

Developing an eData Information Management System (eDIMS) for Railways' Design Build Operation and Maintenance (DBOM) Projects

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Introduction

eDIMS objective is to provide railway project management and general railway system users' efficient access to all documentation which is produced during the implementation of a design build project. The eDIMS shall be compliant, dedicated to and designed on the basis of the relevant project parameters such as the volume and categories of documentation, software and hardware environment, number, categories and situation of users of the eDIMS, required presentation of documents (i.e. hard copy, soft copy) requirements for document accessibility and access times, transmission, traceability, security, storage and so forth.

eDIMS must in all phases of the project be adequate and sufficient. System overload and inefficiency may cause serious management problems. Specifically, eDIMS shall ensure that the document management information system at any time is "just right" (from day 1) as this gives the best opportunities for growth of the system in response to increasing, increasingly varied and to some extent unpredictable demands as the project progresses from pre-tender to tender, construction, handling over and operational phases. The general challenge for the eDIMS is to:

- Manage the vast amount of documents, to be produced in-house or delivered from the client, the contractors and other stake holders
- Provide access to documentation from any authorised user
- Secure long and short term archiving

eDIMS shall also be designed with a view to the post-implementation phase (operational phase). In this respect it is important that information of relevance in the operational phase is preserved and accessible in a convenient way to the owner and operator of the railway line. In order to avoid losing early opportunities to secure efficient operation and maintenance of the railway line in the operational phase it is important to give immediate attention to the perceived situation as it will be after completion of the construction such as:

- Define formats of the works documentation and inventory which shall be handed over to the owner's O&M organization
- Define data to be obtained and stored in O&M organization's repository
- Formulate procedures including control procedures for entry of data by contractors and suppliers to the inventory database

A crucial category of documentation assemblage is the inventory of the railway line. Inventory control during the project implementation phase should be one of the functions of the eDIMS. Inventory control requires that relevant information on all railway line assets is stored, protected and maintained according to prescribed procedures. As eDIMS is designed to be the core of the maintenance management system (MMS) of a railway system, it is crucial to be based on an open concept where it is possible to expand it in stages to meet future requirements of the railway line with regards to the MMS.

1.0 Analysis of the eDIMS requirements

eDIMS is the basic system for document creation and handling of a railway design, build, operate and maintenance project. The document information management system is a set of procedures and regulations for data handling combined with various hardware and software. The document content is not part of the data management system (DMS), nor is document layout and presentation; however the use of certain attributes to the documents (let's say hyperlinks) shall be defined in the DMS. These procedures and regulations are functions of the project and defined through a detailed analysis of the specific situation relating to the relevant project parameters. Although the users of the DMS may be widespread geographically and operating in differing technical environments, the system will by nature be centralised around this common set of procedures and regulations which must be enforced through efficient project discipline.

It is stressed that, although the system will be based on application of standard software and hardware to the maximum level possible, the system will go through the project's unique procedures and regulations in order to be tailored from scratch.

In view of the complexity of a mega railway project it is assumed without further consideration that a fully electronic based DIMS best meets requirements.

1.1 Definition of eDIMS objectives

The following overall objective is defined:

- eDIMS shall at all times effectively meet demand for management control with respect to document handling

Intermediate objectives are that the EDMS shall:

- Be user friendly
- Be fast, efficient and robust
- Based on standard components having good technical backup
- Be easy to maintain
- Maintain high system redundancy
- Be flexible to meet changing requirements and technology updates

1.2 Definition of eDIMS demand

The initial approach will be to define the immediate and projected demand to the eDIMS. A number of issues must be dealt with:

- Types of documentation
- Documentation users
- Needs of the users, including user friendliness
- Quantity of documentation
- Variety of media and formats

1.2.1 Types of documentation

An immediate objective is that the eDIMS shall be tolerant to a wide variety of document types within a given frame. A particular issue will be software created externally by designer, contractor, authorities and stake holders or documents generated overseas – using different software and versions.

Files acceptable to eDIMS will be only those which can be handled in terms of a number of actions prompted through the system. These include:

- Identification of files
- Access (including remote access) to files
- Moving and copying files
- Changing files
- Linking files
- Searching for files
- Searching for files content
- Transmission of files
- Categorization of files (in terms of say significance, subject)

The level of tolerance shall be based on an assessment of actual requirements.

1.2.2 Users

The primary and immediate users of the eDIMS shall be the owner of the database and the owner of the project. Future primary users may be the O&M organization and the operator(s) who may use certain parts of the system (the data holding systems). Secondary users may be other stake holders who will have access to the system and the contractors who will use dedicated parts of the system for their reporting and data recording.

Some users will have management roles; others will only use the eDIMS for data and information access. It is however likely that there are going to be many different users after completion of the works, having widely differing requirements. The design of the eDIMS shall take this into account by identifying basic user groups, and be flexible to accommodate changing requirements.

1.2.3 Needs

The various users will have different needs which to some extent will be unpredictable, at least in the initial stages. In addition needs may be depending on changing circumstances with regards to the:

- Time
- Circumstances
- Personal or organizational objectives

1.2.4 Quantity of works documentation

For large railway projects it can be expected that several million records will be generated in the life of the project. Handling, storing, finding/accessing and eventually disposing of surplus material is a major issue in itself, setting strong requirements to hardware and system structure as well as technical environment and interfacing systems.

1.2.5 Variety of media and formats

The documentation will be produced and issued in a wide variety of media/formats. Documents may be issued as a letter, report, drawing or schedule (using different software) and may be transmitted as a digital file, scanned image, fax or CD/DVD disc.

It is necessary to formulate standardization rules regarding of media format to ease file access. Standardization rules will limit requirements to software flexibility/tolerance and serve to rationalise the storage situation.

Attention should focus on the following events in relation to media use:

- The creation of the record
- Utilization of record
- Intermediate storage
- Lifetime storage of the record

1.2.6 Results of analysis

The analysis described above will lead to the establishment of a set of system requirements which shall be met in the final specification of the eDIMS. A tentative and detailed list of such requirements could be however subject to analysis of the actual railway project. eDIMS shall:

- Be the general toll for collection and coordination of documentation, making it available to personnel in the future O&M organization of the railway line. The documentation will comprise the vast amount of technical documentation produced by contractors in order to keep records of planned and achieved results of the works like design documentation, system documentation, quality records, manuals/instructions, etc.
- Be dynamic in order to adapt to the changing working situation faced by the railway project
- Provide easy and reliable access to the needed information about all the objects (elements, components, parts and items) in the railway line and associated installations
- Ensure the use and re-use of the same information for solving various tasks within the future O&M organization
- Contribute to the establishment of a rational asset management system as well as reliable operation of the railway line
- Allow interoperability with third-party applications
- Provide capability to the personnel in the future O&M organization of the railway line to define associations (attachments) between a task associated to an object in the infrastructure and the information required to execute a task. These attachments shall allow users to access relevant documents while executing a task, and thus can be associated with any stored information from anywhere within the contractor's repository.

2.0 Overall eDIMS description

This section comprises an overall system description for a comprehensive and practical eDIMS as well as a number of assumptions forming the basis of the functional requirements. In addition the perceived requirements to the eDIMS are elaborated in line with expectations for a typical large project.

2.1 General concept

Document management is a term used to refer to the storage, retrieval and tracking of documents and the process of creating, approving, publishing, distributing, modifying and deleting documents within the future O&M organization.

The electronic documents will, within the owner's organization, exist in a variety of formats to include word processing files, HTML, CAD files, spreadsheets, graphics, video, audio, bitmapped images, and compound documents incorporating multiple formats. The eDIMS shall provide the user with access to:

- Electronically stored documents and/or
- Hard copy documents by means of identification of the storage location

The eDIMS shall, as mentioned above, allow its owner in the future to build individual ancillary tools around eDIMS, for example a work order system, preventive maintenance system, plant history system, financial system, etc., for operational purposes as part of the owner's future maintenance management system (MMS). In this way it shall be possible to exchange/share information between the various organization units and different applications within the owner's organization in the O&M phase.

eDIMS consist of two main modules:

- The inventory
- The electronic document management system (EDMS)

And two sub-modules

- System administration
- Report generation

2.1.1 Interface to other systems

The eDIMS shall have interfaces to the following system groups:

- Any windows application used by the owner of the database
- Any other application used by the owner of the database
- Contractors IT systems

2.2 Repository

A repository shall be established and consist of two main components a management element (eDIMS) and an archive component, the "archives". The archives consist of electronic filing facilities (web/file servers) and hard copy filing cabinets.

The archives will contain the electronic archive for the documentation as required for foreseeable use and should include the existing and relevant databases within the consultant's organization. The archives will also contain the documentation which must be archived at least for the duration of the defects liability period.

A filing key within the repository is established to ensure user access to documents throughout the owner's database organization. Documents may need to be shared by one or more users at one storage site or across multiple storage sites.

The file servers will be accessible via the internet or the owner's database IT environment. The document storage index will define the locations of the various file servers in the organization. The owner of the database shall prepare this document storage architecture.

2.2.1 eDIMS

eDIMS is the overall tool for retrieving and accessing stored information in the repository and It has two key components.

2.2.1.1 Inventory

The inventory is the complete catalogue of the objects of the railway line infrastructure for example, comprising railway structures, buildings, other structures, equipment, installations, systems etc. which require operation and maintenance of any sort. The infrastructure constituents shall be defined as objects before entering the inventory and given unique ID codes.

The objective of the inventory is to provide information and an access key to pertinent documentation. The inventory enables the railway line owner to be easily identified, and to retrieve information directly from the inventory, or via attachment links, to other indexes in the repository in a variety of ways.

2.2.1.2 EDMS

The EDMS comprises the retrieval, tracking, and administration of technical documents stored in the various archives. The EDMS also ensures consistency in document data as well as full revision inspection of the individual documents.

The purpose of EDMS is to:

- Present an overview of all document stored in the repository
- Assuring users to locate and retrieve a given document
- Provide access to information with regards to the objects recorded in the inventory
- Provide direct access to the electronically stored documents
- Inform the users on which documents are relevant for a given object and vice versa for which object a document is relevant

The EDMS contains the links (attachment links) to all documentation stored, either in electronic archives or in hard copy archives to objects registered in the inventory. The EDMS also provides information about the location and contents of the documentation stored in the complete archive.

3.0 Functional requirements

This section describes the functional requirements to the eDIMS both in terms of internal functions, interface to other systems and external systems.

3.1 General functions in the eDIMS

eDIMS is the total system concept necessary for managing electronic documentation. The following description indicates how a typical high capacity eDIMS is organized and performs.

1. eDIMS shall be based on commercially available software applications, and be based on an SQL database
2. Standard systems comprising the integration between the two main modules in eDIMS must have been installed, tested and in operation for at least two years
3. eDIMS shall be as fully integrated as possible, without losing flexibility and adaptability
4. We suggest that eDIMS is planned as the core of the future maintenance management system (MMS), therefore eDIMS shall be based on an open concept where it is possible to expand it in

stages to meet future requirements in this respect. eDIMS shall also allow interoperability with third-party applications

5. eDIMS shall automate data input and/or eliminate duplicate or multiple entries of the same or equivalent data items, by using on-line devices or techniques such as input screens and a well-designed relational data base through which every data entry transaction is “automatically” distributed to all applications using that data item
6. All information shall be stored and maintained in only one location. This is necessary to make sure that all eDIMS users have access to updated information and to secure sufficient data quality
7. eDIMS shall include a powerful, on-line query and ad-hoc reporting capability which can access any/all data fields, by an unsophisticated user (i.e. not a programmer)
8. eDIMS shall include a security system (access control) which incorporates multiple levels of passwords which is modifiable by the system manager. User IDs, and assignable user rights including at least: shared read/write, read only, and access excluded
9. Access control key incorporated into other systems shall be valid when retrieving information from the eDIMS
10. In eDIMS a user shall only be able to see the menu alternatives and the information needed
11. eDIMS shall include features like drop down menus, data entry dictionaries and catalogues of codes and other references throughout the system
12. eDIMS shall be able to manage all relevant languages like English, French, German or others. This means that at the log-in procedure the language to be presented in the application shall be chosen
13. The system shall undergo continuous development controlled by the supplier, inspired by the users and in line with computer technology developments
14. It shall be possible to implement new functionalities in the eDIMS, functionalities based on experience gained by the users
15. In eDIMS the process to the individual program facilities shall, in addition to icons or pop-up menu interfaces, include a graphical user interface (GUI) for the inventory by means of a graphical presentation of the railway line on the screen
16. eDIMS application shall include on line help facilities, such as how to perform a particular task
17. It shall be possible for the users to collect documentation / information electronically from all external systems, to which access has been defined by the system manager responsible in the eDIMS
18. The most valuable information for the users is often information of association. That is information detailing which point blades are located in a given track turnout. The user shall be able to see which documents are relevant for this turnout
19. All users shall be able to retrieve the information they need when the information / data is required. The information by means of document shall be achieved by a user friendly interface and by storing the data in a way that seems logical to the users of the eDIMS

3.1.1 Inventory

The inventory in the management system is the complete catalogue of all the owner’s objects which are part of the design-build-operate-maintained railway line and installations.

1. The inventory is partly intended for the project manager (inventory control) during project implementation and partly for the O&M users in the operational phase of the railway line. With a view that the inventory shall be the basis for the future MMS, the inventory will (subject to approval by the client) be designed from the project outset with this function in mind
2. Data in the inventory shall be build-up hierarchically, reflecting the structure in the inventory number

3. Inventory data shall as a minimum be able to handle seven levels, representing both location and functional / technical information
4. Each level shall be represented by an object profile, where data is entered
5. Each object profile shall have a unique inventory number
6. The object profile in the inventory shall contain basic information about all objects, at any level, of the railway line, and provide access keys to all documents and data recorded in the repository
7. It will also be possible to move upwards in the hierarchy. It shall always appear from the object profile, where you are in the hierarchy, see Figure 1 example, model of inventory data hierarchy
8. The primary information of the key fields of the filled-in object profiles shall be of technical / functional character

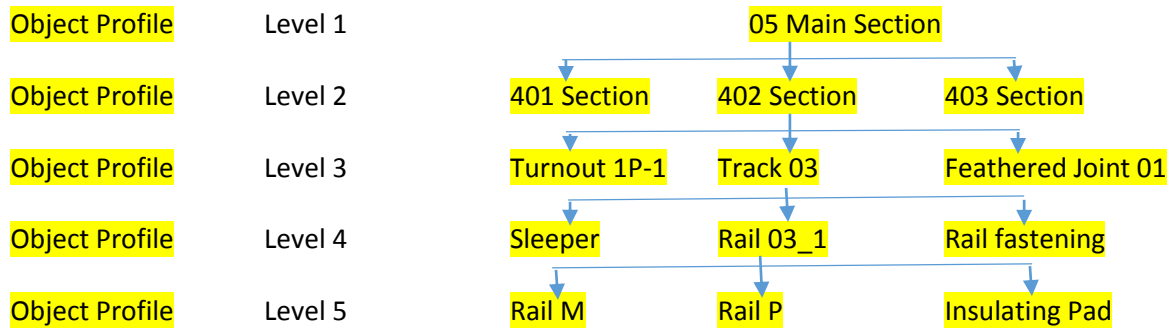


Figure 1: Model of inventory data hierarchy

9. The inventory shall include a facility where it is possible to define customized forms for laying out the technical data
10. It shall be possible on a level in the link hierarchy, to have more than one object profile layout depending on the subject area to be described
11. It shall be possible to describe the individual object of a plant on the specific levels with administrative and technical data
12. It shall be possible to create multiple links from a specification screen to objects profiles on level 5 in the inventory, see Figure 2 example, multiple links from level 5 objects to a specification

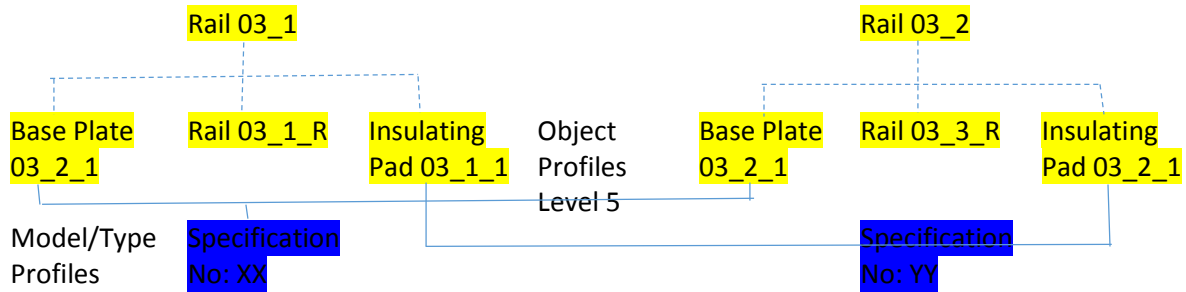


Figure 2: Example, multiple links from level 5 objects to a specification

13. It shall be possible from any object recorded in the inventory to create links associated with attached file(s), filed in the eDIMS, which means that from an object, at any level, recorded in the inventory it should, besides the information stored in the database, be possible to get further information associated to the recorded object by
 - a. Assessing any types of electronically prepared documents (such as word processing documents, spreadsheets, digitally stored pictures, CAD drawings, etc.) filed on any file server within the owner's repository
 - b. A cross-reference to hard copy archives in the repository
14. The EDMS shall enable the attachment of external documents, such as word processing, spreadsheets, CAD drawings, scanned documents, structural encoding documents (HTML, XML, etc.) to the individual objects recorded in the inventory which links objects recorded in the inventory to documentation
15. From the object specification it shall be possible to retrieve a list of parts or spare parts
16. From the part or spare part list it shall be possible to choose a part/spare part profile for the part in question
17. From a part/spare part profile it shall be possible to ask the system to which object specification the part/spare part in question is associated
18. Based on this answer it shall be possible to retrieve a list of objects profile to which the object specifications x, y and z belong
19. The inventory shall include a facility where it is possible to associate crosswise two or more objects on any level in the link hierarchy (functional systems, maintenance systems, etc.)

3.1.2 EDMS

The EDMS controls the entire index, which jointly includes all documentation independent of format and/or filing location within the repository

1. The connections between EDMS and inventory shall be performed by the document profiles, i.e. one for each document. The document profile defines the link between the objects recorded in the inventory and the particular documents recorded in the EDMS
2. Each electronically stored document available in the repository shall have a document profile in the EDMS. The key information of this document profile is the document title and the document number. Furthermore this card contains information about:
 - a. How to locate and retrieve a specific document, filing location and filing keys
 - b. Which documents are relevant for a specific object recorded in the inventory
 - c. Access rights

3. From the EDMS it shall be possible for the user organization to create/obtain access to documentation stored in other programs/applications. Among others, the following document types are relevant:
 - a. Instructions, word processing document
 - b. Spread sheets
 - c. A CAD format, drawings
 - d. A picture format, pictures
 - e. Scanned documents
 - f. Structural encoding format, HTML, XLM
4. Depending on the user's access rights, access to an electronically made document shall be permitted by either:
 - a. Accessing the document in the data environment in which the document was originated. If, with the appropriate access rights, a user wants to amend a document it should be possible from the inventory to select and open that document in the data environment in which the document was originated. For example, if it is a CAD drawing, the CAD application should be started when retrieving the drawing in question, or
 - b. Assessing by a viewer where a view only facility is permitted. No access to application in which the document was originated is permitted
5. From the inventory via the EDMS, single command shall make it possible to retrieve a list of relevant documents for a link object and subsequently to open one of the documents
6. The EDMS shall include a capability to display a selected attachment without launching the associated application. This capability shall be provided through an external interface between EDMS and commercially available file viewing software. For instance, a file created in MS-word shall be viewed on the computer screen without requiring a copy of MS-word.

3.1.3 Document profile facilities in EDMS

1. The EDMS shall include certain capabilities for attachment management, between link objects and documents stored on a file server in the repository by means of facilities for document profiling
2. The document profile in EDMS shall describe each attachment linked to a document. When an attachment is created on a document profile in the EDMS the profile information shall be stored in the EDMS database. The information can then be used to query for and retrieve the document later on. The attributes in the document profile shall be:
 - a. **Document number.** The document number shall be the unique number of the attached document and it shall be the key information on the document profile
 - b. **Document title (attachment title).** The document title/number shall be a descriptive name given to the attached document
 - c. Application
 - d. Storage type
 - e. Filing index
 - f. **Access rights.** The access rights value shall indicate who has authorization to access the attachment. The following options shall be included Read/Copy, and Read/Copy/Edit
 - i. **Read/Copy** allows users to view the document profile and read or to make copies of the original attachment
 - ii. **Read/Copy/Edit** allows users full rights to view copy, or edit the attachment as well as view the document profile
 - g. **Version.** This value shall contain the version number of the attached file

- h. **Attached by.** This value shall contain the EDMS ID of the user who created the link to the attachment file. This value shall be used by EDMS to determine who has subsequent modification rights to the attachment's profile. Only the attachment creator or system administrator shall be able to modify a document profile. If another user makes a copy of the attachment file and links it to a new document profile then EDMS ID of the user copying the attachment shall become the value of the attached by field
 - i. **Date attached.** This value shall contain the date the attachment was created
 - j. **Last edit by.** Contains the EDMS ID of the user who last edited the attachment file
 - k. **Last edit date.** Contains the date the attachment file was last edited
 - l. **Links.** This value shall contain the number of attachments associated with an attached file. From document profile an EDMS user can display a list of objects in the inventory currently linked to the attached file. Users shall have the capability to:
 - i. Link multiple attachments to a single object in the inventory
 - ii. Link multiple objects in the inventory to a single attachment
 - iii. Make a copy of an attachment and link it to a new object in the inventory
 - iv. Move a link between an attachment and an object in the inventory to another object in the inventory
 - m. Comments
3. EDMS shall automatically give the attachment's creator Read/Copy/Edit access rights to the attachment. In addition, only the attachment creator shall be allowed to edit or delete a document profile. This shall ensure that unauthorized users do not alter a document profile. The attachment creator can change the defaults as desired by selecting values from the available options
 4. EDMS shall provide default values for access rights to other users based on the value of storage type. The default value given for public attachments is Read/Copy access rights to all users
 5. Allowing access to a private attachment will result in a message informing that private attachments are stored to the attachment creator's local workstation. The message includes information about the creator/contact person
 6. The attachment creator shall own the link between the attachment and the object in the inventory. The effect of this ownership limits other users from deleting or moving links they do not own.

3.1.4 System administration

Only the system administrator shall have access to this sub-system. The required functions of the sub-system are:

1. System administration shall include function for setting up new users and assign privileges for specific functions in eDIMS, screens and options
2. System administration shall include function for specification of allowed field/data values (terminology), e.g. that it is only allowed to write insulating pad, base plate, turnout, etc.
3. System administration shall include function for application set-up, i.e. specify various system functionality settings regarding users or user groups, create and assign value lists regarding valid field value

3.2 Report generation and query facilities

The critical need for a powerful, user friendly query and ad-hoc reporting capability must be emphasized, for this is where the greatest and most critical need exists. Every contractor must recognize the critical

need for a custom report generator, available on-line, and easy to use so that the most computer resistant user will become an avid proponent in a matter of days.

1. eDIMS shall include a powerful, online query and ad-hoc reporting capability
2. The on-line query and ad-hoc reporting capability shall be able to access any/all data fields
3. The online query and ad-hoc reporting capability can be successfully operated by an unsophisticated user (i.e. not a programmer).

3.2.1 Report facility and report ad-hoc capability

1. eDIMS shall include
 - a. A standard reports menu
 - b. The capability to add reports to the standard reports menu
 - c. The capability to modify the standard reports
 - d. The capability to delete reports from the standard reports menu
 - e. The capability to convert an ad-hoc report into a standard report and include it on the standard report menu
2. eDIMS shall include a standard report comprising the data recorded on the object profiles in the inventory, one report for each level. The reports shall include query facilities when a report in question shall be printed
3. eDIMS shall include a standard report comprising the data recorded on the object profiles in the inventory and on the document profiles in the EDMS. The report shall demonstrate which documents are linked to individual objects or which objects are linked to individual documents. The reports shall include query facilities when a report in question shall be printed
4. eDIMS shall include a standard report comprising the data recorded on the object profiles in the inventory and on the document profiles in the EDMS. The report shall demonstrate which objects are linked to individual hard copy documents and on which location they are stored (file cabinet). The reports shall include query facilities when a report in question shall be printed
5. eDIMS shall include an online custom reports generator
6. The custom reports generator shall be easy to use
7. The custom reports generator shall be powerful
8. The ad-hoc reporting shall include the ability to access any/all data fields
9. The ad-hoc reporting shall include the quality to be operated by an unsophisticated user (i.e. not a programmer), in summary form, with the ability to “drill down” through valid data fields as simply as via a single keystroke
10. eDIMS shall include the following capability when printing a report: “writing out to screen”, “writing out to printer”, “writing out to file”, “writing out to a word processing system”, “writing out to a spreadsheet”, etc.

3.2.2 Query facility in the eDIMS

The query facilities shall help to control a query and save valuable time because it helps to narrow down the list of query results which satisfy the query criteria.

A query for documentation and information is likely to be made both with the aid of functions in the inventory and with functions in the EDMS, such as information/data about systems/units or component stored in the inventory supplemented with information/data to be retrieved via the EDMS in external documents (word, CAD drawings, etc.)

1. The query facility shall be easy to use
2. The query facility capability shall be powerful
3. The query facility shall include the ability to access any/all data fields

4. The query facility shall include the quality to be operated by an unsophisticated user (i.e. not a programmer), in summary form, with the ability to “drill down” through valid data fields as simply as via a single keystroke
5. It shall be possible to retrieve information and documentation in the eDIMS by sending queries to the inventory or EDMS (document database) by keying in search terms in a form containing all available fields in the inventory and the document profiles
6. All information i.e. all fields of the document profile and the inventory shall be searchable
7. The query facility shall search for any occurrence of the user typed search terms (keywords) and display a list, in compact format, of objects profiles or document profiles matching the query
8. When the user selects a specific object profile or document profile on the list, the query facility shall display in full format
9. From the displayed object profile or document profile, it shall be possible for the user to open the corresponding documentation (attachment) for viewing and/or editing depending on the users privileges
10. It shall be possible to combine search criteria for the inventory with search criteria for the document profiles. For example, it shall be possible to search for all CAD documents related to a specific tunnel section.