European Environment Agency

INSPIRE compliance of Environmental Noise Directive (END) datasets

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Terms and acronyms

Terms

Conceptual data model	High-level representation of the entities that a system stores and processes, with a focus on the semantics of the entities and the relationships of these entities (e.g. is-a, has-a relationship). The conceptual model also defines key properties of the entities.
Logical data model	Detailed representation of data structures and their relationships. It specifies the details of the conceptual data model entities e.g., the data type of a property.
Physical schema	Computer-readable data description that defines the data structure and the data types. Examples of physical schemas are an XML application schema (xsd), a JSON schema or a GeoPackage template.
GeoPackage[1]	GeoPackage is an open standard file format for storing geospatial data, widely used in Geographic Information Systems (GIS). It is based on SQLite database technology. GeoPackage tables allow the storage of various types of geographic data, including vector data, raster data, and attribute data.
GeoJSON[2]	GeoJSON is an open standard format designed for representing simple geographical features, along with their non-spatial attributes, based on the JSON format.

[1] https://www.geopackage.org/
[2] https://geojson.org/

Acronyms

END	Environmental Noise Directive (2002/49/EC)
GML	Geography Markup Language
INSPIRE	Infrastructure for spatial information in Europe
INSPIRE IR	INSPIRE Implementing Rules
INSPIRE TG	INSPIRE Technical Guidelines
INSPIRE MIG	INSPIRE Maintenance and Implementation Group
UML	Unified Modelling Language
XML	Extensible Markup Language
GIS	Geographic Information Systems

1 Introduction

Spatial data required under the European Noise Directive (END) falls within the scope of INSPIRE spatial data themes as priority datasets related to environmental reporting[3]. To reduce administrative burden, improve data consistency, and streamline regulations, the END reporting model has been designed to be INSPIRE-compliant, allowing END datasets to satisfy both, END reporting and INSPIRE requirements.

The END datasets represent an example of INSPIRE data in GeoPackage alternative encoding, with the END reporting model listed[4] as an implementation of the INSPIRE Good Practice for GeoPackage encoding in the dedicated INSPIRE GitHub repository[5].

This document describes how compliance with the requirements of the INSPIRE Directive has been demonstrated, documented and made publicly available for END reporting datasets.

Additional guidance on demonstrating INSPIRE compliance for reporting datasets in alternative encodings and on documenting this compliance in INSPIRE metadata is available in the *INSPIRE-datasets-compliance-v1.0*[6] document.

Evidence of INSPIRE compliance is particularly valuable for END data providers, who can "inherit" this reference evidence for the purposes of INSPIRE compliance declarations of their END reporting datasets. In particular, in the INSPIRE metadata they can reference relevant evidence of compliance published in dedicated Noise repository[7] on the Eionet Portal. This minimises the effort that would otherwise be needed to apply the full INSPIRE compliance process to datasets in alternative encodings reported under INSPIRE.

Document structure

- **Section 2** provides a brief overview of the INSPIRE Directive and its ongoing modernisation and simplification efforts.
- **Section 3** presents a step-by-step procedure for demonstrating the INSPIRE compliance of END datasets.
- **Section 4** outlines a proposal for documenting the compliance of END datasets in alternative encodings within the associated INSPIRE metadata.
- **Section 5** presents lessons learnt.

[3] https://inspire.ec.europa.eu/metadata-codelist/PriorityDataset
[4] https://github.com/INSPIRE-MIF/gp-geopackage-encodings/blob/main/examples/overview.md
[5] https://github.com/INSPIRE-MIF/gp-geopackage-encodings
[6] https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/inspire-datasets-compliance-v1-0.pdf/view
[7] https://www.eionet.europa.eu/reportnet/docs/noise

2 About INSPIRE

The INSPIRE Directive[8] lays down general rules for the establishment of a European Spatial Data Infrastructure (SDI) to support Community environmental policies and policies or activities that may have an impact on the environment. The overall objective is to facilitate the exchange of and access to interoperable spatial data across Europe in order to support better informed decision-making at all levels of government.

Datasets in the scope of INSPIRE are those owned by public sector organizations, government bodies and third parties that manage the data on behalf of governmental entities and that come under one or more of the 34 INSPIRE data themes[9].

The Directive imposes obligations on EU Member States to establish spatial data infrastructures following legally binding Implementing Rules[10] and non-legally binding Technical Guidelines[11] which specify the essential requirements for the interoperability and the harmonisation of spatial data sets and spatial data services, as well as for the associated documentation (metadata).

Because the geospatial information contained in environmental reporting overlaps with the INSPIRE scope, achieving INSPIRE compliance for these datasets is highly desirable. It helps to reduce administrative burden on Member States, streamline regulatory provisions, and improve data consistency by enabling datasets to meet both reporting and INSPIRE requirements.

For certain environmental reporting, including END, INSPIRE compliance is mandatory under Regulation (EU) 2019/1010 on the alignment of reporting obligations in the field of legislation related to the environment[12].

INSPIRE Good Practices

A process of modernisation and simplification of INSPIRE requirements has been going on for several years under the governance and approval of the European Commission expert group for INSPIRE Maintenance and Implementation (INSPIREMIG).. As a result of this process, the original set of Technical Guidelines is now complemented by **INSPIRE Good Practice documents**[13] aimed at simplifying implementation, addressing the needs of specific communities, and leveraging emerging technologies and standards.

In particular, to address challenges associated with the INSPIRE default encoding (GML version 3.3), Good Practices have been developed to enable the use of alternative encodings while maintaining compliance.

END reporting datasets follow the Good Practice on the "**GeoPackage encoding of INSPIRE datasets**"[14] which defines how INSPIRE-compliant data can be provided in GeoPackage format.

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[8] https://eur-lex.europa.eu/eli/dir/2007/2/oj
[9] https://knowledge-base.inspire.ec.europa.eu/tools/inspire-themes_en
[10] https://knowledge-base.inspire.ec.europa.eu/legislation/implementing-rules_en
[11] https://knowledge-base.inspire.ec.europa.eu/legislation/technical-guidelines_en
[12] http://data.europa.eu/eli/reg/2019/1010/oj
[13] https://knowledge-base.inspire.ec.europa.eu/evolution/good-practice-library_en
[14] https://github.com/INSPIRE-MIF/gp-geopackage-encodings/blob/main/spec/GeoPackage_Good_Practice_initiation_fiche.md

2.1 INSPIRE compliance of datasets

INSPIRE implementation is guided by two frameworks:

- **Implementing Rules (IR)**, which are legally binding abstract requirements for what Member States must implement, and
- **Technical Guidelines (TG)**, which provide non-binding implementation specifications.

The INSPIRE Reference Validator[15], the reference tool for INSPIRE conformity assessment, verifies compliance of datasets in GML format with the Data Specifications – Technical Guidelines.
Therefore,

- spatial datasets are 'INSPIRE-compliant' if they meet the requirements contained in the *INSPIRE Implementing Rules as regards interoperability of spatial datasets and services*[16]
- to pass the reference conformity assessment, they shall comply with requirements contained in the *Data Specification – Technical Guideline* of the relevant INSPIRE data theme.

COMPLIANCE FOR DATASETS IN ALTERNATIVE ENCODINGS

INSPIRE does not provide a reference tool for directly validating data delivered in alternative encodings. Therefore, a compliance assessment of such datasets requires transforming the data (or a representative subset) into GML format, which can then be validated using the reference tool i.e., the INSPIRE Reference Validator.

[15] https://inspire.ec.europa.eu/validator/home/index.html
[16] https://eur-lex.europa.eu/eli/reg/2010/1089

3 INSPIRE Conformance assessment of the END spatial datasets

A five-step methodology for demonstrating the INSPIRE compliance of datasets provided in alternative encodings is described in the document **INSPIRE-datasets-compliance-v1.0**[17].

This methodology was applied to assess the compliance of the END spatial datasets and is briefly summarised below. Further details on the methodology are available in the referenced document.

3.1 Five-step methodology to demonstrate compliance of datasets in alternative encodings

The first step of the methodology requires a comprehensive documentation of the dataset, covering its data model, encoding rules, physical schema, and mapping to the standard GML model. The data in alternative encoding is then converted into INSPIRE-compliant GML and validated using the INSPIRE Reference Validator. Following validation, INSPIRE-compliant metadata is generated that also references the physical schema and the transformation process. Finally, all compliance evidence is made available in a public repository.

The methodology is composed of the following five steps:

1) **Produce Documentation.**

   The following documents must be produced:

   - **Logical Data Model**: A document describing the alternative encoding data model, its benefits, and its limitations compared to corresponding GML model.
   - **Encoding Rules**: Documentation of the rules used to transform the INSPIRE data model into the alternative data model.
   - **Physical Schema**: A computer-readable file (e.g., a JSON schema or a GeoPackage template) defining the data structure and the data types.
   - **Mapping Table**: A cross-reference between properties in the alternative encoding and the default GML.

2) **Transform to GML**

   Transform the dataset in alternative encoding into an INSPIRE-compliant GML, for example by using data transformation tools such as FME[18] or hale studio[19].

3) **Validate with INSPIRE Reference Validator**

   Successfully validate the generated GML file using the INSPIRE Validator, specifically selecting the test relevant to the dataset's INSPIRE data theme, and download the validation report.

4) **Create Metadata**

   Create INSPIRE dataset metadata that explicitly references the physical schema and the executable transformation project used to prove compliance.

[17] https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/inspire-datasets-compliance-v1-0.pdf/view
[18] https://fme.safe.com/
[19] https://wetransform.to/halestudio/

5) **Publish compliance evidence in a public repository**
Store the dataset, documentation, transformation project, and validation reports in a public repository.

The five steps are illustrated in Figure 1 below.

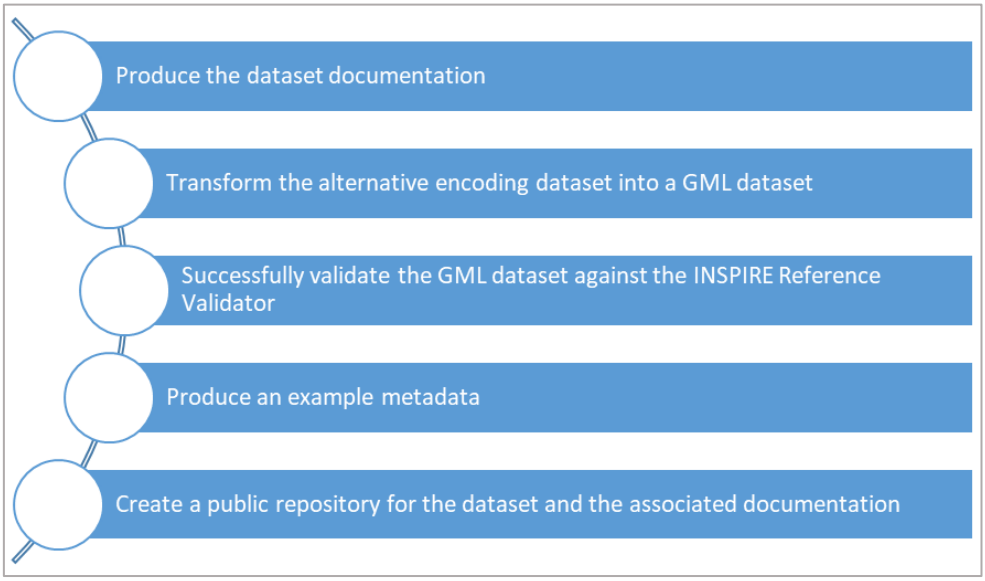

Figure 1: Steps to demonstrate compliance of datasets in alternative encodings

To support implementation, the table below provides a reference **compliance checklist** outlining the required evidence for each of the five steps.

Compliance step	Required evidence
Step 1 Produce Documentation	Logical Data Model (UML)
	Document describing the logical data model, its benefits and limitations
	Encoding Rules
	Physical Schema for alternative encoding
	Mapping Table
Step 2 Transform to GML	Alternative encoding dataset
	Data transformation executable process
	INSPIRE GML dataset
Step 3 Validate with INSPIRE Reference Validator	Successful validation report from the INSPIRE Validator
Step 4 Create Metadata	INSPIRE Metadata Example
Step 5 Publish compliance evidence in a public repository	Public repository to store INSPIRE validation evidence

3.2 Workflow for END spatial datasets conformance assessment

The five-step methodology described above has been implemented for the END use case following the workflow illustrated in Figure 2 below. The figure also shows the tools used at each step to support the compliance assessment, however other tools with equivalent functionality could be used.

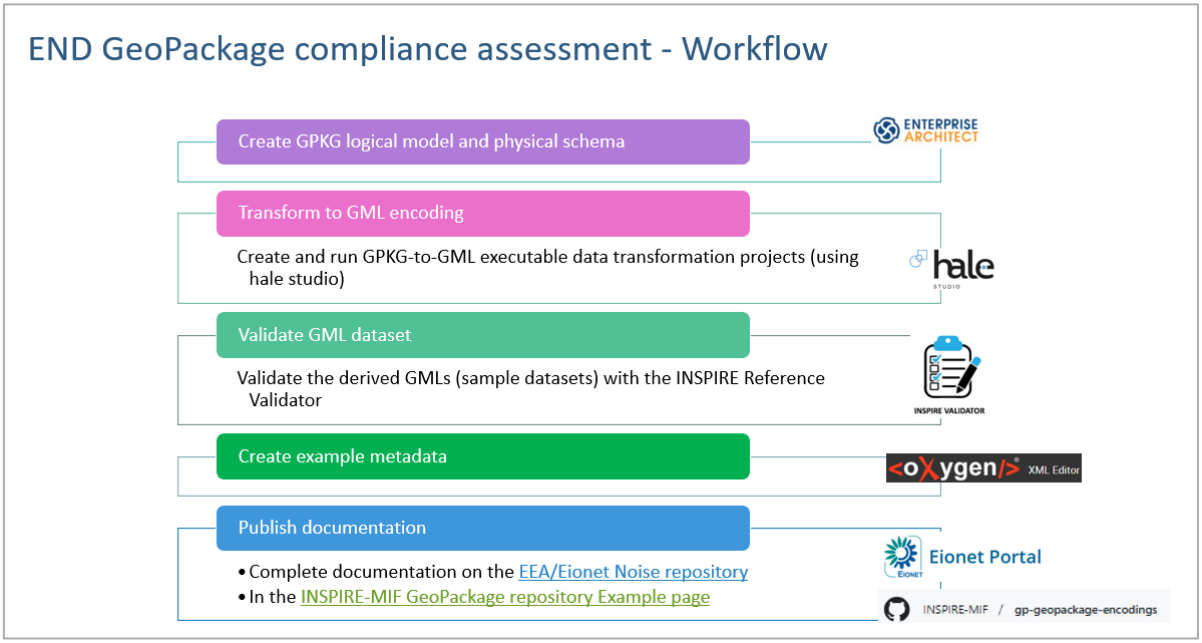

Figure 2 : END compliance assessment workflow

Evidence of END datasets compliance with INSPIRE is published in a dedicated Noise repository[20] on the Eionet Portal (see Figure 3).

This evidence can be referenced by INSPIRE data providers that use the END GeoPackage templates for their datasets, thus reducing the burden of applying the full INSPIRE compliance demonstration process to each END dataset reported under the INSPIRE obligation.

[20] https://www.eionet.europa.eu/reportnet/docs/noise

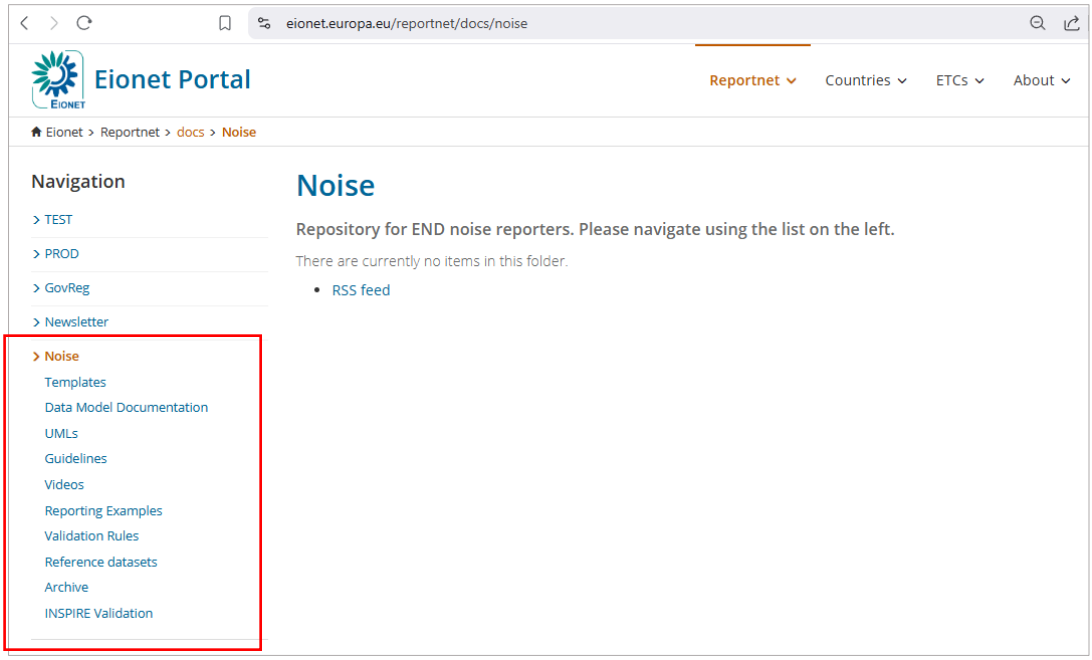

Figure 3: Noise repository on the Eionet Portal

A common "Noise" page in the Eionet portal provides the evidence serving as general documentation applicable to all the END data flows, namely:

- **The END conceptual data model**[21], presenting the agreed content for the END reporting data flows and the relation to INSPIRE spatial data themes
- **The GeoPackage encoding rules for the END reporting datasets**[22]

Dataflow-specific folders provide evidence only applicable to a specific dataflow:

- **The dataflow logical data model (UML)**[23] (Data Model Documentation, UMLs),
- **Physical schema (GeoPackage template)** (Templates),
- **One-off documentation on INSPIRE validation** (INSPIRE Validation), specifically:
  - The source sample data in GeoPackage (GPKG) format
  - The hale studio GPKG-to-GML data transformation project
  - The GML file obtained by executing the GPKG-to-GML data transformation. In most cases, this GML file is a subset of the original GML file obtained, because the online INSPIRE Validator can only handle file sizes up to 50 MB.
  - INSPIRE Reference Validator report of the successful validation of the GML
  - GPKG to GML mapping table.

The table below lists the END dataflows along with their corresponding INSPIRE data themes and provides direct links to the associated INSPIRE compliance evidence in the Eionet portal.

[21] https://www.eionet.europa.eu/reportnet/docs/noise/data-model-documentation
[22] https://www.eionet.europa.eu/reportnet/docs/noise/guidelines/geopackage-encoding-rule-end.pdf/view
[23] https://www.eionet.europa.eu/reportnet/docs/noise/umls

Dataflow / Dataset	INSPIRE Data Theme	Link to INSPIRE compliance evidence in the Eionet portal
DF1_5 Major Airport	TN (TN-a schema)	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/noise-sources-df1_5/df1_5-majorairport.zip/view
DF1_5 Agglomeration	AM	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/noise-sources-df1_5/df1_5-agglomeration.zip/view
DF1_5 MajorRailway	TN (TN-ra schema)	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/noise-sources-df1_5/df1_5_major_railway.zip/view
DF1_5 Major Road	TN (TN-ro schema)	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/noise-sources-df1_5/df1_5_major_road.zip/view
DF4_8 Strategic Noise Map – Noise Contours	HH	
(Major Airport – Noise Contours)	HH	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/strategic-noise-maps-df4_8-2013-noise-contours/df4_8_major_airports_noise_contours.zip/view
(Major Railway – Noise Contours)	HH	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/strategic-noise-maps-df4_8-2013-noise-contours/df4_8_major_railways_noise_contours.zip/view
DF7_10 Noise Action Plan – Coverage Area	AM	
(Major Airport – Coverage Area)	AM	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/coverage-areas-df7_10/df7_10_nap_coverage_area_airport.zip/view
(Major Railway – Coverage Area)	AM	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/coverage-areas-df7_10/df7_10_nap_coverage_area_major_railway.zip/view
DF7_10 Quiet Area	AM	
(Quiet Area - with documentation)	AM	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/quiet-areas-df7_10/df7_10_quiet_area_with_documentation.zip/view
(Quiet Area - without documentation)	AM	https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/quiet-areas-df7_10/df7_10_quiet_area_without_documentation.zip/view

The INSPIRE spatial data themes relevant for the END datasets are:

- AM: INSPIRE Area management/restriction/regulation zones and reporting units[24]
- HH: INSPIRE Human health and safety, Environmental Health Determinant Measure - Noise[25]
- TN (TN-a schema): INSPIRE Transport networks, Air Transport Network[26]
- TN (TN-ra schema): INSPIRE Transport networks, Railway Transport Network[27]
- TN (TN-ro schema): INSPIRE Transport networks, Road Transport Network[28].

[24] https://inspire.ec.europa.eu/theme/am
[25] https://inspire.ec.europa.eu/theme/hh
[26] https://inspire.ec.europa.eu/theme/tn
[27] https://inspire.ec.europa.eu/theme/tn
[28] https://inspire.ec.europa.eu/theme/tn

4 How to document INSPIRE compliance of END datasets in the INSPIRE metadata

In the context of the END reporting compliance assessment, a proposal has been developed for documenting compliance of datasets in GeoPackage encoding. This proposal, including a corresponding INSPIRE metadata example for the END DF1_5 Agglomeration dataset, has been shared[29] in the INSPIRE MIF GeoPackage repository and presented to the INSPIRE MIG without objection.

The proposal includes guidelines on providing the following metadata information:

1) the **dataset distribution format** - i.e., the GeoPackage dataset physical schema (GeoPackage Template) and the GML-to-GPKG encoding rules
2) the **procedure used to evaluate conformity** (i.e., data transformation to the default GML encoding)
3) the **conformance declarations** to the INSPIRE Implementing Rules and to the Noise Implementing decision.

The excerpts below are from the INSPIRE metadata example for the END DF1_5 Agglomeration dataset[30] and illustrate how above information can be encoded.

Please note that explanatory comments appear in green colour, and that the dots ("…") indicate that some elements have been omitted for better readability.

Distribution format (GeoPackage file format)

The <*gmd:distributionFormat*> metadata element is used to provide links to:

- the dataset physical schema (GPKG template)
- the encoding rules.

```
 <gmd:distributionFormat>
  <!-- link to the dataflow-specific GeoPackage template in the Eionet Noise repository -->
<gmd:name>
<gmx:Anchor
xlink:href="https://www.eionet.europa.eu/reportnet/docs/noise/templates/df1_5/agglomerationsource
.gpkg/@@download/file/AgglomerationSource.gpkg">END GeoPackage Template DF1_5
AgglomerationSource</gmx:Anchor>
  <!--  link to GeoPackage Encoding Rule for END Reporting Data specification document -->
  <gmd:specification>
…
```

[29] https://github.com/INSPIRE-MIF/gp-geopackage-encodings/issues/25#issuecomment-1580380410

[30] https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/inspire-metadata/metadata-example-end.zip/view

```
 <gmx:Anchor xlink:href="https://www.eionet.europa.eu/reportnet/docs/noise/guidelines/GeoPackage-encoding-rule-end.pdf">GeoPackage Encoding Rule for Environmental Noise Directive Reporting Data</gmx:Anchor>
…
 </gmd:distributionFormat>
```

Conformity: evaluation procedure and conformance declarations

Under the <gmd:report>, the <*gmd:evaluationprocedure*> is used to link a documentation page giving access to evaluation procedure and validation evidence.

The <gmd:result> element within <gmd:report> is used to indicate the dataset's degree of conformity, both with the INSPIRE Implementing Rules and with the Noise Implementing Decision, by including two consecutive <gmd:report> elements.

```
<gmd:report>
<gmd:DQ_DomainConsistency>
the link to the Eionet page giving access to evaluation procedure and validation evidence
 <gmd:evaluationProcedure>

 <gmx:Anchor xlink:href="https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation/noise-sources-df1_5">INSPIRE Validation evidence for DF1_5 Agglomeration Source</gmx:Anchor>
 … </gmd:evaluationProcedure>

<!-- Conformity to the INSPIRE Implementing Rule (Commission Regulation (EU) No 1089/2010 ) -->
  <gmd:result>
… <gmd:specification>
…<gmx:Anchor
      xlink:href="http://data.europa.eu/eli/reg/2010/1089">Commission Regulation (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services
</gmx:Anchor>
… <gmd:pass>
  <gco:Boolean>true</gco:Boolean>
   </gmd:pass>
    </gmd:result>
…</gmd:report>

<!-- Conformity to Noise Implementing Decision(Commission Implementing Decision (EU) 2021/1967) -->
<gmd:report>
<gmd:DQ_DomainConsistency>
 <gmd:evaluationProcedure>
 <!-- link to the document describing the validation rules against END requirements. -->
 … <gmx:Anchor xlink:href="https://www.eionet.europa.eu/reportnet/docs/noise/validation-rules/document_qcs_df1_5.xlsx/">Validation Rules for DF1_5</gmx:Anchor>
…  <gmd:result>
   <gmd:specification>
```

```
  <gmx:Anchor xlink:href="http://data.europa.eu/eli/dec_impl/2021/1967/oj">Commission Implementing Decision (EU) 2021/1967 of 11 November 2021 setting up a mandatory data repository and a mandatory digital information exchange mechanism in accordance with Directive 2002/49/EC of the European Parliament and of the Council (Text with EEA relevance)</gmx:Anchor>
  <gmd:pass>
    <gco:Boolean>true</gco:Boolean>
   </gmd:pass>
    </gmd:report>
```

5 Lessons learnt

1) INSPIRE compliance by design

Demonstrating INSPIRE compliance for the END GeoPackage datasets proved to be quite straightforward, largely because INSPIRE compliance requirements had been integrated into the data modelling process from the outset.

Specifically, the END data models streamline and extend the INSPIRE data models by applying a common set of transformation[31] and encoding rules[32] explicitly designed to simplify INSPIRE data while preserving interoperability and ensuring compliance with the INSPIRE Directive.

This approach enabled compliance to be built in from the design phase, embedding it directly into the system architecture rather than relying on retrospective adjustments.

Reusing INSPIRE common concepts, features, and data types across different reporting data flows was another key success factor. Establishing shared building blocks - derived from simplified INSPIRE models - not only improved consistency and interoperability but also reduced duplication of effort. This approach made data modelling more efficient and enabled the reuse of validation and quality control procedures, simplifying overall implementation.

The approach also relied on the *Good Practice for GeoPackage Encoding of INSPIRE Datasets* for selecting the GeoPackage file format as the best encoding for END data and to maintain full INSPIRE compliance.

2) Reference END - INSPIRE compliance evidence

Making compliance evidence available in a public repository provides clear benefits for END data providers who use the END GeoPackage templates and adhere to the established guidelines. Once the END GeoPackage datasets have been successfully reported to the European Environment Agency Reportnet 3[33] platform (i.e., they have passed the quality controls to ensure compliance with the END specification) data providers can "inherit" the related INSPIRE compliance evidence by referencing the corresponding artefacts in the Eionet Noise repository within their INSPIRE dataset metadata.

This approach substantially reduces the effort required to apply the full INSPIRE compliance process to END datasets that also need to be provided and accessible according to the INSPIRE Directive.

3) Validation of the END reporting data flows including some INSPIRE elements

The reporting data flows include a set of validation rules (data quality controls) to ensure required data quality. The main scope of validation in the END reporting data flows is ensuring submitted data fulfil thematic END requirements, including data consistency and encodings. The validation rules include also a basic set of quality controls for some INSPIRE elements, such as use of code lists and code list values, coordinate reference systems, uniqueness of identifiers and identifier data types. This validation ensures that INSPIRE elements are included in the END datasets, which contributes to complete and successful Noise - INSPIRE compliance evidence.

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[31] https://github.com/INSPIRE-MIF/model-transformation-rules

[32] https://github.com/INSPIRE-MIF/gp-geopackage-encodings/blob/main/spec/GeoPackage_Good_Practice_initiation_fiche.md

[33] https://reportnet.europa.eu/