A Classification System for Documents on Fast Reactors

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1. Introduction, Background

The present work note proposes a classification system for documents which are of interest in the context of the 'Fast Reactor Data Retrieval & Knowledge Preservation Initiative'.

2. General Principles of Classification

Taxonomies are classification systems which enable the classification and retrieval of items by guiding the user from general subjects to more and more specific *instances* until a granularity is reached which matches the classification need of the item to be classified. An example for such a classification path is:

life form -> animal -> mammal -> human being

This is different from the classification approach used in a *partonomy*, where subsequent levels of detail are part of their parent levels rather than instances. An example for a partonomy path is:

Earth -> Europe -> Austria -> Lower Austria

For the present work, we liberally mix these types of classification in order to obtain a classification system which suits the given subject best. We only retain the basic idea that a sequence of classes should lead from more general to more specific contents.

Exclusiveness: Another important principle of classification is that categories at the same level of granularity should not overlap. For example, a geographic partonomy should not have competing categories for 'Upper Austria' and 'Mountain Regions' because a given location might belong to both. This exclusiveness requirement is crucial for systems with a physical representation, such as a library, where a unique physical location for each item must exist. We will try to implement exclusiveness as closely as possible, but in an electronic archival system compromises are possible where they lead to more intuitive classification according to the conventions used by the prospective users who are thought to be professionals in the field of nuclear engineering. Unlike a book which can only occupy one particular location in a shelving system, an electronic resource may be accessible via several catalogue locations.

Completeness: The classification system needs to be able to accommodate all items which are in the scope of the collection. A common approach for achieving completeness is to introduce categories like "other items", "auxiliary documents" or negations like "Non-safety aspects". While such categories fulfil the cataloguers need to accommodate all items, they are of very little value for retrieval and should therefore be avoided. The approach taken here is an attempt to provide a complete set of top categories. Consequently, if items should be encountered which are in scope and can not be accommodated in one of the top categories, an additional, new category will need to be added at the first level. A different approach is taken for the sub categories. Sub categories try to enumerate aspects of a given top category as complete and as exclusive as practical, but it is not mandatory to have a sub category for each conceivable specific context. The aim is to support retrieval by highlighting important sub aspects and by observing naming conventions used in nuclear engineering. Items which can not be accommodated by the listed sub categories of a given category will be catalogued at the next higher level of classification. For example: If the sub categories of 'animal' are 'cat', 'dog', 'bird' than reports about mice will have to be listed directly under the higher category 'animal'. Similarly, items on mammals in general will be listed in the category 'animal'.

Facets and dimensionality: The practical implementation of a categorization scheme depends on the facet of interest. If, for example, the academic facet of a given field of activity is important, then classification according to academic disciplines (physics, chemistry, biology etc) could be the most practical approach. For other audiences, engineering, administrative or legal aspects, could provide the framework for an appropriate classification. If the subject matter is complex, like in the present case, no one single facet might be able to cover all items of the collection appropriately. We therefore propose to arrange the items in the collection according to a two dimensional classification matrix, which lists R&D aspects along one dimension and components along the other dimension. In loose analogy to Ranganathan's Colon Classification[1], every item in the collection would be classified according to R&D aspects as well as to component aspects.

Limit fields: In addition to hierarchical classifications, other aspects of the items in the collection might be useful for increasing the precision of retrieval. Such aspects are usually arranged in small, non-hierarchical lists and stored in the so called 'limit fields' of the database. Examples are: Names of experiments or facilities, type of document (book, article, videotape, etc), accessibility of documents. A characteristic of the application of limit fields for data retrieval is that they may be used to limit the retrieved data collection to a more relevant sub-set, but their use is not compulsory. Consequently, every limit field which is not explicitly used during retrieval must default to the value 'any'.

[1] http://www.slais.ubc.ca/courses/libr517/winter2000/group7/index.htm

3. Classification by Research & Development Aspects

R&D aspects form one ‘dimension’ of the access structure – components (see below) are the other dimension. If a user wants to retrieve information on R&D aspects of a particular component, he has to select at least one category from each of the ‘dimensions’.

Example: “Thermo hydraulic testing” together with “Fuel pins” and “Fuel matrices”.

If the user is interested in an R&D aspect per se, independently of a particular component, he can select “any” in the component dimension.

A proposal for a classification by R&D aspects follows:

1. *Safety aspects*
    a. *Failure and failure propagation mechanisms*
    b. *Failure detection*
    c. *Consequences of failure*
    d. *Common failure analysis*
    e. *Operating experience during accident conditions and recovery from accidents*
    f. *Sodium fires*
2. *Reactor physics*
    a. *Analytic and numeric methods*
    b. *Neutron spectra*
    c. *Testing at zero-power in critical assemblies and confirmation at various power levels*
3. *Thermo hydraulics in all operating, shut-down and accident regimes*
    a. *Thermo hydraulic testing*
    b. *Thermo hydraulic monitoring*
4. *Thermo mechanical properties of systems during normal and beyond-design operating regimes and materials science*
    a. *Lifetime effects, aging behaviour (fission product production, irradiation induced swelling, etc.)*
    b. *Structural properties, static design, structural integrity, movements due to thermal expansion*
    c. *Mechanical behaviour during seismic activity*
    d. *Heat transfer coefficients*
5. *Commissioning and start-up testing, rise to power, transient testing*
6. *Systems analysis*
7. *Industrial standards and regulations*
    a. *Structural standards*
    b. *Quality control, quality assurance*
    c. *Standards for monitoring instruments*
    d. *Assembly methods*
    e. *Seismic analytical methods*
8. *In-service inspection and repair (methods, reliability, experience)*
9. *Decontamination, decommissioning, disassembly*

4. Component Oriented Classification

Includes elaboration of available options, criteria for selection, design, fabrication, testing, operational experience and the design of testing facilities. Users who need information regarding particular components, regardless of related R&D aspects can retrieve that information by selecting the components together with the R&D category "any".

A proposal for a component oriented classification follows:

1. *Reactor components*
    a. *Core components*
        i. *Fuel assemblies*
        ii. *Fuel pins*
        iii. *Fuel and cladding*
        iv. *Fuel matrices*
        v. *Heat transfer systems*
        vi. *Piping, elbows, valves*
        vii. *Core structural materials*
    b. *Coolant, cover-gas and Primary cooling system including heat exchangers*
    c. *Vessel and piping*
    d. *Secondary cooling and steam generator*
    e. *Monitoring systems, their circuits and electronics*
        i. *Thermo-mechanical parameters (thermo-couples, flow meters, pressure sensors, flux meters, etc.)*
        ii. *Radiation and particles (delayed neutron detectors, etc)*
    f. *Decay heat removal systems*
    g. *In-vessel fuel handling systems*
    h. *Protective and shut-down systems (shutdown rods and drive mechanisms, passive control systems, support systems)*
2. *Out-of-vessel systems*
    a. *Fuel handling*
    b. *Fuel storage*
    c. *Cleaning and decontamination systems*
3. *Containment and confinement systems*
4. *Balance of plant systems*
    a. *Turbines*
    b. *Electric generators*

5. Additional Limit Fields

Limit fields and their application have been introduced above. The type and number of limit fields needed is up for discussion. The examples given below are initial suggestions.

5.1. Project selector

This field enumerates all individual research projects which have contributed materials to the collection. It is to be expected that this list will grow with time.

As of the time of writing it contains only:

- KNK II, Karlsruhe, Germany

5.2. Document type

The ‘document type’ enables the user to specifically filter out ‘human consumable’ materials such as printed materials (reports, other texts) and recordings (films, voice recordings) or ‘computer readable’ materials.

The principle document types are:

- Text
- Data in numeric form
- Multimedia

5.3. Access type

The accessibility of materials has practical implications for the information seeker. ‘Direct access’ labels materials which are physically immediately accessible as part of the present collection. Other materials might be described in the context of the data collection, but the actual materials are held elsewhere. In the latter case additional efforts to obtain access to the materials is necessary.

- Direct access
- Access by reference