Development and Deployment of Knowledge Management Portal
for Fast Breeder Reactors

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Abstract. Knowledge Management is the process of creating value from an organization's tangible and intangible assets and regarded as a significant contributing tool to enhance the performance of an organization. Knowledge accumulated over decades of nuclear research, development & operation (organizational memory) have to be preserved and used for the future design, innovations, and continued safe operation of nuclear plants. IGCAR's IT-enabled nuclear knowledge management system is designed as a generic, customizable framework and developed in-house fully using open-source platform and APIs. This paper describes the development and implementation of web-enabled, taxonomy based, advanced knowledge management system for effective management and utilization of the Prototype Fast Breeder Reactor(PFBR) records available in the form of Control Notes, Design Notes, Operation Notes, Experiments Notes, Specifications, Project Reports, Commissioning Documents, Test Procedures & Reports, Manuals, Drawings etc. The portal deployed acts as a gateway to FR Knowledge repository and enables collection, retrieval, preservation and presentation of knowledge assets in different forms. It also highlights the capabilities with which the system has been designed like controlled-vocabulary based organization of documents, multi-format document upload facility with meta-data, enhanced authentication and multi-level access control, advanced search and retrieval mechanism, online viewing and print requests management, and dynamic reports generation facility.

Key Words: Knowledge management portal, Fast Breeder Reactor, Knowledge taxonomy, Nuclear knowledge.

1. Introduction

Knowledge management (KM) is an integrated, systematic approach to identifying, acquiring, transforming, developing, disseminating, using, sharing, and preserving knowledge, relevant to achieving specified objective [1]. It helps the nuclear organization better to acquire, store and disseminate the knowledge throughout its lifecycle. The issue of knowledge management has become especially significant due to the recent hiatus in Nuclear Power Plant construction/development and the associated loss by resignations and retirements of significant numbers of experienced personnel, who often take large amounts of important, undocumented knowledge with them [2]. Fast Breeder Reactors form the second stage of the Indian nuclear programme to meet the energy needs of the country in a sustained way. The life span of this programme is high where the knowledge management and transfer are essential across generations of employees. Knowledge accumulated over decades of nuclear research, development & operation have to be preserved and used for the future design, innovations and continued safe operation of nuclear plants. Realizing the significance of KM at the organizational level, a dynamic knowledge management portal has been deployed with IT-as-enabler for collecting, storing and disseminating the nuclear knowledge among the employees in an easy and user friendly way.

2. Organizational Knowledge management

IGCAR Knowledge Management system houses the organizational knowledge repository in a distributed structure. It is built on a federated model consisting of a Gateway server at primary

level and a number of group servers at secondary level [3]. The knowledge assets of individual groups are collected, organized and stored in respective group servers. All the group servers and the gateway server are connected to the campus network and provided with secured user access. Each group server is equipped with scientific search engine to perform user queries and retrieve the relevant results from local knowledge repository. In addition the gateway server provides a federated search facility to the users to search across distributed knowledge repositories, fetch and rank the results in the order of relevance. FIG.1. depicts the system architecture of IGCAR knowledge management system (KMS). This paper describes the features of portal designed and implemented at group-level for managing knowledge assets of FBTR and PFBR.
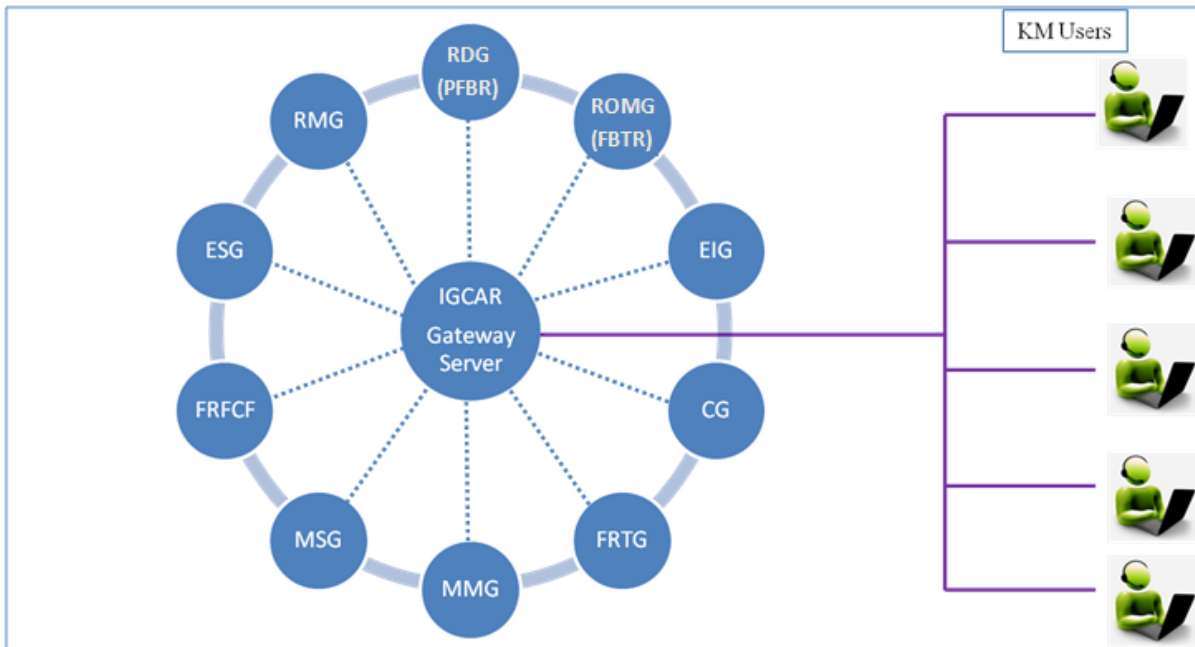

FIG.1. System architecture of IGCAR KMS

3. Fast Breeder Reactors (FBR) at Kalpakkam

Fast breeder reactors constitute the second stage of India's three stage nuclear energy programme. The Fast Breeder Test Reactor (FBTR) built at IGCAR is a loop type reactor with Pu-U mono-carbide as fuel[4]. The main objective of FBTR is its deployment as a test bed for fast reactor fuels and structural materials. The operating experience of FBTR has provided sufficient feed-back and confidence for India to launch the design and construction of a Prototype Fast Breeder reactor (PFBR) at Kalpakkam. PFBR is India's first fast breeder reactor with 500 MWe capacity, pool type reactor utilizing sodium as main heat transport medium and uses mixed uranium, plutonium oxide as fuel. The heat transport system consists of primary sodium system, secondary sodium system and steam water system. The steam water system adopts a reheat and regenerative cycle using live steam for reheating. Energy transfer is done through electrical system using turbo alternator set[5].

IGCAR is actively engaged in operation & maintenance of Fast Breeder Test Reactor and design & development of prototype/commercial fast breeder reactors to meet the energy needs of the country. At IGCAR, vast knowledge has been accrued from reactor operating experience, engineering experiments, technology development, basic research, modelling & simulation activities, etc.

4. FBR Knowledge Assets

IGCAR's Fast Reactor Knowledge assets are predominantly available in the forms of technical reports, drawings, manual/guides, publications, software codes, progress/review reports, and meeting minutes, etc. The knowledge assets are classified based on stage of the plant (construction, commissioning, operation and maintenance). Table I shows different types of explicit knowledge assets available for FBTR and PFBR in hardcopy & softcopy forms. The KM portal designed is capable of managing all these types of documents.

TABLE I: FBR KNOWLEDGE ASSETS

FBTR	Design Note, Erection Note, Service Report, Operation Experience Report, Operation Note, Operating Procedure, System Analysis Report, Flow Sheet, Significant Event Report, Detailed Drawing, Flow Sheet, Operating Procedure, Annual Performance Report, Commissioning Procedure, Commissioning Report, System/Training Manual, Journal/Conference Publications etc.
PFBR	Design Notes, Control Note, Experiments Note, Instrumentation Schematic, Project Report, Specification Note, Architectural Drawing, Significant Event Report, Test Procedure & Report, Bill of Materials, Manuals, Journal/Conference Publications , Presentation materials etc

5. Knowledge Taxonomy

Taxonomy is a hierarchical tree based classification of knowledge or information which divides the knowledge into finer sets [6]. Knowledge taxonomy focuses on enabling efficient retrieval and sharing of knowledge and information across the organizational entity in a consistent way using a controlled vocabulary [7].   Hence taxonomy creation has to be treated as an integral part of a knowledge management system. Building taxonomy involves defining the structure for organizing information, specifying individual terms used for classification, and defining the relationships among terms [8] .
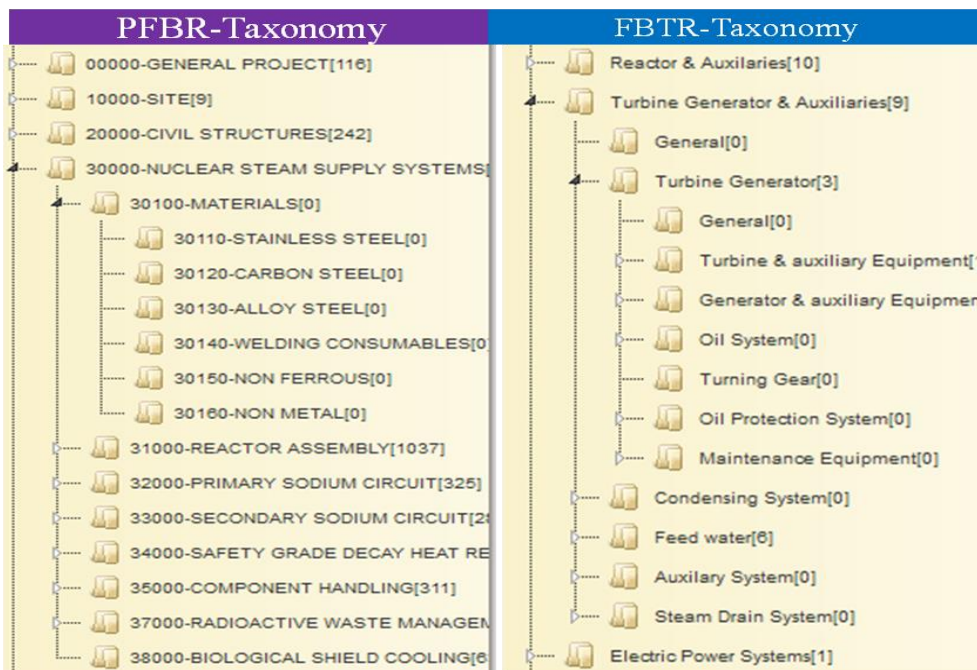

FIG.2. FBTR & PFBR Taxonomy Topics

FBR & PFBR KM portals use knowledge organization system implemented with combined faceted and hierarchical taxonomy accommodating topics starting from nuclear core to power evacuation. The topic tree broadly has 8 to 10 topics at first level and further expands to 3 to 4 sub-levels for comprehensive coverage[9]. FIG. 2. shows the sample first-level taxonomy topics in FBR & PFBR Knowledge Organization System.

6. KM portal for FBRs

A web enabled, taxonomy based, knowledge management portal with advanced features has been designed, developed and deployed for acquisition, organization, storage, retrieval, transfer, sharing, and utilization of Fast reactor knowledge available in explicit forms. The PFBR KM Portal repository has around 5,300 design reports and 20,000 drawings. The FBTR KM Portal repository has around 2,000 reports and 4,800 drawings.

The knowledge management portal is based on a generic & customizable framework developed in-house using an open-source platform and APIs. The Portal provides an interactive and convenient user interface for individual users to upload, organize, list, search, view and share the knowledge assets in different forms and in different file formats with required security measures. The major functionalities implemented in the portals are as follows:

a) *Automatic Metadata Extraction*

The module automatically extracts the metadata like title, authors, abstract, keywords, publication details etc from PDF text contents. Also it applies OCR and image processing techniques to extract limited meta-data from the scanned PDF contents (raster images) of legacy technical reports. It aids the user by relieving from the task of filling the metadata while uploading documents to the KM portal.

b) *Taxonomy based knowledge organization*

The module enables the building of the taxonomy and the categorization of the knowledge assets to the relevant topic. It helps in concept based search of the uploaded knowledge assets. The taxonomy creation system in the KM portals has been made as flexible and adaptable to review and accommodate the new topics without affecting the existing system.

c) *Enhanced multilevel Authorization*

The authorization module provides extensive access control over the knowledge assets present in the portal repository by specifying the relevant rights for each knowledge asset. Multi-level access control list can be created for each category of users (Owner/Author, Group, Others) to allow or deny different operations (List, View, Download) on the documents.

d) *Online copy safe viewing of documents*

The copy safe view enables users to view the full text of documents while restricting them from copying or downloading the document. The module converts the document pages into a set of lightweight images and displays the pages in the browser with relevant options like zoom, shrink, scroll etc.

e) *Dynamic Analytics and reporting*

The module aids the users and administrators in performing extensive analysis of knowledge assets in repository and generating various types of textual and graphical

reports dynamically.   It provides drill down features and custom filters to narrow down to specific details on the reports.

The sample screenshots of KM Portals developed and deployed for PFBR and FBTR are shown in FIG. 3.

FIG . 3. Snapshots of FBR Knowledge Management portals

In addition, the following additional features have been implemented in the portals for effective utilization and management of fast reactor knowledge related assets towards assisting plant operators and records management.

a) Control Room Alarm View & Testing

This module facilitates the control room operators to view the relevant details associated with window alarms like alarm names, panel numbers, testing procedures, and test reports, etc. in an interlinked fashion. It helps the operator to upload the reports online after carrying out alarm testing and to refer associated procedures and drawings for further assistance. FIG. 4. shows the snapshot of the alarm window details display.

FIG . 4. Typical view of alarm window details display (FBTR)

b) Shift logs Management

The module enables operators to record the shift logs online. The log records stored in KM repository can be retrieved and displayed to the operators whenever required. It helps the operators to diagnose faults and assess the performance of components in the plant.

c) Online Print Request facility

Employees who want to take a hardcopy of the FBR records (reports/drawings) available in the repository can avail this facility to submit a request with necessary approvals and keep track of the status. It enables record section authorities to approve the request and print documents watermarked with date & time and user details.

7. Conclusion

KM is the process of creating value from an organization's tangible and intangible assets and IGCAR has embraced KM as a key strategic initiative to enable organizational learning and enhance the performance of an organization by leveraging existing skills and competencies on fast reactors. An advanced IT enabled KM system has been successfully put into operation to deal with information flow from distributed sources to a reusable repository. The documented and digitized explicit knowledge related to FBRs are acquired, preserved, and disseminated

using this system. It also provides a scientific search platform for navigation, efficient retrieval and sharing of knowledge assets distributed across the organization.

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