NRIC Asset Suite Engineering and Operations Data Integration Plan

December 2021

Paul Plachinda

NRIC | iNL Idaho National Laboratory

DISCLAIMER

REVISION LOG

Revision No.	Date	Affected Pages	Description
0	12/13/21	All	New document

Page intentionally left blank

ACKNOWLEDGEMENTS

Page intentionally left blank

CONTENTS

FIGURES

Page intentionally left blank

ACRONYMS

AS   Asset Suite

CD   Controlled Document

DL   Deep Lynx

DCR   Design Change Request

INL   Idaho National Laboratory

MEAAL   Master Equipment and Activities List

MFC   Materials and Fuels Complex

NRIC   National Reactor Innovation Center

P&ID   Piping and Instrumentation Diagram

PDF   Portable Document Format

CONOPS   Concept of Operations

CD   Controlled document

BUP   bulk upload process

GUI   graphical user interface

EDMS   Electronic Document Management System

ADL   Affected Documents List

USQ   Unreviewed Safety Question

SW   Software

Page intentionally left blank

NRIC Asset Suite Engineering and Operations Data Integration Plan

1. INTRODUCTION

The National Reactor Innovation Center (NRIC), established by the U.S. Department of Energy (DOE) in August 2019, accelerates the demonstration and deployment of advanced nuclear energy through its mission to inspire stakeholders and the public, empower innovators, and deliver successful outcomes through efficient coordination of partners and resources. NRIC is a national program led by Idaho National Laboratory (INL), enabling collaborators to harness the world-class capabilities of the U.S. National Laboratory System. Committed to demonstrating advanced reactors by the end of 2025, NRIC is designed to bridge the gap between research, development, and the marketplace to help convert some of the Nation's most promising advanced nuclear reactors into commercial applications by 2030.

To meet these needs, NRIC is developing two reactor demonstration test beds at INL, the Laboratory for Operation and Testing in the United States (LOTUS) and the Demonstration and Operation of Microreactor Experiments (DOME) test beds. Each test bed involves the modification of existing facilities at INL's Materials and Fuels Complex (MFC).

Retrofitting these facilities to accommodate novel reactors, as well as subsequent but similar NRIC projects, is a non-trivial engineering task and is expected to generate a significant amount of new and revised documentation. Leveraging digital engineering practices, this documentation will be managed in a purpose-built data management tool to facilitate origination, review, and approval while coordinating with the design contractor. The subsequent upload and review of documentation to INL's existing document control system comprises a long and unnecessarily manual task. An opportunity exists to automate this upload process and save job-hours while continuing to adhere to INL/MFC document management procedures.

2. CURRENT DOCUMENT MANAGEMENT PROCESS

2.1 Description and Management of Document Types

Currently the document exchange is conducted between three main actors. Two software (SW) pieces: Asset Suite (AS), Electronic Document Management System (EDMS), and one human: Documentation Control. Currently, the process requires manual interactions at each step:

1. NRIC requests a number from the EDMS depending on the type of document.

2. NRIC creates a controlled document.

3. NRIC creates an engineering change (EC) entry in AS, adds the document number requested earlier to the affected documents list (ADL).

4. NRIC initiates the document change request (DCR) process.

    a. In the DCR system, NRIC attaches a controlled document to the record with the number requested earlier.

    b. Document control verifies that the document and its meta data meet INL design criteria.

    c.   Document control approves the DCR, the controlled document is now permanently stored in EDMS.

5. Once the DCR is approved, the EC status can progress toward closure. This is done manually by the responsible NRIC engineer.

3.   PROPOSED DOCUMENT MANAGEMENT PROCESS

3.1   Concept of Operations

The figure below describes, in form of a sequence diagram, the process of uploading some portions (See discussion in 3.3 of the NRIC documentation.) The bulk upload process (BUP) now involves six actors: NRIC Engineering (NRIC), Deep Lynx (DL), a product lifecycle management (PLM) tool (in this example we used Autodesk Vault [henceforth Vault], but any tool with similar capabilities can be used), EDMS, AS, and Documentation Control.

In the diagram (Figure 1), colors are used to represent different categories of actions:

- Orange lines represent currently utilized manual actions that will not be automated
- Violet lines represent currently utilized manual actions that will be automated
- Green lines represent currently non-existing actions which will be automatically performed by DL
- Blue lines represent existing actions/interfaces between AS and EDMS
- Grey lines represent interfaces/actions to be programmed on the AS/EDMS side
  Line types are also used to indicate call and response:

- Solid lines indicate a communication request
- Dashed lines indicate a response to a communication request.
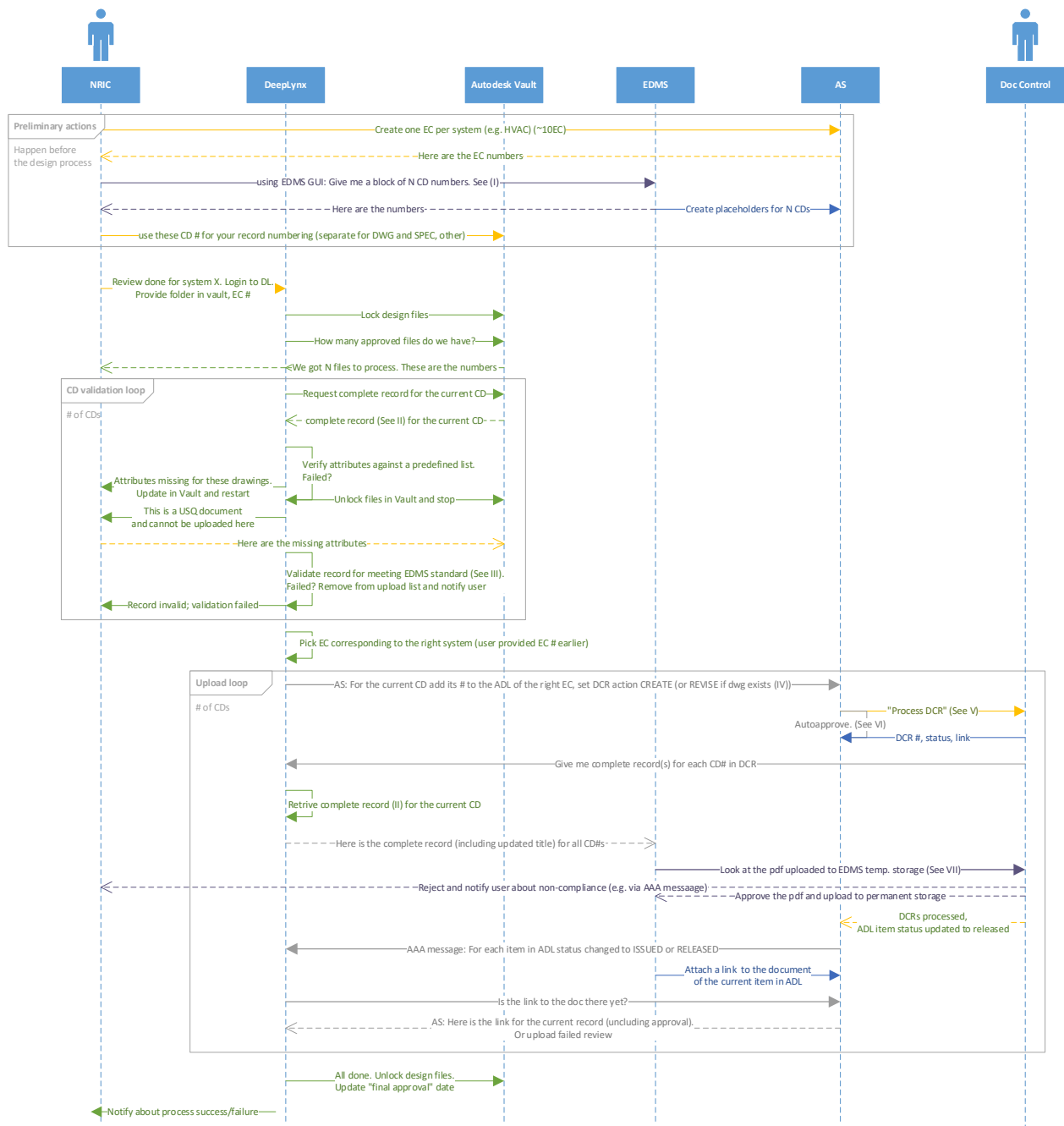
Figure 1 CONOPS.

The concept of operations (CONOPS) is broken down in three major blocks:

1. Preliminary actions: are the prerequisites to the entire process. These actions are not directly related to the upload process, but rather set the stage for it and enable a flawless upload in the future by gathering some necessary data.
2. Controlled Document (CD) validation loop.
3. Upload loop.

CONOPS actions discussed in a greater detail:

1. First, NRIC manually creates several EC placeholders in AS. A good strategy is to create one EC per system. Thus, the number of ECs will be kept relatively small. The documents will be grouped by EC.

2. NRIC requests blocks of controlled document numbers from EDMS (See 3.4). Upon reception, NRIC provides these numbers to the Vault's numbering scheme, as well as to DL.

3. NE populates the Vault storage with CDs and performs internal engineering reviews per process. Once the review is done, NRIC initiates the BUP in DL.

4. Using DL graphical user interface (GUI), NRIC specifies the folder in Vault and provides the EC number (created earlier).

5. DL retrieves the list of all entries in the specified folder and locks all of them from editing.

6. For each entry in the specified folder, DL retrieves the complete record, comprised of the portable document format (PDF) of the document, native files (*.doc, *.dwg), aux files (if present), revision history, metadata (title, sheet number, facility, division, unit, etc.)

7. DL validates each entry's attributes for completeness. If an attribute is missing, the entry is excluded from the BUP and NRIC is notified about missing data.

8. DL validates each entry's document type. Only non-unreviewed safety question (USQ) documents are permitted for the BUP. If the document type does not match one of the types in Step 3.3, the entry is excluded from the BUP and NRIC is notified about incorrect document type data.

9. For drawings, DL validates compliance with EDMS document standards: each PDF drawing shall have a title block that matches the INL standard. All fields shall be present and filled in. The text (title, sheet, etc.) on the drawing should match the metadata. If the drawing does not pass validation, the entry is excluded from the BUP and NRIC is notified about failed drawing validation.

10. For each entry, DL will compare its number (an attribute) against the list supplied in Step 2. If the entry's number belongs to the pool supplied in Step 2, this is a new drawing and DL shall set its internal DCR action attribute (not in vault) to CREATE. Conversely, if the number is outside the pool, the DCR action shall be set to REVISE.

11. Once validation of entries is done, DL will interact with AS via provided API to upload information about the items to the EC supplied in Step 4.

12. DL will add numbers of each item in the folder to the ADL of the provided EC and set DCR actions to CREATE or REVISE.

13. NE will manually review the EC for completeness and suitability to advance to the next step of the EC process. Once all necessary fields are populated, NRIC will manually select all items in the ADL and click "Process DCR" button in AS.

14. Document control will review (manually or automatically) the DCR and send an automatic request to the DL to provide an updated, complete record to EDMS.

15. DL will upload a complete record (as defined in Step 6) to the EDMS temporarily storage, using an API.

16. Document Control will review (manually or automatically) each entry in EDMS and push it to the permanent storage if the review is passed. If the review failed, Document Control will notify responsible engineer from NRIC via AS's AAA message.

17. Upon completion of review, DCR status of each item in the ADL will be updated to either ISSUED/RELEASED or FAILED.

18. DL will poll AS via a new interface to check for status change of each item in the ADL.
19. DL will poll AS via a new interface to check that the link to the document is attached to each item in the ADL when status is ISSUED or RELEASED.
20. EDMS will interface with AS via an existing interface and attach links to the documents to the RELEASED/ISSUED entries in ADL.
21. Once all RELEASED/ISSUED entries in the ADL have the links, DL generates a report with a digest of the process: how many documents were successfully uploaded to AS/EDMS, how many failed and why.
22. DL will unlock the design files in Vault and update the "final approval date" attribute in Vault for the items that were successfully uploaded.
23. DL will notify NRIC about completion of the BUP and provide NRIC with a human readable version of the report from Step 21.
24. NE will manually review the EC and advance it to next possible status.
25. END

3.2   Requirements

To execute the actions outlined in the CONOPS, all actors shall fulfill the requirements below:

1. The BUP shall enable placement of multiple CDs to the EDMS and AS databases.
    a. DL shall provide a way to request multiple CD numbers from the EDMS.
    b. DL shall retain the block of numbers provided by the EDMS internally for validation purposes and deliver it to the NRIC engineer to use in Vault's numbering scheme.
    c. NE shall manually setup a numbering scheme in Vault to match the pool of numbers provided by EDMS.
    d. NE shall manually create as many new ECs in AS as there are systems in NRIC. (Rationale: We anticipate about 10 different systems, and thus ~10 different ECs. The ECs are recommended to be created in the order in which they will be processed to correspond turn-in with the schedule.)
    e. NE shall retain the EC numbers and upload them to DL when the corresponding system's documentation is ready to be uploaded.
    f. NE shall manually populate all necessary (as defined by the current AS ontology) attributes of the EC: name, facility, responsible engineer, cancellation route, other.
    g. NE shall initiate the upload process in DL.

2. The BUP shall enable validation of each CD against currently existing INL quality standards. (See 3.4).
    a. DL shall lock (check out) all relevant entries in the Vault DB. (Rationale: Upload process can be lengthy and we shall not permit editing of half of the uploaded documents.)
    b. Attributes are divided into mandatory and optional. Only mandatory attributers will be verified. (Rationale: Each drawing or other artifact has several attributes as required by AS.)
        i.   Exact list of attributes is TBD pending interface between AS and DL.
    c. DL shall be able to check that all mandatory attributes are present for each file in Vault.

d. DL shall notify the user of mismatching or missing attributes, provide a list of items for which attributes are mismatched or missing, and request that those are corrected in Vault.

    i. NE shall manually fill in missing or correct inaccurate attributes in Vault and restart the BUP.

e. DL shall validate each PDF to ensure that each drawing has a title block that matches the INL standard.

f. All fields in the title block shall be present and filled in. Specifically:

    i. The drawing number field in the title block shall match the drawing number attribute.

    ii. If the drawing number is within the range of numbers received from DCR it shall be marked as NEW by DL.

    iii. If the drawing number is outside the range of numbers received from DCR it shall be marked as REVISED by DL.

3. The BUP shall have a GUI to allow NRIC engineering to interact with the process:

a. DL shall have a GUI for ease of interaction.

b. The GUI shall be accessible to approved users only.

c. The GUI will be used to select the project (folder) in Vault, notify the user of progress, errors, completion.

    i. The GUI will not be used to fill in missing drawing and/or other CD attributes. This shall be done in Vault.

d. The GUI shall have read only fields containing project metadata: Name, facility, responsible engineer, etc. Data from these fields will be used for user information only to ensure processing of the right system. (Rationale: ECs are broken down by systems. Once design of one system is complete it can be pushed to AS/EDMS without waiting for other systems.)

e. The GUI shall display progress of the BUP (i.e., indicate which step we are on).

f. The GUI shall display errors and the reason for the errors.

g. The GUI shall have a way to upload a block of numbers reserved in EDMS for the NRIC project. (Rationale: Upon receipt of a block of numbers [e.g., CSV format], DL should have a GUI element to upload this file or paste the list in any other way.)

h. The block of numbers reserved in EDMS shall be retained in the back end of DL and be later used for PDF validation and interfacing with AS.

i. The GUI shall have a way to upload the EC number to the DL back-end. (Rationale: Empty ECs are created manually. As many ECs as systems. The user shall manually supply necessary attributes to EC: name, facility, etc.)

j. DL shall be able to save a "project" and the user will be able to return and continue from the previous spot. (Rationale: There are several manual steps in the BUP. Some of them may take days. DL shall be able to handle this intermission gracefully.)

4. Back-end requirements for DL interaction with Vault:

a. DL shall have an interface interact with Vault.

b. The level of interaction is dictated by DL/Vault user credentials.

    i. DL shall inherit user credentials from Vault accounts.

   c. DL shall enable and Vault shall support the actions below:
      i. DL shall be able to lock/unlock all files and their attributes in a Vault folder.
      ii. DL shall be able to retrieve full list of items belonging to a given folder.
      iii. For each item, DL shall be able to retrieve its attributes, revision history, native files, PDFs.
      iv. For each item, DL shall be able to download the associated document/drawing (in both native and PDF formats).
      v. DL shall be able to update some attributes in Vault (e.g., "final approval date").

5. Back-end requirements for DL interaction with AS and EDMS:
   a. DL shall be able to add to the EC's ADL all relevant documents and supply necessary and optional attributes for each CD. EC number is provided by NRIC manually
   b. DL shall have a way to set DCR action for each item in ADL to CREATE or REVISE (based on ii and iii).
   c. DL shall be able to receive a request from Document Control to provide more information (e.g., in form of an AAA message).
   d. DL shall respond the request to provide more information about an ADL item by uploading a complete record to the EDMS storage.
      i. A complete record shall be comprised of (at least): CD number, PDF of the document, native files (*.doc, *.dwg), aux files (if present), revision history, metadata (title, sheet number, facility, division, unit, etc.)
      ii. A complete record shall be pushed to EDMS **temporary** storage.
      iii. Conversely EDMS shall have an interface to receive complete records.
   e. DL shall be able to poll AS for ADL items status:
      i. DCR status change to ISSUED or RELEASED.
      ii. Link to the EDMS entry is attached to the ADL item.
   f. DL shall internally retain the status of each ADL item for each EC and shall display this status to NRIC engineers.

6. Back-end interaction internal to EDMS and AS:
   a. AS shall allow manual DCR process initiation for *all* ADL items. (Rationale: currently the user can only select a limit number of items displayed on one page. TBD: Potentially NRIC records can have a dedicated DCR action (e.g., CREATE NRIC) in AS. All DCRs with this action will be approved automatically.)
   b. Document Control shall be able to perform partial review of the complete records in the EDMS temporary storage.
      i. TBD: Upon review of 5% of the documents, if no errors found, Document Control shall initiate mass migration of the documents from the temporary to the permanent storage.

3.3 Included Document Types

Only non-USQ documents and drawings (DWG) will be processed by the BUP.

The Following Document Types Do Not Require USQ: CTR (Charter), ECAR (Engineering Calculation And Analysis Report), EDF (Engineering Design File), FOR (Functional And Operational Requirements), GDE (Guide), HAD (Hazard Assessment Document), IAG (Interface Agreement) , MSD (Material Safety

Data), PER (Permit), RPT (Report), SDD (System Design Description), SOW (Statement of Work), SPC (Specifications), STD (Standards), TEM (Template), TEV (Technical Evaluation), TFR (Technical And Functional Requirements) and TOC (Table Of Content).

3.4   Automated Document Number Request Requirements

The first action that deviates from the manual process in Figure 1 is to request the block of numbers. It is compulsory that this action is performed before the bulk of the design work is done. Autodesk Vault can auto number the documents in its repository. Currently, only the numbers for the drawings can be requested in blocks by 100 numbers. This process needs to be upgraded to enable bulk number requisition for all types of documents specified in Section 3.3. Below are the requirements to facilitate this process:

1. User Interaction:
    a. The blocks numbers shall be requested manually using existing web interface.
    b. The blocks shall be up to 1000 numbers long. (The user can select less if needed.)
    c. The interface shall have fields to provide data for required fields in Asset Suite and in EDMS.
2. Document Types:
    a. The system shall allow bulk number generation for each permitted type of document. One group of numbers per document type. Rationale: currently the document numbers contain a prefix, describing the type of the document. Mutating the document type will imply changing the number. Therefore, NRIC shall manually request blocks of numbers for each document type it is planning to produce.
    b. The system shall only generate numbers for valid document types.
        i.   Document types and subtypes must only be engineering-type documents, with no Laboratory Instructions (LI).
        ii. Document types must NOT require a USQ. (See 3.3.)
3. The system shall be agnostic of the titles of the documents for which the numbers are requested.
    a. A generic title may be assigned to the entire block of numbers.
    b. The title shall be amended with the actual one during the complete record upload process.
4. Numbers Generation:
    a. The system shall generate only new, non-duplicate numbers.
    b. The numbers shall be validated against DOE and ICP (Investor Confidence Project) databases.
    c. The system shall make effort to generate the block of numbers in a continuous fashion.
5. The system shall enable downloading a list of critical document numbers in a CSV format.

3.5 Detailed Validation Algorithm

Upon agreement with the stakeholders, fully automated validation is not possible. Below, we outline a desired validation process.

DL shall be able to read the title block of drawings and documents. DL shall compare the title block imprinted in the PDF with the critical attribute metadata fields in Vault. If mismatch is detected, DL shall mark a CD as failed validation and notify NRIC of the reasons why a particular CD failed validation.

For the drawings, critical attributes are:

- Drawing number
- Control Center
- Status
- Status Date
- Revision Number
- Title
- Owner
- Total Pages
- Owning Company
- Facility
- Class Code
- Division Code
- Project.

For the documents, critical attributes are:

- Date Added
- Title
- Document Type
- Document Sub Type
- Owner S Number
- Owner Name
- Project Number
- Requester Name
- Requester S Number
- Request Date
- Facility
- Division
- Rev Number
- Revision Date
- Security Group
- Date Modified

- Document Status
- Authors
- Organization
- Periodic Review Date
- Periodic Review Cycle
- Task Name
- Area
- Safety Class
- Control Center
- Effective Date.