HyApproval

WP4, ST3

Identification and Review of Databases for Reliability Data

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Identification and Review of Databases for Reliability Data

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1 Introduction

This document is serving as input to WP4 of the project HyApproval. In the Minutes of Meeting from the WP4 kick-off meeting 07/10/2005, action point D4.4, it is referred to the task of identification and review of reliability data from past studies and data collections.

The first edition of this document was prepared by DNV Consulting's Jan Erik Eldor and Espen Funnemark on behalf of HyApproval WP4 describing some generic data sources being used in risk studies, Reliability, Availability and Maintainability (RAM) studies and studies of instrumented safety systems that DNV Consulting has performed for the oil and gas industry world wide. As this document has status as a 'public' delivery, individual partners in the HyApproval project may have internal, confidential information that could not be disclosed for the purposes of this study. The report is considered to give a good and relevant overview over databases of reliability data being currently available.

Based on contributions received from HSL, JRC and Norsk Hydro the document has been updated accordingly.

Availability of relevant, high quality reliability data is important for risk studies and consequently for cost efficient installation, operation and general risk management of hydrogen installations and applications. When relevant reliability data is lacking, this increases the uncertainty and decreases the accuracy of risk studies. This is most relevant in cases where hydrogen installations behave differently compared to 'conventional' and well known installations. Good reliability data is also very useful in determining and optimising maintenance schedules for safe operation of installations.

As a general conclusion, it is unfortunately realised that reliability data are lacking for hydrogen applications, and hence it is suggested to initiate a project for this purpose in line with what has been done for non-hydrogen equipment and systems. Details of the suggested approach are outlined in section 5.

2 Reliability data sources in RAM studies

2.1 General

A number of generic reliability databases are available to the public, of which some are listed below:

- **OREDA-84**: Offshore Reliability Data 1st Edition, ISBN 82-515-0087-7
- **OREDA-92**: Offshore Reliability Data 2nd Edition, ISBN 82-515-0188-1
- **OREDA-97**: Offshore Reliability Data 3rd Edition, ISBN 82-14-00438-1
- **OREDA-02**: Offshore Reliability Data 4th Edition, ISBN 82-14-02705-5
- **SINTEF**: Reliability Data for Safety Instrumented Systems, PDS Data Handbook, 2003 Edition, ISBN 82-14-02709-8
- **SwedPower**: T-Book, Reliability Data of Components in Nordic Nuclear Power Plants – 5th Edition, ISBN 91-631-0426-1
- **Concawe**: Western European Cross-country oil pipelines, 25-year performance statistics, report no. 2/98

- **NPRD-95**
- **EIREDA**: European Industry Reliability Data Bank, Volume-2, ISBN 2-9509092-0-5

Brief descriptions of these sources are given in the following subsections.

Based on our experience, the following prioritisation and recommendations for use are given:

- For equipment classes covered by OREDA this has been considered the most relevant database as it is based on data from the oil and gas industry.
- For safety related equipment covered by PDS this has been the preferred database as this is also based on data from the oil and gas industry.
- The T-book has been used for most of the electrical equipment as this is quite poor covered by OREDA and PDS.
- For pipelines Concawe is the obvious best choice.

2.2 The OREDA handbooks

The OREDA, Offshore Reliability Data, project has been running since the early eighties with a number of major oil companies as participants. The data collected are mainly from the North Sea, but a small amount is from the Gulf of Mexico, the Adriatic and from onshore facilities. The project has issued four handbooks in 1984, 1992, 1997 and 2002 respectively. The 1984 handbook has been withdrawn after a quality assurance process in connection with the 1992 edition selected the data to be included in the new edition. The 1992, 1997 and 2002 handbooks do not contain overlapping data, and the information may thus be merged to produce overall failure rates and repair times.

The OREDA handbooks are considered to contain top quality reliability data in the sense that the data has been collected over a long time, data comprises a wide range of equipment items and that the data collection and quality assurance has been performed according to the ISO standard for such work.

2.3 The PDS Data Handbook

The PDS Forum is a forum of oil companies, vendors of safety equipment, engineering companies and consultants. The forum issued the first version of the PDS Data Handbook in 1998 and a new version, which is used in the present study, in 2003. The data in this handbook is based on the OREDA database which has been supplemented by expert judgements performed by the participants of the PDS Forum. The reliability data covers safety related equipment classes.

The PDS Data Handbook is considered to contain top quality reliability data.

2.4 The T-book

Reliability data collection started in Swedish nuclear power plants in the middle of the seventies, and later the Finnish company TVO joined the data collection system. The first edition of the T-book was published in 1982, and the latest version, which is used presently, was published in 2000.

The T-book is considered to contain top quality reliability data.

2.5 Concawe

Concawe is the oil companies' European organisation for environment, health and safety and has been collecting data on oil spills from cross-country pipelines since the early seventies. It is considered as the best data source for oil pipeline leaks.

2.6 Eireda

The Eireda database was firs published in 1990. The database concerns critical failures of components important for the safety of nuclear plant, and covers experience from 1978 to 1987, and then updated with data up to 1993. Eireda contains data on electrical, mechanical and electromechanical eequipment of thermal power plants.

2.7 ZEDB

The Centralized Reliability and Events Database (ZEDB) gathers and analyses operating experience gained at nuclear power plants in Germany, Netherlands and Switzerland. The analysis is performed using a two-stage Bayesian model to calculate plant specific and generic reliability parameters. The collection of operating experience and the generation of reliability data for safety-related nuclear power plant components is continuously ongoing. The results of analyses are published in technical-scientific reports of VGB PowerTech (German Technical Association of power and heat generators).

3 Reliability data sources in studies of Instrumented safety systems

This section describes some relevant databases with regards to Instrumented Safety Systems. Note that some of the databases are also described in general above, this section however points out important aspects related to safety systems.

- The PDS Data Handbook
- The OREDA Database
- The T-book
- The EIREDA Database
- The Exida Safety Equipment Reliability Handbook
- ZEDB

Each source is presented in detail in the following subsections.

3.1 The PDS Data Handbook

The data in this handbook is based on data collected during phases 1,2, 3 and 4 of the OREDA project combined with expert judgements by the PDS Forum. The PDS Handbook contains data on equipment like:

- Transmitters
- Gas detectors
- Smoke detectors
- Heat detectors
- Flame detectors
- Push buttons
- Control logic
- Emergency shutdown valves
- Control valves
- Pressure relief valves

3.2 The OREDA Database

The OREDA, Offshore Reliability Data, project was started in the early eighties as a joint industry project by companies operating in the Norwegian sector of the North Sea. The project has passed through several phases and released three data handbooks. OREDA contains data on safety equipment like:

- Transmitters
- Gas detectors
- Smoke detectors
- Heat detectors
- Flame detectors
- Control logic
- Emergency shutdown valves
- Control valves
- Pressure relief valves

In addition the OREDA contains data on several non-safety related equipment classes.

3.3 The T - Book

The T-book is based on data from Swedish and Finnish nuclear power stations. Data collection was started in the eighties and the latest edition of the book is Edition 5, 2000. The T-book contains data on safety equipment like:

- Isolation valves
- Pressure relief valves
- Solenoid valves
- Transmitters
- Sensors
- Limit switches
- Circuit breakers

In addition the T-book contains data on several non-safety related equipment classes.

3.4 The EIREDA Database

The Eireda database is based on data from French nuclear power stations. Data collection was started in the late seventies and the latest edition of the book is Volume 2, 1995. EIREDA contains data on safety equipment like:

- Isolation valves
- Pressure relief valves
- Check valves
- Circuit breakers
- Sensors
- Transmitters
- Control logic

In addition EIREDA contains data on several non-safety related equipment classes.

3.5 The Exida database

"Safety Equipment Reliability Handbook" is a handbook describing in short safety equipment reliability, the use of such data, and the data collection. The data in the second edition (2005) are gathered from FMEDA data (product specific data from Failure Modes and Effects Analysis), manufacturer data and data from other databases such as Oreda-92, SINTEF1998/2003, IEEE Std 500, RAC publications CCPS Guidelines and Lees 1996. The Exida handbook contains data on safety equipment like

- Sensors
- Input and output interface modules
- HART Communication Interfaces
- Logic solvers
- Final elements (e.g. valves, actuators etc.)

3.6 The ZEDB database

The ZEDB Database is based on continuously updated events/operating time data from German, Dutch and Swiss nuclear power plants. ZEDB contains data on the following components:

- Valves
- Pumps
- Emergency diesel generators
- Batteries
- Rotating inverters
- Static inverters
- Transformers
- Fan/Compressors
- Busbars
- Circuit breakers

The results of current ZEDB analysis for 2004 were published in the following VGB report:

Report „***Reliability Data for Nuclear Power Plant Components – Analysis for 2004***"; English; ord.no. TW804e

(Remark: Preface and contents are published in VGB website: http://www.vgb.org/data/vgborg_/ DBs-Statistiken/KKW/Komponenten/TW804e_VorwortInhalt.pdf)

4 Equipment Release Databases

Throughout the years a number of databases and data collection projects have been initiated for several industries such as nuclear, offshore and onshore process, related to compiling release data for process equipment and systems. It is important to have such data at hand when conducting quantitative risk analyses for the calculation of release frequencies. The data being publicly available today through reports and/or electronic databases varies a lot with respect to quality, quantity and application, and many of them contain old and outdated data. In DNV's work for the oil and gas operators in the North Sea (UK and Norway), we have be searching for the "state-of-the-art" regarding offshore process release data, and we concluded in co-operation with the operators that the UK Health & Safety Executive's (HSE) HydroCarbon Release Database HCRD holds such qualities that is required. Below is given a short presentation of the database.

The HCRD has become the standard source of leak frequencies for offshore QRA and provides a large, high-quality collection of leak experience, and is today available on-line. Offshore releases of hydrocarbons are currently reported to the HSE Offshore

Division (OSD) as dangerous occurrences under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) which became effective offshore on 1 April 1996. The database contains detailed voluntary information on offshore hydrocarbon release incidents supplementary to that provided under RIDDOR (and previous offshore legislation prior to April 1996) and the database contains reports dating from 1 October 1992, now containing recording of some 2500 releases. The original HCRD was built by UK HSE and became operational in May 1993, with hard copy statistical reports being produced from 1994 onwards. Up to 2001, a Statistics Report was available, using matching equipment populations (equipment "countings") to obtain leak frequencies and hole size distributions.

The UK Health & Safety Executive (HSE) has collected a considerable amount of information on equipment failures, in addition to the data referred to above. However, a significant part of this information is confidential, as it may be used in court cases and other legal proceedings. It would not be possible to gain access to this data.

5 Recommendations for further work

It is realised that reliability and release data are lacking for hydrogen applications. Work is needed to close this knowledge gap. It is therefore suggested to initiate an initiative or project for this purpose in line with what has been done for non-hydrogen equipment and systems presented in this document. This will enable high-precision risk and reliability analyses to be conducted also for hydrogen systems/applications like hydrogen refuelling stations. It is therefore highly recommended that initiatives are taken to plan for data collection of such data in line with what has been done throughout the years for other industries. Some work is already ongoing in this field both through the CUTE project and HySafe's WP5 establishing HIAD, the Hydrogen Accident and Incident Database. However, HIAD is – at least not initially - intended to be a reliability type of database.

Projects like HyApproval, HySafe and CUTE already work to assure a safe introduction of hydrogen in society and it is recommended that these projects establish cooperation on these issues. Each project could contribute with relevant and specific competence and experiences. By joining forces and agreeing on a suitable way forward, the partners' experiences from similar work, and the successful database concepts that have been referred to in this document can be utilised efficiently to facilitate the safe and reliable introduction of hydrogen in Europe. It is suggested to initiate this project by running a pilot project for hydrogen refuelling stations. If successful, it will in the future not be necessary to use (adjusted) non-hydrogen data for release frequency estimations and reliability calculations for hydrogen applications. It will of course take some time to compile the required data in such a quantity that it will be useful for analysis purposes, it is therefore important to initiate such activities as soon as possible.

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Failure prediction and evaluation of operational reliability of aeroengines is an important activity for the fleet management. Studies have been reported in the literature on the reliability analysis of components and systems but publications on data preparation, validation etc. which is a prerequisite for successful reliability evaluation is scarce. Failure mode identification and data preparation assumes greater significance due to the fact that the utility of the outcome of statistical analysis for operational decisions is limited by the quality of the data that had gone into the analysis. In this study, an assessment of the accuracy and reliability of sequences in these databases was performed.Â PLOS ONE promises fair, rigorous peer review, broad scope, and wide readership â€“ a perfect fit for your research every time. Learn More Submit Now.Â DNA barcoding has been broadly accepted as a reliable method of identification, and the barcoding concept has extended beyond animals; a 2-locus barcode of ribulose 1,5-biphosphate carboxylase (rbcL) and maturase K (matK) can resolve land plants [3] and a 645 bp region of ITS (spanning subunits 1 and 2) is used for fungi identifications [4]. One main advantage of DNA.Â This study was aimed at performing an initial assessment of both the quality and reliability of data contained in BOLD and GenBank for obtaining We measured the reliability and validity of 5 databases. Databases were queried for 30 medications identified as having varying degrees of interactions with warfarin in a recent systematic literature review. Reliability was measured by the percentage agreement between the databases for each interaction and validity was measured by agreement between each database and the systematic literature review. All of the databases and the systematic review agreed on 14 medications (47%). There were 5 medications (17%) where all databases reported an interaction, but no interaction was noted by the system