 23.	Base layer 5/8" Type X gypsumboard applied at right angles to steel framing 24" on center with 1" Type S drywall screws spaced 24" on center. Face Layer 5/8" Type X gypsum board applied at right angles to steel framing attached through base layer with 1 5/8" Type S drywall screws 12" on center at end joints and intermediate joints and 1 1/2" Type G drywall screws 12 in. on center placed 2" back on either side of face layer end joints. Joints of the face layer are offset 24" from the joints of the base layer.	Varies	1 1/4
Wood I-joist (minimum joist depth 9 1/4" with a minimum flange depth of 1 5/16" and a minimum cross-sectional area of 2.3 sq in. at 24" o.c. spacing with 1” by 4” (nominal) wood furring strip spacer applied parellel to and covering the bottom of the bottom flange of each member, tacked in place. 2" mineral wool insulation, 3.5 pcf (nominal) installed adjacent to the bottom flange	1/2" deep single leg resilient channel 16" on center (channels doubled at wallboard end joints), placed perpendicular to the furring strip and joist and attached to each joist by 1 7/8" Type S drywall screws. 5/8" Type C gypsum wallboard applied perpendicular to the channel with end joints staggered at least 4' and fastened with 1 1/8" Type S drywall screws spaced 7" on center. Wallboard joints to be taped and covered with joint compound.	Varies	5/8

of the I-joist and supported by the 1"x 4" furring strip spacer.			
Wood I-joists (minimum I-joist depth 9 1/4" with a minumum flange depth of 1 1/2" and a minumum flange cross sectional area of 5.25 sq in.; minumum web thickness of 3/8") @ 24" o.c., 1 1/2" mineral wool insulation (2.5 pcf nominal) resting on hat-shaped furring channels.	Minimum .026" thick hat shaped channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1 5/8" Type S drywall screws. 5/8" Type C gypsum wallboard applied perpendicular to the channel with end joints staggered and fastened with 1 1/8" Type S drywall screws spaced 12" o.c. in the field and 8" o.c. at the wallboard ends. Wallboard joints to be taped and covered with joint compound.	Varies	5/8
Wood I-joist (minimum I-joist depth 9 1/4" with a minumum flange depth of 1 1/2" and a minimum flange cross sectional area of 5.25 sq in.; minumum web thickness of 7/16") @ 24" o.c., 1 1'2" mineral wool insulation (2.5 pcf nominal) resting on resilient channels.	Minimum .019" thick resilient channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1 5/8" Type S drywall screws. 5/8" Type C gypsum wallboard applied perpendicular to the channel with end joints staggered and fastened with 1" Type S drywall screws spaced 12" o.c. in the field and 8" o.c. at the wallboard ends. Wallboard joints to be taped and covered with joint compound.	Varies	5/8
Wood I-joist (minimum I-joist depth 9 1/4" with a minumum flange depth of 1 1/2" and a minimum flange cross sectional area of 2.25 sq in.; minumum web thickness of 3/8") @ 24" o.c.	Two layers of 1/2" Type X gypsum wallboard with the long dimension perpendicular to the I-joists with end joints staggered. The base layer is fastened with 1 5/8" Type S drywall screws spaced 12" o.c. and the face layer is fastened with 2" Type S drywall screws spaced 12" o.c. in the field and 8" o.c. on the edges. Face layer end joints shall not occur on the same I-joist as base layer end joints and edge joints shall be offset 24" from base layer joints. Face layer to also be attached to base layer with 1 1/2" Type G drywall screws spaced 8" o.c. placed 6" from face layer end joints. Face layer wallboard joints to be taped and covered with joint compound.	Varies	1

Wood I-joist (minimum I-joist depth 9 1/2" with a minumum flange depth of 1 5/16" and a minimum flange cross sectional area of 1.95 sq in.; minumum web thickness of 3/8") @ 24" o.c.	Minimum .019" thick resilient channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1 5/8" Type S drywall screws. Two layers of 1/2" Type X gypsum wallboard with the long dimension perpendicular to the I-joists with end joints staggered. The base layer is fastened with 1 1/4" Type S drywall screws spaced 12" o.c. and the face layer is fastened with 1 5/8" Type S drywall screws spaced 12" o.c. Face layer end joints shall not occur on the same I-joist as base layer end joints and edge joints shall be offset 24" from base layer joints. Face layer to also be attached to base layer with 1 1/2" Type G drywall screws spaced 8" o.c. placed 6" from face layer end joints. Face layer wallboard joints to be taped and covered with joint compound.	Varies	1
Wood I-joist (minimum I-joist depth 9 1/4" with a minumum flange depth of 1 1/2" and a minimum flange cross sectional area of 2.25 sq in.; minumum web thickness of 3/8") @ 24" o.c. Unfaced fiberglass insulation is installed between the I-joists supported on the upper surface on the flange by stay wires spaced 12" o.c.	Base layer of 5/8" Type C gypsum wallboard attached directly to I-joists with 1 5/8" Type S drywall screws spaced 12" o.c. with ends staggered. Minumum .0179" thick hat-shaped 7/8" furring channel 16" o.c. (channels doubled at wallbaord end joints), placed perpendicular to the joist and attached to each joist by 1 5/8" Type S drywall screws after the base layer of gypsum wallboards has been applied. The middle and face layers of 5/8" Type C gypsum wallboard applied perpendicular to the channel with end joint staggered. The middle layer is fastened with 1" Type S drywall screws sapced 12" o.c. The face layer is applied parellel to the middle layer but with the edge joints offset 24" from those of the middle layer and fastened with 1 5/8" Type S drywall screws 8" o.c. the joints shall be taped and covered with joint compound.	Varies	

4.4 Performance Based Assemblies

There are other options to provide an equivalent 1-hr fire-resistance rating that are not using the above prescriptive construction options. These "performance based" assemblies are specific assemblies and brands that have been tested in their particular arrangement for a specific outcome. They are not general assemblies like that given in Section 4.3. These assemblies must be recreated exactly to ensure the proper fire-resistance rating is provided where required.

There are a few different labs that will do testing for performance based assemblies, and one of the more well-known labs is the International Code Council – Evaluation Service (ICC-ES). They provide an evaluation service that will test any material and assembly for a certain rating or purpose, and then produce an evaluation report on the product. These reports "present findings of ICC-ES as to the compliance with code requirements of the subject of the report- a particular building product, component, method or material" [2].

Three assemblies were found in the ICC-ES database that tested positively on providing a 1-hr fire-resistance rating for exterior wall projections. The first assembly is a plastic siding by CertainTeed Corporation, ESR-1066, and the second assembly is a fiber cement lap and panel assembly by Plycem USA, Inc., ESR-1668. The third assembly is a fire-retardant wood by Hoover Treated Wood Products Inc., ESR-1791. ESR-1066 has a renewal date of 5/2016, ESR 1668 has a renewal date of 10/2016, and ESR-1791 has a renewal date of 12/1/15.

Overall, there are very few options besides using prescriptive assemblies to provide the appropriate 1-hr fire-resistant construction required for the underside of projections.

4.5 Cost Effective Alternative Construction

The options in Section 4.4 are the only main alternativs to the prescriptive assemblies listed in Section 4.3. All options to provide 1-hr fire-resistance protection to the underside of a projection are costly and specific in how the assemblies should be constructed. The 2015 IRC provides an option that allows the 1-hr underside protection requirement to be reduced to 0 hrs when the roof vents are relocated from within the projections to the roof ridge and fireblocking is used to block off the projections from the remainder of the roof.

This allowance is provided in both the sprinkler protected and non-sprinkler protected building tables, and as such, still provides allowances for zero lot line buildings even when the buildings are not sprinkler protected. Following the 2015 IRC is the most cost effective way of addressing projection protection. Moving roof vents and providing fireblocking are significantly less expensive and easier to install than providing 1-hr fire-resistance rated construction for the projections.

5. CONCLUSION

This report contains the requirements and construction options for zero lot line buildings allowed in the IRC and therefore, the FBC-R. It provides prescriptive and performance based options to provide the required protection for projections and the best cost effective alternatives to those fire-resistance rated assemblies.

Koffel Associates trusts that this report provides information to assist in Florida adopting the 2015 IRC into their next code adoption.

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