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RESEARCH ARTICLE

NFDI-RFC - A Community Driven Standardization Service for Research Data Management

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Date Submitted:
2026-05-22

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Keywords:
Research Data Management, FAIR, Standardization, NFDI, RFC, Community Review, Interoperability, Best Practices NFDI-RFC standardization service, Quality Assurance

Data availability:
Data can be found here: All draft materials, templates, and discussions are publicly available via the designated GitLab instance git.rwth-aachen.de/nfdi-rfc. Published NFDI-RFC artefacts (HTML/PDF/metadata) will be accessible through the NFDI-RFC catalogue (planned).

Software availability:

Corresponding Author:

Abstract.
Standardization is pivotal for making research data FAIR, this means findable, accessible, interoperable, and reusable - across disciplines and infrastructures. Inspired by the Internet Engineering Task Force's (IETF) Request for Comments (RFC) model, we introduce NFDI-RFC, a community-driven service for the specification, discussion, and dissemination of research data management (RDM) practices, protocols, and guidelines within the National Research Data Infrastructure (NFDI) and beyond. The service provides a lightweight, transparent, and iterative pathway from early ideas to broadly adopted practices and, where appropriate, onward to formal standardization (e.g., DIN/ISO). We present (i) the scope and design principles of the NFDI-RFC service, (ii) the document classes and maturity stages, (iii) a governance and workflow model that balances editorial quality with open community review, (iv) an implementation leveraging GitLab for drafting, discussion, and traceability, and (v) an initial set of drafts, including style and authoring guides and an errata policy. We conclude with the next steps toward broader adoption across NFDI sections and consortia.

1 Introduction

The sustainable reuse of research data hinges on norms and interfaces that are both technically sound and socially adopted. While formal standards bodies (e.g., DIN/ISO) ensure rigor and longevity, communities often require faster, open, and iterative mechanisms to articulate emerging practices, test specifications, and converge on interoperable solutions. The NFDI-RFC service addresses this need by adapting the proven RFC paradigm to the context of RDM.

NFDI4ING, the consortium for engineering within the NFDI, has adopted and is actively developing the NFDI-RFC concept as a tool to support community-driven discourse and standardization in research data management (RDM) [1], p. 94-95. NFDI-RFC is formalized text document that specifies and explains a technical issue.

The RFC concept [2], originally developed by the IETF as a mechanism for open, community-driven development of standards [3], is being adapted within the NFDI to foster transparency, collaboration, and standardization in research data management (RDM) [4], [5]. The presented work explores the adaptation of NFDI-RFCs in the NFDI context, outlining how they serve as a structured yet flexible format for documenting and discussing evolving best practices, poli-

cies, and technical specifications. By encouraging open peer review and iterative improvement, NFDI-RFCs help unify diverse RDM approaches across disciplines, enhance interoperability, and ensure that data stewardship principles are both FAIR (Findable, Accessible, Interoperable, Reusable) and communityaligned. The NFDI-RFC process within NFDI not only facilitates broader engagement among stakeholders but also provides a persistent, citable format for the ongoing evolution of research data infrastructures in Germany and beyond.

Our goal to contribution to NFDI4ING's objectives [6]:

a) Building a coordinated, networked NFDI-RFC standardization service to develop sustainable interoperable RDM

b) Creation of a reliable and sustainable service that covers overarching and subject-specific needs of RDM

c) Establishment of a process and procedure accepted in scientific disciplines for the standardized handling of research data

Already reached Key milestones include finalizing the concept and structure, publishing a style guide, and piloting the first NFDI-RFCs (A). The process aims to contribute to NFDI's broader goals by establishing a coordinated, sustainable, and widely accepted standardization service for RDM across disciplines.

NFDI-RFCs undergo formal stages:

- Proposed standard: Stable, well understood, and generally considered useful
- Draft standard: Stable enough to implement implementations of the standard in RDM applications
- NFDI standard: Technically mature, widely implemented and of great benefit to RDM in science

With a close connection to the research community and the NFDI sections the NFDI-RFC concept is assessed and refined by regular community, NFDI sections and NFDI office feedback loops, content reviews, and technical assessments. Key performance metrics include the number of NFDI-RFCs, contributors, and the quality of outputs.

Founded in the context of NFDI4ING (Engineering), the vision of NFDI-RFC is intentionally broader: a cross-disciplinary, NFDI wide service that lowers barriers to proposing, reviewing, and adopting RDM specifications ranging from APIs and metadata profiles to workflows and policies, while remaining compatible with subsequent formal standardization.

2 Background and Rationale

The IETF RFC series has played a central role in shaping the modern Internet by enabling open, transparent, and iterative discussion of technical specifications. Through openly accessible drafts, expert review, and sustained community engagement, the RFC model has demonstrated that robust and interoperable specifications can be developed and maintained at global

scale. Core principles of the RFC process—such as structured document types, precise normative language, public feedback, and continuous refinement—have proven effective in balancing technical rigor with adaptability.

These principles offer a compelling foundation for addressing challenges in RDM. While RDM requirements vary significantly across domains, for example between experimental and computational sciences, they nonetheless share a set of foundational concerns, including the use of metadata, persistent identifiers, versioning strategies, and provenance information. Translating the RFC approach into the RDM context enables researchers and infrastructure providers to formalize their expertise in documents that are both technically precise and openly discussed, while remaining responsive to evolving scientific and infrastructural needs.

A key advantage of an RFC-inspired process is its low threshold for participation and its emphasis on transparency and iteration. Communities can converge on solutions that are "good enough for today" without foreclosing future improvements, thereby avoiding paralysis in the face of complexity or incomplete consensus. Over time, this process fosters shared understanding, incremental improvement, and collective ownership of emerging practices.

Furthermore, a publicly accessible corpus of well-structured documents—encompassing, for example, Best Current Practices and Informational notes—can significantly accelerate learning, interoperability, and reuse across projects and domains. Such a corpus serves not only as documentation but also as an evolving knowledge base that captures lessons learned and supports onboarding of new communities.

Importantly, a community-driven RFC process for RDM is not intended to replace formal standardization efforts. Instead, it complements existing standards organizations by providing a pipeline of reviewed, tested, and community-endorsed specifications that can inform or feed into subsequent consideration by bodies such as DIN or ISO. In this way, the RFC approach bridges the gap between grassroots practice and formal standardization within the research data ecosystem.

3 Scope and Design Principles

This section defines the thematic scope and guiding principles of the NFDI-RFC framework. It establishes what kinds of research data management topics are in scope, and clarifies the values and procedural assumptions that shape how NFDI-RFCs are proposed, reviewed, and evolved over time. Together, scope and design principles provide orientation for authors and reviewers alike, ensuring that contributions are both practically relevant and methodologically consistent. By delineating areas this section aims to balance inclusiveness with technical rigor of applicability across the research data lifecycle and articulating a small set of core principles: Openness, quality, iteration, reusability, and complementarity. The intent is to enable a diverse range of communities to contribute actionable guidance while fostering interoperability, reuse, and a clear pathway toward broader adoption and, where appropriate, formal standardization.

3.1 Scope

NFDI-RFCs focus on scpecification of research data management across the data lifecycle. The goal is to ensure that research data are comparable, interoperable, reusable, and sustainably managed across institutions, disciplines, and infrastructures, rather than handled in isolated, project-specific ways. Typical topics include:

- Service specifications (e.g., terminology or PID service APIs; features and compliance expectations).
- Metadata schemas and profiles (mandatory/optional fields; validation; controlled vocabularies).
- Workflows and processes (curation, annotation, preservation, archiving, access control).
- Data handling practices (compression, storage tiers, formats, packaging, checksums, reproducibility).
- Governance and policy guidance (roles, responsibilities, accountability; change management).

Both domain specific and cross domain contributions are welcome, with encouragement to articulate interfaces, mappings, and minimal common denominators that enable interoperability.

3.2 Design Principles

The NFDI-RFC framework is designed to be inclusive and accessible. Any interested authors may initiate a draft, regardless of their institutional or consortium affiliation, provided the topic relates to research data management. This openness recognizes that RDM practices emerge across a wide variety of research contexts and benefit from cross-disciplinary exchange. At the same time, the NFDI-RFC workflow ensures that drafts receive structured feedback. Editorial and expert reviews focus on clarity, technical plausibility, and community relevance and community adoption determines success. A lightweight intake review by the relevant NFDI section validates the document's scope and structure, while a technical review by an expert group ensures plausibility and clarity. Following publication as a draft, the broader community is invited to contribute comments, thereby facilitating collective refinement. Only after the comment period and subsequent revisions is a document accepted into the official NFDI-RFC series. The documents in the series can evolve across related topics. To clearly distinguish between different stages of development of the specification, version numbers are not assigned. Instead, new NFDI-RFC documents are created with a new number. Designed to feed into formal standardization where appropriate, e.g. NFDI-Standardization Workflow [7], DIN or ISO.

4 Document Classes and Maturity Stages

This chapter introduces the structured classification framework used for NFDI-RFCs, which distinguishes documents by both content class and maturity stage. The intent is to provide clarity on the role, scope, and expected stability of each document published in the series, while supporting transparency for authors, reviewers, and users alike. By defining complementary content classes from normative technical specifications to explanatory background material, the

NFDI-RFC series accommodates a wide range of contributions while maintaining clear expectations regarding applicability, authority, and long-term relevance. Together with the maturity stages described in section 4.2, these content classes form the foundation for consistent governance, evolution, and adoption of NFDI-RFCs within the NFDI ecosystem.

4.1 Content Classes

The concept defines several complementary document types (see table 1). Standards Track NFDI-RFCs describe normative technical specifications and interfaces that aim for broad applicability within the NFDI, such as API definitions for terminology services or structural requirements for metadata schemas. Best Current Practice documents outline workflows or procedures that have been validated through community use, while informational documents provide background context, problem analyses, or surveys. Experimental NFDI-RFCs offer a space for early stage concepts or prototypes, encouraging innovation without implying maturity. In addition, historic NFDI-RFCs document legacy formats and procedures that remain relevant for longterm data accessibility. A key principle of the series is that NFDI-RFCs are not versioned; any substantive revision requires the publication of a new document, while minor corrections can be accommodated through an errata mechanism.

Type	Description
Standards Track (ST)	Normative specifications intended for broad adoption (e.g., APIs, profiles).
Best Current Practice (BCP)	Community endorsed recommendations that capture current state of the art.
Informational (INFO)	Explanatory, survey, or problem statement documents (non normative).
Historic (HIST)	Context for deprecated/legacy formats or workflows with guidance on continued access.
Experimental (EXP)	Early stage proposals addressing recognized needs with partial implementations.

Table 1: Definition of complementary document types

4.2 Maturity Stages

This Section explains the maturity model used for NFDI-RFCs, describing the formal status of a document as it evolves over time (see table 2 on page 6).

Maturity stages indicate the level of review, stability, and community validation associated with a given RFC. Documents typically progress from an initial Draft, which is openly developed and discussed, to Accepted (Published) status after successful editorial review, expert evaluation, and a public comment phase. Once published, an NFDI-RFC is considered stable and citable. The model also supports evolution and continuity: older documents may be marked *Superseded* when replaced by newer NFDI-RFCs, with explicit links preserving the lineage of standards. Finally, particularly successful *Standards Track* NFDI-RFCs with proven adoption and technical robustness may be designated as *Candidates* for *Formal Standardization*, enabling their transfer into established NFDI standardization governance structure. Together, these stages ensure transparency, quality assurance, and long-term sustainability of the NFDI-RFC series.

5 Governance and Workflow

The NFDI-RFC workflow is designed to balance methodological rigor with openness and transparency (see table 1 on page 6). An NFDI-RFC is initiated by one or more authors, who draft the document using the standardized NFDI-RFC template to ensure structural consistency and clarity. The draft then undergoes a section intake, where the relevant NFDI section(s) perform a lightweight content review focused on scope alignment, structural completeness, and relevance to the series, explicitly without acting as a scientific accept-or-reject gate.

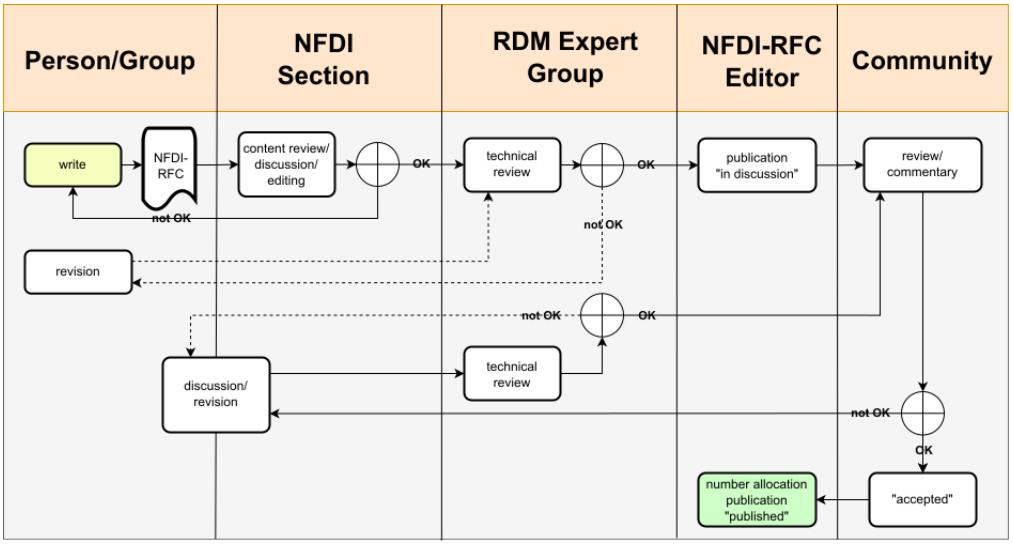

Figure 1: NFDI-RFC document worflow with with review stages and iterative rework loops

Following intake, the document is reviewed by a small RDM Expert Group, which assesses the technical plausibility, testability, and clarity of the proposal while avoiding disciplinary or organizational considerations. In parallel, editorial handling by the NFDI-RFC Editor(s) ensures adherence to formal requirements, style guidelines, and process rules, after which the document is published as a public draft. Particular attention is paid to reusability through a clear structure, persistent discoverability, and bilingual (English/German) support.

The draft is then opened for a time-boxed public community comment period, during which

Type	Description
Draft	Under active development; open for comments.
Accepted (Published)	Document has passed editorial and expert review and a public comment period; assigned an official NFDI-RFC number and class.
Superseded	A newer RFC supersedes prior content; supersession chain is declared.
Candidate for Formal Standardization	A published Standards Track NFDI-RFC with demonstrated adoption and measured technical fitness is considered mature for submission to established NFDI standardization governance structure.

Table 2: Definition of maturity stages

feedback is collected and addressed transparently using issues and merge requests. Once all substantive comments have been satisfactorily resolved, the Editor assigns an official NFDI-RFC number and content class and publishes the document as part of the series.

Long-term maintenance is supported through a clear distinction between errata, which allow minor, non-substantive corrections, and supersession, whereby significant revisions are handled by publishing a new RFC with explicit cross-references. Throughout the workflow, clearly defined roles—*authors, NFDI section, the RDM Expert Group, NFDI-RFC Editors, and the broader community*—ensure shared responsibility and accountability (see Appendix 12 on page 10).

6 Implementation Platform

To ensure accessibility and minimize administrative overhead, the NFDI-RFC process is implemented on an instance of GitLab [8], which offers established tools for version control, collaborative editing, issue tracking, and open commentary. GitLab also enables bilingual documentation. All initial NFDI-RFC drafts are available in both German and English to support usability within the NFDI. The platform hosts a glossary of key terms, an overview of the NFDI-RFC concept, the foundational drafts, and a template that guides authors in structuring new NFDI-RFCs. To prioritize specification over platform development, the service leverages GitLab and provides the following repositories containing: *Overview*, *Glossary*, *Drafts*, *Published*, and a *Template repository* for new NFDI-RFCs. As a future feature a searchable public catalogue of published NFDI-RFCs with metadata, HTML/PDF, and cross-references is planned.

7 Initial NFDI-RFC Draft Dokument Set (NFDI-RFC-1 to 5)

The foundational set of five draft NFDI-RFCs provides the institutional basis for the series. These documents define the publication process, the criteria for documenting RDM services, the style conventions for NFDI-RFCs, practical guidance for authors, and procedures for handling errata. Meanwhile, first pilot applications of the framework - such as a draft NFDI-RFC on machine-actionable Data Management Plans see chapter 8 - are underway and serve to test and refine the workflow in practice. The overview in table 3 on page 8 shows the drafts to establish the service's foundation. Each draft is open for community discussion and refinement prior to acceptance and assignment in the NFDI-RFC series.

8 Pilot Example: Developing a New NFDI-RFC for a standardized Machine-Actionable Data Management Plan (maDMP)

To demonstrate the practical application of a standardized, machine-actionable workflow for research data management, a pilot project was conducted to create a new NFDI-RFC (Recommended Practice or Standards Track document) using a Data Management Plan (DMP) as the foundational artifact. Achieving FAIRness for research data relies not only on best practices but also on machine-actionable metadata. By implementing DMPs as machine-actionable DMPs (maDMP), research communities can embed standards early in the research lifecycle. To support

Number	Name & Short Description
NFDI-RFC-1	**Technical Publication Service - roles, workflow, maturity, numbering, publication** One goal of the NFDI is to discuss, develop and disseminate technical specifications to advance the infrastructure for research data management. Technical publication is the process by which these results are disseminated to the general public.
NFDI-RFC-2	**Provisioning Guidelines for RDM Services - criteria and minimum requirements for RDM services referenced by RFCs** This document provides guidelines for the creation, quality control, documentation, and publication of NFDI-RFCs. It contains the organizational and technical framework for the NFDI-RFC release process. It also outlines the roles and responsibilities of the authors and supporting bodies involved in the process of creating and releasing NFDI-RFCs.
NFDI-RFC-3	**Style Guide - mandatory sections, optional sections, language conventions, normativity markers (MUST/SHOULD/MAY), glossary usage** This document describes the fundamental and unique style conventions and editorial policies currently in use for the NFDI-RFC Series. It captures the NFDI-RFC Editor's basic requirements and offers guidance regarding the style and structure of a NFDI-RFC. Additional guidance is captured on a Website that reflects the experimental nature of that guidance and prepares it for future inclusion in the NFDI-RFC Style Guide.
NFDI-RFC-4	**Author's Guide - step-by-step authoring, structure guidance, naming, submission, review, and community engagement** This document aims to support authors in writing an NFDI-RFC starting as a NFDI-RFC-draft. Creating an NFDI RFC is about meeting the needs and expectations of the community. By considering these factors, you can ensure that your content is important, relevant, valuable, and engaging for your audience. Writing an engaging ultimate NFDI-RFC requires a combination of skills, including research, organization, and clarity of text.
NFDI-RFC-5	**Errata Handling - scope of errata, submission, triage, approval, and publication without changing normative intent** This document describes the current process for handling the submission, verification, and posting of errata for the NFDI-RFC Series. The main concepts behind this process are: (1) distributing the responsibility for verification to the appropriate organization or person for each NFDI-RFC stream, and (2) using the NFDI-RFC Editor to execute the processing of erratum reports.

Table 3: Definition of maturity stages

this vision, the NFDI basic service *DMP4NFDI* is developing the *NFDI DMP Template Framework*, a unified standard for DMPs across the NFDI ecosystem. Built on the collaborative work of the cross-consortia *infra-dmp* working group within NFDI's *Common Infrastructures* section, this initiative reflects a shared commitment to interoperability, sustainability, and community-driven standardization in research data management. The process began with defining the scope and target audience of the DMP—specifically, researchers and institutions required to comply with funder mandates and machine-actionable DMP standards. The NFDI-RFC template was forked and initialized with a bilingual structure to support broad accessibility. Core sections, including normative statements, illustrative examples, and validation criteria, were drafted in alignment with the NFDI glossary and technical requirements. The draft is planned to underwent structured review by domain experts to assess technical feasibility, including schema validation and compatibility with standardized exchange formats. A public draft will then circulated across NFDI-RFC Workflow to gather feedback for the NFDI-RFC concept and identify potential improvements. Upon finalization, the document will be published as an official NFDI-RFC (either a Best Current Practice (BCP) or Standards Track (ST)), with mechanisms established for ongoing maintenance, errata handling, and future supersession as practices evolve.

9 Contribution to NFDI Objectives

Through its combination of openness, technical clarity, and structured review, the NFDI-RFC service offers a mechanism that complements the formal standardization landscape and directly supports the goals of the NFDI. By enabling communities to capture their practices in a transparent and citable manner, the NFDI-RFC series promotes the interoperability and reusability of research data. At the same time, it supports harmonization across NFDI consortia while respecting the diversity of domain specific requirements. Ultimately, the NFDI-RFC framework aims to empower researchers and infrastructure providers by providing a shared vocabulary and well-defined processes, thereby enhancing the quality and sustainability of research data management across disciplines according to the NFDI objectives [9].

10 Outlook

Future work includes consolidating the existing drafts based on community feedback, conducting workshops with stakeholders across NFDI sections, establishing long-term editorial governance, and implementing a dedicated repository for published NFDI-RFCs. The success of the initiative depends on strong community participation, and researchers are invited to contribute by proposing NFDI-RFCs, reviewing drafts, and sharing their domain-specific expertise. In doing so, they help lay the groundwork for a coherent, interoperable, and future-oriented landscape of research data management.

11 Conclusion and Summary

NFDI-RFC provides a lightweight, open, and rigorous pathway for the co-creation of RDM standards and best practices. Inspired by the proven success of the IETF RFC model, which has demonstrated over decades that open, transparent, and iterative specification development

produces robust and globally interoperable results, the approach transfers core principles into the RDM domain. These principles include *public review, structured document types, clear normative language, and continuous refinement*. This approach addresses shared foundations across disciplines, such as metadata, persistent identifiers, versioning, and provenance, while remaining flexible enough to accommodate domain-specific needs.

A public, well-organized corpus of documents such as *Best Current Practices* and *Informational Notes* accelerates knowledge exchange, interoperability, and reuse across communities. At the same time, the NFDI-RFC process complements formal standardization by acting as a pipeline for vetted and tested specifications that may later inform DIN/ISO standards where appropriateand therefore provides a robust foundation for the development of widely accepted NFDI standards. This directly supports the goals of the NFDI by improving compatibility and interoperability between systems, increasing quality and reliability, enhancing efficiency, reducing costs, and enabling clearer communication across disciplines and organizations. In addition, it creates a fertile ground for innovation and technological development by lowering barriers to contribution and adoption. They should ensure compatibility with existing international and disciplinary standards, while remaining open to all NFDI-relevant domains, including but not limited to technical topics.

The initial drafts lay the foundation for this ecosystem, defining processes, style guidelines, authoring workflows, and errata handling. Early pilot topics, such as Data Management Plans (DMPs), already demonstrate the feasibility and value of the approach.

The NFDI-RFC process offers a low-threshold, community-driven mechanism to address these shared needs, enabling practical solutions in the present while allowing for structured evolution over time. By combining structured editorial oversight with open community review and a clear maturity model, NFDI-RFC supports rapid iteration, broad adoption, and traceable development pathways.

We invite the community to actively contribute topics, reviews, and implementations, helping to establish NFDI-RFC as a shared, NFDI-wide asset for advancing FAIR research.

12 Appendix - Roles and Responsibilities (Summary)

Role	Responsibilities
Authors	Draft content; respond to reviews; ensure clarity and testability
NFDI Section Intake Reviewers	Confirm scope/fit and structural compliance
RDM Expert Group	Assess technical plausibility and clarity; recommend refinements
NFDI-RFC Editor(s)	Enforce style/process, manage numbering, publish drafts and accepted RFCs, oversee errata
Community	Provide comments, use cases, and implementation reports

13 Acknowledgements

We thank colleagues across NFDI sections and consortia for early feedback on the concept and for piloting the authoring template. We also acknowledge the longstanding inspiration provided by the IETF RFC process.

C. Langenbach and M. Selzer would like to thank the Federal Government and the Heads of Government of the Länder, as well as the Joint Science Conference (GWK), for their funding and support within the framework of the NFDI4ING consortium. Funded by the German Research Foundation (DFG) - project number 442146713.

14 Roles and contributions

Christian Langenbach: Conceptualization, Methodology, Writing – original draft

Michael Selzer: Conceptualization, Methodology, Writing – original draft

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