ANL-ART-127

External Access to the TREXR Database

Nuclear Engineering Division

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Summary

TREXR: The TREAT Experiments Relational Database

The DOE Advanced Reactor Technology program has supported knowledge preservation efforts to recover and preserve fuel data from the US sodium cooled fast reactor (SFR) program. Efforts have focused on establishing databases of experimental data generated during the Integral Fast Reactor program (at EBR-II, FFTF, and TREAT) as well as during related out-of-pile examinations. The information in these databases is essential to support further development and licensing activities of advanced fast reactor designs.

The TREAT Experiments Relational Database (TREXR) effort began in FY2010 to preserve the records of ~150 tests conducted in the TREAT reactor, but has since grown to a comprehensive database of more than 800 transient tests with over 4000 accompanying documents pertaining to the various programs that have performed tests in TREAT [1]. This immense resource was recently advertised and made available to the broader nuclear science community with the support of the GAIN program [2].

This report describes the effort to extend access to the TREXR Database to users outside of the Nuclear Engineering division at Argonne National Laboratory – first to other DOE laboratories, then to US industry and academic institutions. Although the report lays out the plan to facilitate external access to TREXR, it will serve as the template for opening up other Argonne databases, specifically the EBR-II safety testing database and Fuels Irradiation and Physics Database (FIPD), to users outside Argonne.

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1 INTRODUCTION

The ART "Fast Reactors Methods, Modeling and Validation" program supports development of the EBR-II, FFTF, and TREAT safety testing databases, the metal fuel irradiation and physics databases, and the SFR component reliability database. These activities complement broader ART program knowledge preservation and management efforts to achieve the science-based R&D goals by providing data needed for validation of the state-of-the-art codes and advanced methods for design and analysis of advanced fast reactors. As these efforts approach fruition, enabling access for users outside the host national laboratory (where each database is developed) becomes a priority. As the first such application nearing its completion at Argonne, a plan has been developed to facilitate external access to the TREAT Test Database (TREXR).

The TREAT facility was built to conduct transient reactor tests, which subjected test materials to simulated off-normal or accident conditions within the reactor. The tests focused primarily on fuels for sodium-cooled fast reactors (SFRs), but also examined light water reactor and special-purpose fuels (e.g. those for space applications). The thousands of transient irradiations conducted in TREAT from 1958 to 1994 span a wide variety of test conditions. Tests were conducted in different cooling environments on a variety of fuels (of varying composition and geometry) while simulating different accident-related scenarios [3]:

TREAT Test Parameters

Fuel type (fresh or pre-irradiated)	Cooling environment	Transient Conditions	Fuel geometry	Outcome
- LWR oxide - SFR oxide - SFR metallic - SFR carbide - SFR nitride	- Flowing sodium - Stagnant sodium - Flowing steam - Stagnant water - Inert gas	- Loss of flow (LOF) - Overpower (TOP) - LOF-TOP combination - Max. sample heating rate	- Pellet - Whole pin - Pin bundle (3,4,7) - Special	- Little to no sample change - Large microstructural change - Incipient cladding failure - Mild cladding failure - Gross cladding failure and fuel relocation - Fuel vaporization

These experiments produced valuable information about reactivity effects, margins to failure, fuel dispersal, and failure propagation. The TREAT test results from over 30 years of experimentation were reported in various places ranging from limited-distribution reports and memos to published articles and proceedings.

TREXR, the TREAT experiment database, was created to preserve the knowledge and data pertaining to the experiments conducted at TREAT. Considerable effort was devoted to collecting all available records. Much of the experimental information was not available in electronic form, having been preserved only in handwritten and typed hard copy. Those records were collected, scanned, and sorted for inclusion in TREXR's digital archive. TREXR, a searchable database with readily accessible data and technical reports, allows for better use of TREAT legacy experimental data and incorporation of it into present-day modeling and experimental studies.

TREXR maximizes the utility of its content by highlighting the relationships between the different pieces of information. Tests are described according to their characteristic parameters, and related documentation is linked to the test it describes. The user can therefore search the database by selecting a combination of experimental parameters and values (such as U-Zr fuel in pin form) and be provided with a list of tests that meet the selected criteria. After choosing a test, the user is presented with a summary description, any available numerical data, and all related documents. Closely related tests can be found by displaying other tests with the same experiment objective, test vehicle, or various other characteristics [4].

Although this report lays out the plan to enable tiered external access to different classes of data/ reports that are part of TREXR, it will serve as the template for opening up the other Argonne databases, specifically the EBR-II safety testing database and Fuels Irradiation and Physics Database (FIPD), to users outside Argonne. The goal is to facilitate external access to TREXR in FY18 and EBR-II safety testing database in early FY19. The access to FIPD will take place at a later time since that database is still under development and not near its completion.

1.1 Motivation

In recent years, a number of institutions have shown interest in developing new fast reactors (e.g., Terrapower, General Electric, Oklo). The TREXR database can provide the fuel irradiation data needed to support future reactor design and licensing, contributing to the safety case for the fuels tested. The TREXR data can also serve to validate computational models, providing a licensing authority with confirmation that the transient behavior of similar fuel is well understood and predicted by the analysis, thereby lending confidence in the model's ability to make a qualification case for a newly designed fuel. Making TREXR available to these institutions and others working in the fast reactor space provides the nuclear science community with a library of previously unavailable and valuable information on the transient behavior of reactor fuels.

1.2 Overview

Initially, TREXR was only accessible by US citizens at Argonne, who were able to access all of the included content. Funding from GAIN (Gateway for Accelerated Innovation in Nuclear) supported expanding access to users in industry and beyond. Providing TREXR access to the broader research community required two major efforts: content classification and access control.

The process of content classification involved determining the levels of sensitivity associated with the content in TREXR and determining which users were allowed to access what content. This determination was made according to the sensitivity or access control designation of each piece of content (document, image, or data) and the category and affiliation of each individual user. This process is discussed further in Section 2.

The process of access control involved modifying the original TREXR application to support a prescribed tiered access system and modifying the application to ensure that it was secure from a cybersecurity standpoint. Access control and broader access to the application are discussed further in Section 3.

2 CONTENT ACCESS CLASSIFICATION

This section describes the levels of sensitivity associated with the content in TREXR as well as the categories of users given access to the different levels of content.

2.1 Content Classifications

A review of the content in TREXR was conducted to ascertain the potential sensitivity of included items. Scanned documents were reviewed for any access control markings, and OSTI records were used to identify those cleared for unlimited distribution. Because the part of Argonne laboratory that operated TREAT (ANL-West, in Idaho) has been separated from Argonne and has become part of INL, OSTI's central records were considered the definitive source of access control information. Seven content groups were created based on various levels of sensitivity. These content groups, or classes, were created such that each content item would only be associated with a single group. The content classes, with descriptions and guidelines used to assign content items to each, are:

I. Open / Unlimited DOE Laboratory Reports
- Numbered reports issued by DOE laboratories (ANL and others) which have no restrictions on distribution, i.e., which have been confirmed by the publication office of the originating laboratory and/or OSTI to be previously-cleared for unlimited open distribution.

II. ANL Applied Technology (AT) Reports
- ANL numbered reports which have an AT marking, excluding AT reports marked as containing proprietary information (proprietary documents are in Class VII).

III. All Other ANL Reports
- All other ANL reports that are not approved for open unlimited distribution and not explicitly and exclusively marked as AT. Some of these reports were status/progress reports which were intended for a limited distribution audience. These reports may contain:
  a) preliminary information,
  b) details about a collaborative partner's technology which they may consider proprietary or not appropriate for broad distribution (e.g. information on their fuel design), or
  c) other OUO information.
- It's assumed that these reports may have never been reviewed for ECI, and therefore should be handled as they may contain ECI until a determination is made.
- All instrumental data is in this category until it can be reviewed.

IV. Informal Documents
- Documents which were never intended for distribution outside of ANL, including ANL-E and ANL-W memos, notes, calculation logs, records of measured data, etc.

V. Copyright owned by a publisher
- Journal articles, conference papers, etc. Because these items are published and shared in open literature, they are assumed not to contain propriety or export

controlled information. They are distinguished from items in Class I (open access) because they are publisher-owned. TREXR will not share these files with external users; the content will need to be obtained directly from the publication (see Section 2.3).

VI. Reports by Others (non ANL)

- The reports that are not included in Class I-III, and may be subject to access restrictions by the originating organization. Examples of report originators include other DOE Labs (e.g., ORNL, HEDL) and private companies. Some of the reports may be marked as AT or have other restrictive marking from the originating organization.

VII. Proprietary Documents

- Documents, including AT reports, which are marked as containing proprietary information.

Because of the volume of content in TREXR, items that were not individually reviewed for assignment to a particular content class were automatically binned into the most restrictive group. Approximately 75% of the content has been deliberately assigned to a content class. The remaining 25% still awaits review of any document markings, and is considered to have the maximum access restriction in the interim.

2.2 User Classifications

Users are currently divided into 3 major groups based on their organizational affiliation:

- ANL – Argonne employees
- Other DOE – Employees from other DOE laboratories (INL, ORNL, Sandia, etc.)
- US Industry/University – Users associated with US industry or university organizations

A distinction is also made based on the citizenship of the user, either as a US citizen or a foreign national. Foreign nationals are not currently being granted user accounts and therefore can only access public content.

Individuals can be reviewed for promotion into a less restrictive user category as needed. For example, a user at INL could be reassigned to the ANL group to provide access to content that would be otherwise restricted, provided the necessary permission was given.

2.3 User-Content Access Matrix

In consultation with Argonne's Nuclear Engineering Division management, the following matrix was created to define the content that may be accessed by users in each group.

Content Class	Can the user group view this class of content?					
	US Citizens			Foreign Nationals		
	ANL	Other DOE	US Industry/ Universities	ANL	Other DOE	US Industry/ Universities
I. Open/ Unlimited DOE Laboratory Reports	YES	YES	YES	YES	YES	YES
II. ANL Applied Technology (AT) Reports	YES	YES	YES	ANL-NE AT List*	NO	NO
III. All Other ANL Reports	YES	YES	Bibliographic information only	ANL-NE AT List*	NO	NO
IV. Informal Documents	YES	YES	Bibliographic information only	ANL-NE AT List*	NO	NO
V. Copyright owned by a publisher	YES	Bibliographic information only	Bibliographic information only	YES	Bibliographic information only	Bibliographic information only
VI. Reports by Others (non ANL)	YES	YES	Bibliographic information only	ANL-NE AT List*	NO	NO
VII. Proprietary Documents	YES	NO	NO	ANL-NE AT List*	NO	NO

* YES if on ANL-NE AT List, NO if not

This access matrix provides a complete picture of who may access what content. TREXR does not yet support displaying partial information (i.e., "Bibliographic information only") for a given piece of content to users that cannot fully access said content, but this feature can be supported in future upgrades to TREXR. Further discussion of the implementation of this access matrix in the TREXR web framework can be found in Section 3.1.

3 WEBSITE IMPLEMENTATION AND CYBERSECURITY

A preliminary review of the existing TREXR web application revealed it could not yet accommodate the agreed upon user-content access matrix and contained several potential security vulnerabilities that would preclude allowing access from external networks. Consequently, the entire application needed to be reviewed to ensure support for (1) the tiered access structure defined in Section 2, (2) standard web application security considerations required of any application on the open internet, and (3) security considerations specifically related to providing access to potentially sensitive information.

After a more extensive review, it was determined that, rather than attempting to retrofit the existing application to conform to the new requirements, it would be faster and more effective to redesign and re-implement the application in a modern web application framework. The Django Web Framework [5] was chosen as the basis for the redesigned TREXR application.

3.1 Access Control

The TREXR web application implements the tiered access described in Section 2. ContentGroups are created based on the content classes described in Section 2.1. Each piece of access-restricted content (documents, digital datasets, etc.) is associated with a single ContentGroup. UserGroups are created based on the user groups described in Section 2.2. Each user account in the application is associated with a single UserGroup. Finally, each UserGroup is assigned a list of accessible ContentGroups based the access matrix described in Section 2.3.

When accessing the application, all users must authenticate, even when accessing only the public content. In the case of public content, a specific public_user account has been created and can be authenticated automatically if the user does not have their own account. In general, users navigating the application are only offered access to content that they are permitted to access. However, in all cases, when content is requested (document, digital dataset, etc.) the item is checked against the authenticated user. Access is only allowed if the item's ContentGroup is in the list of ContentGroups allowed for the requesting User's UserGroup. This ensures that attempts to circumvent the access control system are denied.

UserGroup	**ContentGroups approved to view**
ANL	I, II, III, IV, V, VI, VII (all content)
Other DOE	I, II, III, IV, VI (all *except* publisher-owned and proprietary content)
US Industry/University	I, II (*only* open literature and ANL documents marked AT *without* proprietary content)
PUBLIC	I (*only* open literature)

3.2 User Accounts

Each user of the TREXR application is given an individual user account. The access level for each user is determined by manual review when the account is created, in order to ensure that users do not gain access to unauthorized content.

It is possible for authentication to be handled internally by the application, however, TREXR instead utilizes Argonne's Active Directory service for this task. Centralizing authentication in this manner provides several administrative benefits. Argonne's Active Directory service is maintained by the laboratory IT department and it conforms to all the laboratory and DOE rules regarding password storage/strength/security. Additionally, all Argonne employees can use their existing login credentials to access the application without needing to maintain a separate password.

Non-Argonne persons can request equally-functional collaborator accounts through the Argonne Cyber Gate Pass system [6]. Instructions to new users are given on the TREXR login page. The Cyber Gate Pass system is designed to allow collaborators to obtain Argonne Active Directory credentials which can be used to access laboratory resources such as this.

When a new user requests access to the TREXR application, their request is reviewed, and if approved, a user account is created in the application. The new user account is associated with the user's Argonne credentials (either an employee or collaborator account) and assigned to an appropriate User access group, as described in Sections 2.2 and 3.2.

3.3 Multi-factor Authentication (MFA)

In accordance with Argonne's Cybersecurity Office's requirements, users accessing potentially sensitive content are required to use multi-factor authentication (MFA). DOE lab employees who are authorized to view such content are able to obtain HSPD-12 smartcard badges, and are required to authenticate to their client computers before accessing the application. It is typically not possible (or at least not easy) for industry/university partners to obtain this level of credential. Argonne's Cybersecurity Office has approved the Duo multifactor authentication service [7] for use in these situations.

The TREXR application has been extended to support Duo authentication. After initial authentication using password credentials (either with an Argonne employee account or a collaborator account), secondary authentication is performed using the Duo service, which can be satisfied with the Duo smartphone application, text message, or phone service.

At present, sensitive content is only accessible to users at DOE labs (who are currently able to obtain HSPD-12 smartcards), so the Duo solution is not yet required, and is disabled in the application. However, to provide access to sensitive content for industry/university partners in the future, Duo will be required and enabled.

3.4 Sequential Website Rollout

The rollout of external access to the TREXR application was performed in stages. This allowed for sequentially testing the application, server, settings, and firewall settings, in increasingly "open" network environments. This also allowed for targeted testing of the application's design and usability by a subset of testers who were able to provide higher quality feedback to the developers.

The rollout proceeded in the following stages:

- Stage 1: Argonne Nuclear Engineering Division
- Stage 2: DOE lab networks (e.g., INL, ORNL, Sandia)
- Stage 3: Specific US company networks (e.g., TerraPower)
- Stage 4: Open Internet

The rollout to the open internet required additional testing and security probing to check for vulnerabilities frequently used by attackers. No issues have yet been found, however, IT systems continue to monitor the application and the system for issues and ensure that best practices in cybersecurity are followed.

4 FUTURE ACTIVITIES

The acquisition of Duo services licenses is ongoing. An order for licenses was sent to Argonne procurement and is awaiting legal review and remediation to resolve software license terms. Once the licenses have been obtained, multi-factor authentication with Duo will be enabled in the application. To the extent provided with continued support, TREXR could respond to user feedback with further improvements to the web interface and content, including full implementation of the access matrix described in Section 2.3. These updates could also include extension of accounts to foreign nationals at DOE laboratories and US institutions. As individual reviews of the most conservatively binned content items are conducted and some subsequently reassigned to more open content categories, it is anticipated that external users will be able to access an increasing range of information available in TREXR.

Although the external access plan presented in this report is initially being implemented for the TREXR database, it serves as the template to enable tiered external access to different classes of data/reports for the other ART program databases being developed at Argonne. Once its implementation for TREXR is successfully completed in FY18, it will next be rolled out for the EBR-II safety testing database since it is already completed. The external access to EBR-II Fuels Irradiation and Physics Database (FIPD) and out-of-pile metallic fuel testing databases (for furnace tests) will be facilitated later as these ongoing database development efforts near their completion. After release of this report, discussions will take place with the PNNL team to consider a similar approach for the FFTF passive safety testing and metallic fuel irradiation databases.

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