



Deliverable 2.5

Machine-readable rulesets

ITEA4 22003 FireBIM

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Abstract	Deliverable 2.5 provides a collection of machine-readable fire safety rulesets developed within the FireBIM project. Building on the terminology and ontologies established in D2.1–D2.2 and the digitization methods developed in D2.3–D2.4, the deliverable demonstrates how regulatory requirements can be represented in computational formats and applied to digital building information. The



	collection includes SHACL shapes, IDS specifications, RDF-based regulation graphs, YAML rulesets, RASE representations, and geometric rule implementations, covering regulations from multiple participating countries. Together, these examples demonstrate the interoperability, reusability, and practical application of machine-readable fire safety requirements in digital building workflows.
Keywords	Digital Building Regulations, SHACL, IDS, EIR, RASE, Mermaid



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1. Introduction

1.1. Context and Motivation

The primary driver for this work is the need to translate fire safety regulations into machine-readable rules that can be applied to digital building models. While the previous deliverables establish the terminology, ontologies, and methods required to digitize fire safety regulations, these results ultimately need to be expressed in a form that can be processed by software. Machine-readable rules enable regulatory requirements to be automatically evaluated against building information, thereby reducing the need to manually translate regulatory text into model-based checks. This provides a basis for automated compliance checking and supports the integration of fire safety regulations into digital building workflows.

1.2. Objectives of Deliverable 2.2

The primary objective of Deliverable 2.5 is to provide a collection of machine-readable fire safety rulesets resulting from the methods developed in D2.4. These rulesets express regulatory requirements in computational formats that can be applied to digital building information. The rulesets make use of the terminology, concepts, relationships, and modelling principles established in the FireBIM Ontology Stack (D2.2), as well as the digitization methods and processes defined in D2.3 and implemented in D2.4. The Fire Code Matrix (D2.1) provides the underlying collection of fire safety concepts and requirements from the participating countries.

The deliverable contains examples of different representations of digital regulations and machine-readable rules, including SHACL shapes, IDS specifications, RDF-based regulation graphs, YAML-based rulesets, and other computational rule implementations. Together, these examples demonstrate how fire safety requirements can be represented in machine-readable form and connected to digital building information.

1.3. Positioning within Work Package 2 (WP2)

Deliverable 2.5 is the final step in the sequence of outputs developed in Work Package 2 (see Figure 1). The work builds on the *D2.1 Fire Code Matrix*, which provides the underlying fire safety terminology and regulatory requirements. These concepts are formalised in the *D2.2 FireBIM Ontology Stack*, which provides the terminology and semantic structures required to represent the regulatory knowledge. *D2.3 Generic framework for digitization of fire safety regulations* then defines the generic approach for converting textual regulations into machine-readable representations, which is implemented and demonstrated through the *D2.4 Requirement generator*. D2.5 contains the resulting machine-readable rulesets and examples produced using these methods.

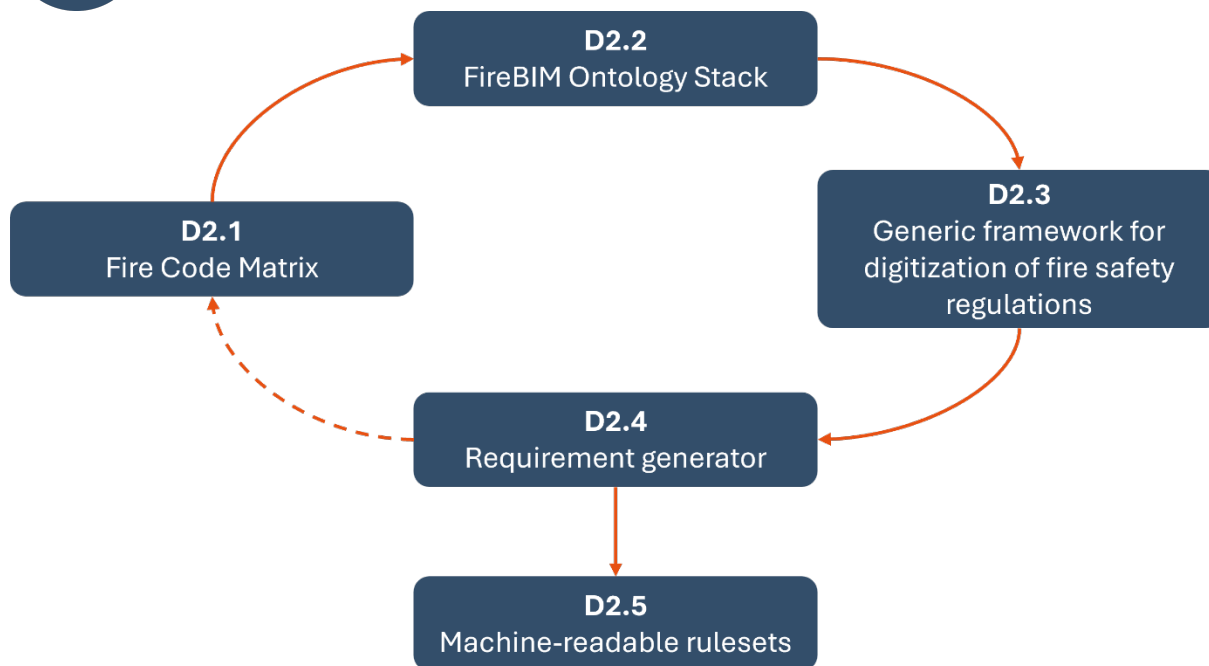


Figure 1 Placement of D2.3 relative to other deliverables in Work Package 2

1.4. Positioning within FireBIM

The machine-readable rulesets developed in D2.5 provide a bridge between the regulatory knowledge developed in WP2 and its application to digital building information in subsequent FireBIM work. The rulesets can be used as inputs for automated validation and compliance checking, for example by evaluating building information represented using the FireBIM terminology against SHACL-based constraints. They can therefore support the development of the FireBIM reference architecture and demonstrators in WP3 and WP5.

The deliverable also demonstrates that the digitization approach is not limited to a single rule representation or a single national regulatory framework. By providing rules in different computational representations and for multiple countries, while still using similar technologies (such as the FBO/FRO/FRQ ontologies) and frameworks (as presented in D2.3), D2.5 supports the broader objective of FireBIM to make fire safety regulations interoperable, machine-readable, and reusable across different digital building workflows, while still fulfilling the specific national needs.



2. Contents of the deliverable

The D2.5 folder contains a collection of machine-readable fire safety rules and supporting examples produced during the FireBIM project. The contents are organised according to the different types of digital representations and rule implementations.

The fact that these representations and rule implementations (and some of their intermediate representations) are slightly different across the countries stems from the fact that the original representation of the regulations are different, as well as practical applications of these regulations. Deliverable 2.3 analyzes these differences in more detail.

There are two origins of the regulations, that end with slightly different representations. Some countries took the regulatory documents directly, extracted individual regulatory statements from these documents, and converted them to SHACL. Some other countries made intermediate flowchart representations of the regulations (see Figure 2), typically grouping individual statements in a sequence of checks that represents a specific theme, such as ‘Checking the fire compartments’. This mirrored the practical application of these regulations.

Both the direct conversions and the flowchart-to-SHACL conversions result in SHACL shapes using the same ontologies, and therefore they can use similar downstream software applications. These sequential rule checks could even be created based on the direct conversions, by afterwards creating the sequences in the regulation graph. Listing 1 shows three example statements that could be directly converted from a regulatory document, and Listing 2 shows how these statements could later be represented as a sequence.

```
:Statement1
  a fro:Statement ;
  rdfs:label "Maximum fire compartment size base rule"@en .

:Statement2
  a fro:Statement ;
  rdfs:label "Correction factor for sprinkler installation"@en .

:Statement3
  a fro:Statement ;
  rdfs:label "Assessment of open connections and recesses"@en .
```

Listing 1: Example statements directly converted from the regulatory document

```
:FireCompartmentSizeCheck
  a fro:CheckSequence ;
  rdfs:label "Fire Compartment Size Check Sequence"@en ;
  fro:hasOrderedStatements [
    a rdf:Seq ;
    rdf:_1 :Statement1 ;
    rdf:_2 :Statement2 ;
    rdf:_3 :Statement3
  ] .
```

Listing 2: Example theme-based sequence of statements

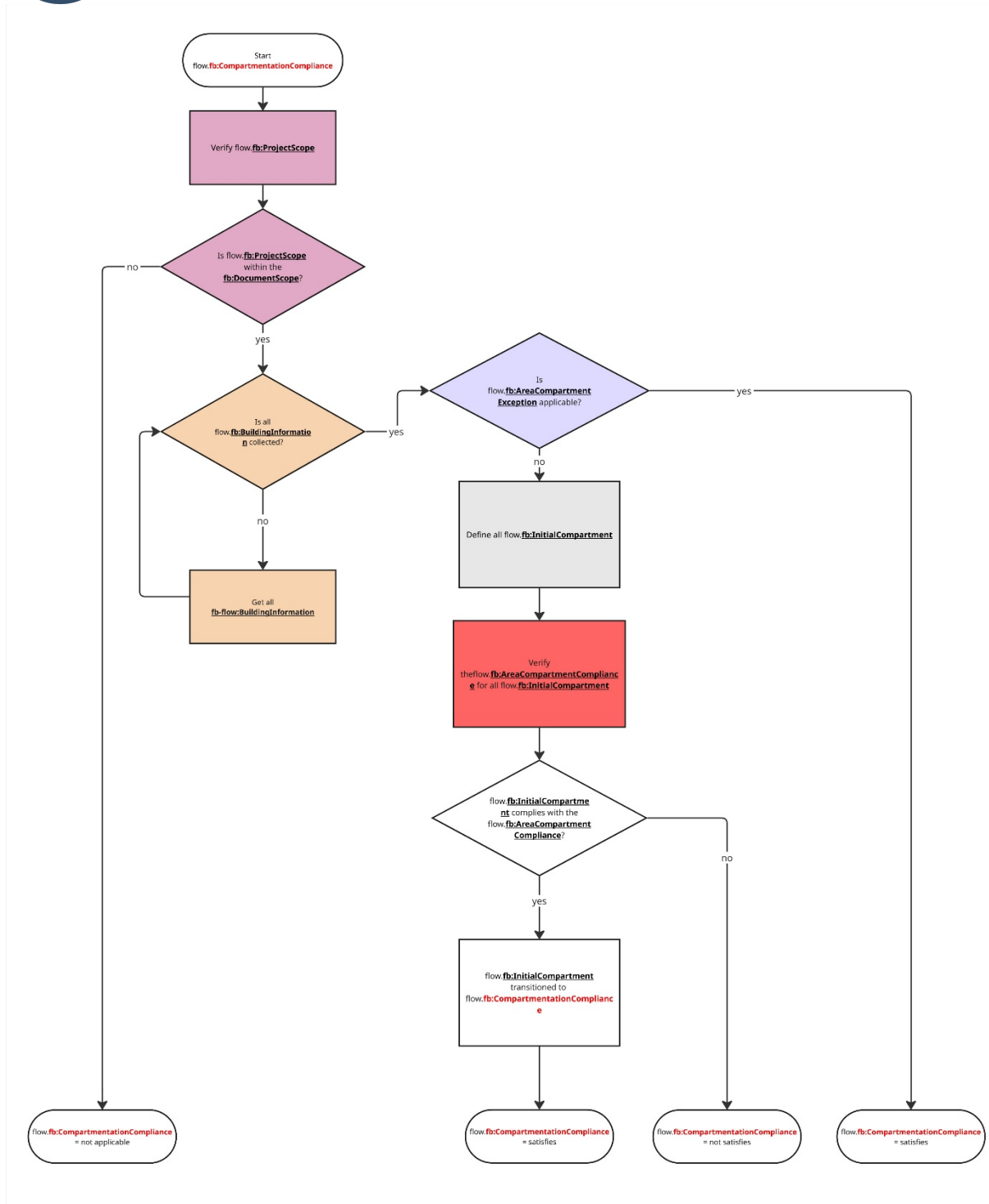


Figure 2 A Portuguese flowchart containing a sequence of checks to validate the compliance of compartments

2.1. SHACL shapes

The SHACL shapes folder contains SHACL-based representations of fire safety requirements. These include rules for the Netherlands, Denmark, Lithuania, and Portugal. The examples cover different types of requirements, including spatial relationships, compartment sizes, areas, properties, and exceptions. The folder also contains examples of different approaches for deriving



SHACL shapes from regulatory representations, including flowcharts, Markdown, first-order logic, and RASE-based representations.

2.2. Exchange information requirements

The `ExchangeInformationRequirements` folder contains rules expressed as IDS (Information Delivery Specification) files. These specifications define information requirements that can be checked against BIM models. Examples are provided for Belgium and the Netherlands, including an example of converting IDS requirements into SHACL.

2.3. Regulation graphs

The `Regulation` graphs folder contains RDF representations of regulatory documents. These graphs provide a machine-readable representation of regulatory knowledge and its structure, and demonstrate how regulatory information can be represented using the FireBIM ontology stack.

2.4. Other rule representations

The `OtherRules` folder contains additional examples of machine-readable fire safety rules that do not fit directly into the SHACL or IDS categories. These include geometric rules implemented in Python, multi-interpretable SHACL rules, and examples of rules represented in RASE. The folder also contains a complete example of Dutch compartmentation rules together with the corresponding building data and validation results.

Together, these folders provide a collection of examples showing how fire safety requirements can be transformed into different machine-readable representations and subsequently applied to digital building information.