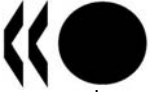


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**NEA/CSNI/R(2009)19**



Organisation de Coopération et de Développement Économiques  
Organisation for Economic Co-operation and Development

**05-Nov-2009**

**English text only**

**NUCLEAR ENERGY AGENCY  
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS**

**NEA/CSNI/R(2009)19  
Unclassified**

**OECD/NEA PIPE FAILURE DATA EXCHANGE (OPDE) PROJECT  
2002-2008 Status Report**

**JT03273659**

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## EXECUTIVE SUMMARY

Structural integrity of piping systems is important for plant safety and operability. In recognition of this, information on degradation and failure of piping components and systems is collected and evaluated by regulatory agencies, international organisations (e.g., OECD/NEA and IAEA) and industry organisations worldwide to provide systematic feedback for example to reactor regulation and research and development programmes associated with non-destructive examination (NDE) technology, in-service inspection (ISI) programmes, leak-before-break evaluations, risk-informed ISI, and probabilistic safety assessment (PSA) applications involving passive component reliability.

Several OECD Member countries have agreed to establish the OECD-NEA Piping Failure Data Exchange Project (OECD-NEA OPDE) to encourage multilateral co-operation in the collection and analysis of data relating to degradation and failure of piping in nuclear power plants. The scope of the data collection includes service-induced wall thinning, part through-wall cracks, through-wall cracks with and without active leakage, and instances of significant degradation of piping pressure boundary integrity.

The project was formally launched in May 2002 under the auspices of the OECD/NEA. Organisations producing or regulating more than 80 % of nuclear energy generation worldwide contribute data to the OECD-NEA OPDE data project. Currently (February 2009) eleven countries<sup>1</sup> have signed the OECD OPDE 3<sup>rd</sup> Term agreement (Canada, Czech Republic, Finland, France, Germany, Korea (Republic of), Japan, Spain, Sweden, Switzerland and United States of America).

A key accomplishment of the OPDE project is the establishment of a framework for the systematic collection and evaluation of service-induced piping degradation and failure. Numerous database application projects have been pursued by the project members. These applications have been essential in improving database structure and database field definitions. Looking forward, OPDE will serve as an important resource for nuclear engineering professionals that are actively involved in plant ageing management research as well as in the validation of degradation mechanism mitigation strategies.

This report describes the status of the OECD-NEA OPDE database after 6 years of operation from May 2002 to May 2008, and gives some insights based on ca. 3600 piping failure events in the database.

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<sup>1</sup> Belgium participated in the project during the 1<sup>st</sup> and 2<sup>nd</sup> terms but has decided not to participate in the 3<sup>rd</sup> term (2008-2011) of the project.



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## 1. INTRODUCTION

Structural integrity of piping systems is important for plant safety and operability. In recognition of this, information on degradation and failure of piping components and systems is collected and evaluated by regulatory agencies, international organisations (e.g., OECD/NEA and IAEA) and industry organisations worldwide to provide systematic feedback for example to reactor regulation and research and development programmes associated with non-destructive examination (NDE) technology, in-service inspection (ISI) programmes, leak-before-break evaluations, risk-informed ISI, and probabilistic safety assessment (PSA) applications involving passive component reliability.

Reviews of service experience with safety-related and non safety-related piping systems have been ongoing ever since the first commercial nuclear power plants came on line in the 1960's. In 1975 the U.S. Nuclear Regulatory Commission established a Pipe Crack Study Group (PCSG) charged with the task of evaluating the significance of stress corrosion cracking in boiling water reactors (BWRs) and pressurised water reactors (PWRs). Service experience review was a key aspect of the work by the PCSG. Major condensate and feedwater piping failures (e.g., Trojan and Surry-2 in the U.S.) due to flow accelerated corrosion (FAC) resulted in similar national and international initiatives to learn from service experience and to develop mitigation strategies to prevent recurrence of pipe failures. Early indications of the significance of thermal fatigue phenomena evolved in the 1970s, and, again, systematic reviews of the service experience enabled the introduction of improved piping design solutions, NDE methods, and operating practices.

In parallel with these focused efforts to evaluate service experience data and to correlate the occurrence of material degradation with piping design and operational parameters, initiatives have been presented to establish an international forum for the systematic collection and exchange of service experience data on piping. An obstacle to the use of the database by other countries of national qualitative and quantitative pipe failure information is that criteria and interpretations applied in the collection and analysis of events and data differ among the various countries. A further impediment is that the descriptions of reported events and their root causes and underlying contributing factors, which are important to the assessment of the events, are usually written in the native language of the countries where the events were observed.

To overcome these obstacles, the preparation for the OECD Pipe Failure Data Exchange (OPDE) Project was initiated in 1994 by the Swedish Nuclear Power Inspectorate (SKI)<sup>2</sup>. In 1994 SKI launched a 5-year R&D project to explore the viability of creating an international pipe failure database. During this period SKI hosted meetings to present results of the R&D and to discuss the principles of database development and maintenance.<sup>3</sup> Since May 2002, the OECD/NEA has formally operated the project under the coordination of the Committee on the Safety of Nuclear Installations (CSNI). The first term of the Project covered the years 2002-2005 and the second term covered the period 2005-2008. This report summarises the project results of the OPDE Project after six years of operation from May 2002 to May 2008. Approved by the Project Review Group (PRG) in June 2008, a third project term covers years 2008-2011.

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<sup>2</sup> Swedish Radiation Safety Authority (SSM) as of July 1, 2008

<sup>3</sup> In September 1996 SKI organised the "Initial Meeting of the International Cooperative Group on Piping Performance" with participants from thirteen countries. Again, in September 1997 SKI organized the "Seminar on Piping Reliability" (SKI Report 97:32); this time with participants from eleven countries.





## 2. OPDE OBJECTIVE AND SCOPE

OPDE has established an international database on pipe degradation and failures in commercial nuclear power plants in OECD Member Countries. The database supports the following activities:

- Trend analysis, including ageing analysis
- Statistical analyses to determine pipe failure rates and rupture frequencies for use in risk-informed activities (e.g., loss-of-coolant-accident frequency assessment, internal flooding initiating frequency assessment, high-energy-line-break frequency assessment, RI-ISI  $\Delta$ -risk assessment, etc.)
- Source of data parameters for input to probabilistic fracture mechanics codes. The database is also a source of information on degradation susceptibilities and degradation rates for use in the verification and validation of probabilistic fracture mechanics (PFM) codes.
- Degradation mechanism analysis (DMA) in risk-informed ISI (RI-ISI) applications
- Development of defences against recurring (e.g., systematic) pipe failures
- Exchange of service data in order to pinpoint potential generic implications of a specific, significant pipe failure.

The OPDE Project addresses typical metallic piping components of the primary system, main process and standby safety systems, and support systems (i.e., ASME Code Class 1, 2 and 3, or equivalent, piping). It also covers non safety-related (non-Code) piping, which if leaking could lead to common-cause initiating events such as flooding of vital plant areas. As an example, raw water systems such as non-essential service water, circulating water or fire protection could be significant flood sources given a pipe break. In other words, the OPDE database covers degradation and failure of high-energy and moderate-energy piping as well as safety-related and non safety-related piping.

Included in the database are events that result in remedial action (e.g., replacement, weld overlay repair) with or without reactor shutdown to cold shutdown condition. The types of degradation or failure include service induced inside diameter pipe wall thinning and non through-wall cracking as well as pressure boundary breaches, such as pinhole leaks, leaks, severance and major structural failures (pipe “breaks” or “ruptures”). For pipe flaws that do not penetrate the pipe wall or weld/weld heat affected zone the OPDE work scope encompasses degradation exceeding design code allowable for wall thickness or crack depth as well as such degradation that could have generic implications regarding the reliability of NDE/ISI techniques. In summary, the following types of degradation and failures are considered:

- Non through-wall defects (e.g., cracks, wall thinning) interpreted as structurally significant and/or exceeding design code allowable
- Through-wall defects without active leakage; leakage may be detected following a plant operational mode change involving for example depressurization and cool-down, or as part of preparations for NDE
- Small leaks (e.g., pinhole leaks, drop leakage) resulting in temporary or permanent repair

- Leaks (e.g., leak rate within Technical Specification limits)
- Large leaks (e.g., through-wall flow rates in excess of Technical Specification limits)
- Severance (pressure boundary failure attributed to external impact or vibration fatigue)
- Rupture (major structural failure).

In May 2002 the starting point for the Project was an in-kind contribution by SKI in the form of an international pipe failure database in Microsoft® Access. This database included pipe failure data for the period 1970 to 1998, and it contained approximately 2,300 records. During the first term of the project the emphasis was on validating the content of the SKI in-kind contribution, improving and streamlining the database structure and data input format, and populating the database with new failure data for the period 1999 to 2008 (end of the second term), as well as with pre-1998 records.

During the second term (2005-2008) an Online-version of the database has been implemented to facilitate data submission. Authorised users can access the Online-version via a secure server operated by the NEA Information Technology (IT) Group. An effort is underway to encourage plant operators to directly input failure records via the Online-version. Database user IDs and passwords are provided by NEA-IT to respective National Coordinator.

Signatory countries can use the database content to generate their own qualitative and quantitative piping reliability insights. An international co-operation for quantification of piping reliability parameters may be established separately in the future should the participating organisations wish to do so.

### 3. OPDE ORGANISATION

Each participating country is represented by a National Coordinator. The OECD/NEA is responsible for administering the project according to OECD rules. To assure consistency of the data contributed by the National Coordinators the Project operates through the Clearinghouse. The Clearinghouse verifies whether the information provided by the National Coordinators complies with the OPDE Coding Guidelines (OPDE-CG). The OPDE Project Review Group (PRG) controls the project with support from the OECD/NEA project secretary and a Clearinghouse.

The PRG runs the Project and meets at least once per year. The PRG responsibilities include but are not limited to the following types of decisions:

- Secure the financial and technical resources necessary to carry out the Project
- Nominate the OPDE Project chairperson
- Define the information flow (public information and confidential information)
- Approve the admittance of new members
- Nominate project task leaders (lead countries) and key persons for the PRG tasks
- Define the priority of the task activities
- Monitor the progress of the Project and task activities
- Monitor the work of the Clearinghouse and quality assurance

The first and second term OPDE participating countries and organisations are listed below:

- Belgium (Electrabel and Tractebel)
- Canada (Canadian Nuclear Safety Commission)
- Czech Republic (Nuclear Research Institute, REZ)
- Finland (Radiation and Nuclear Safety Authority)
- France (Institut de Radioprotection et de Sûreté Nucléaire)
- Germany (Gesellschaft für Anlagen- und Reaktorsicherheit)
- Japan (Japan Nuclear Energy Safety Organisation)
- Korea (Republic of) (Korea Institute of Nuclear Safety and Korea Atomic Energy Research Institute)
- Spain (Consejo de Seguridad Nuclear)
- Sweden (Swedish Radiation Safety Authority)
- Switzerland (Swiss Federal Nuclear Safety Inspectorate)
- United States of America (Nuclear Regulatory Commission)

Participating countries remain intact with the exception of Belgium which has not joined the 3<sup>rd</sup> term of the project.



#### 4. QUALITY ASSURANCE & DATA QUALITY

The OPDE Quality Assurance Program (OPDE-QAP) establishes the organisational and technical principles and measures for quality assurance and monitoring of the work during operation of the OPDE Project to ensure high quality of the end product (the database with companion reports). The OPDE-QAP applies to all activities in the project and is to be followed by all project participants.

To achieve the objectives established for the OPDE database, a Coding Format has been developed. This Coding Format is reflected in the Coding Guidelines. The Coding Guidelines are built on established pipe failure data analysis practices and routines that acknowledge the unique aspects of passive component reliability in heavy water reactor and light water reactor operating environments (e.g., influences by material and water chemistry).

For an event to be considered for inclusion in the OPDE database it must undergo an initial screening for eligibility. An objective of this initial screening is to go beyond the abstracts of event reports to ensure that only pipe degradation and failures according to the work scope definition are included in the database.

Data quality is affected from the moment the service data is recorded at a nuclear power plant, interpreted, and finally entered into a database system. The service data is recorded in different types of information systems ranging from work order systems, via ISI databases and outage summary reports, to licensee event reports or reportable occurrence reports. Consequently the details of a degradation event or failure tend to be documented to various levels of technical detail in these different information systems. Building an OPDE database event record containing the full event history often entails extracting information from multiple sources.

The term “data quality” is an attribute of the processes that have been implemented to ensure that any given database record (including all of its constituent elements, or database fields) can be traced to the source information. The term also encompasses “fitness-for-use”, that is, the database records should contain sufficient technical detail to support database applications.

In OPDE, a “Completeness Index” (CI) is used for database management purposes. It distinguishes between records for which more information must be sought and those considered to be complete (Table 1). Each record in the database is assigned a CI, which relates to the completeness of the information in the database relative to the requirements of the Coding Guidelines.

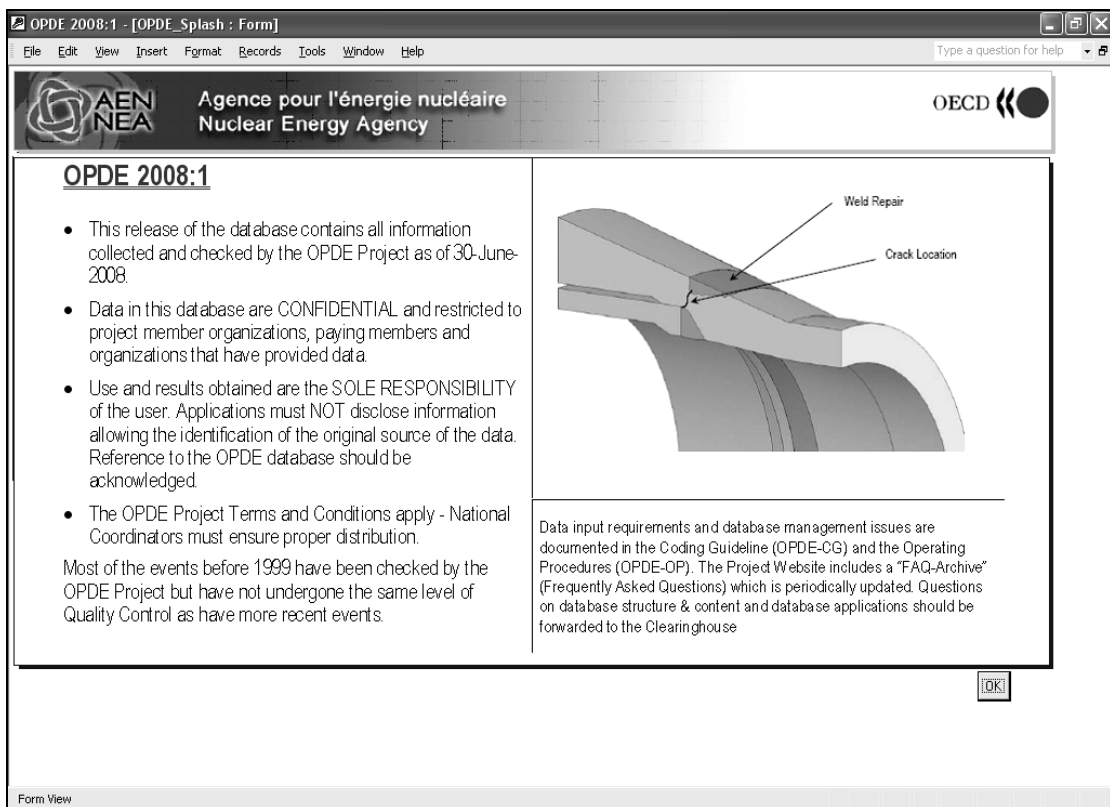
The “Completeness Index” is also intended as a database filter for determination of the ‘fitness-for-application.’ The range of possible database applications covers advanced applications (e.g., the study of effect of different water chemistries on specific degradation susceptibilities), risk-informed applications (e.g., technical basis for degradation mechanism assessment in risk-informed ISI programme development, or statistical parameter estimation in support of internal flooding PSA), and high-level summaries of service experience trends and patterns. Advanced database applications would normally rely on queries that are based on the subset of the overall database content consisting of those records for which CI = 1. By contrast, high-level database applications would draw on information from the entire database content.

<b>Completeness Index</b>	<b>Description</b>
1	Validated – all source data have been reviewed – no further action is expected
2	Validated – source data may be missing some non-essential information – no further action anticipated. The term “non-essential” implies that information about piping layout (including location of a flaw) may not be known exactly but can be inferred based on other, similar events (at same or similar plant)
3	Not validated – validation pending

**Table 1: OPDE Completeness Index (CI) Definitions**

## 5. OPDE DATABASE STRUCTURE

OPDE is a relational database in Microsoft® Access. It includes information on pipe degradation and failure in light water reactors and heavy water reactors for the period 1970 to 2008. The opening screen of the Access version (Figure 1) includes the user terms and conditions.



**Figure 1:** OPDE 2008:1 Database Opening Screen

OPDE data entry is managed via input forms, tables, roll-down menus and database relationships. Database searches and applications are performed through queries that utilise the tables and data relationships. The database structure is presented in Figures 2 through 6.

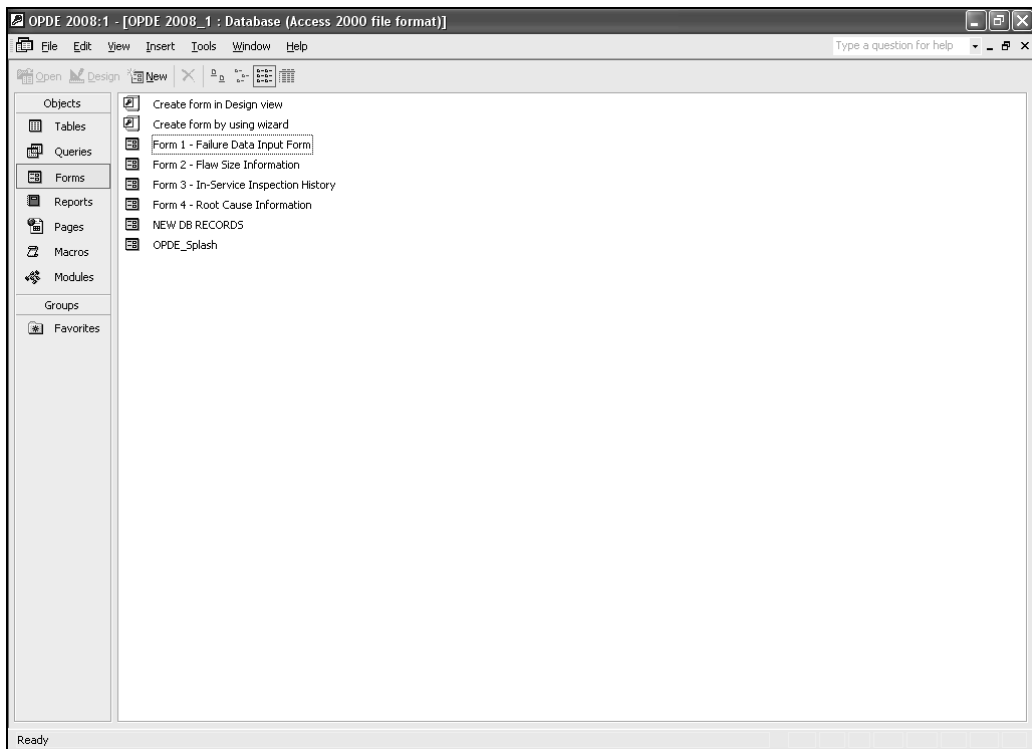


Figure 2: Database Input Forms

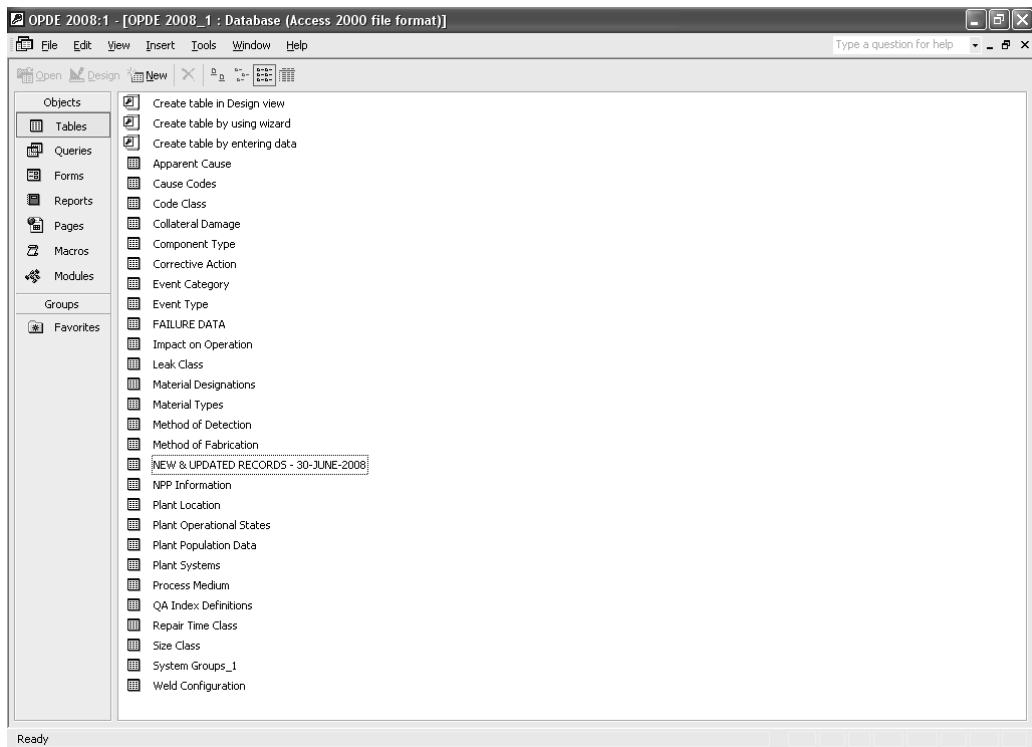


Figure 3: Database Tables & Roll-Down Menus



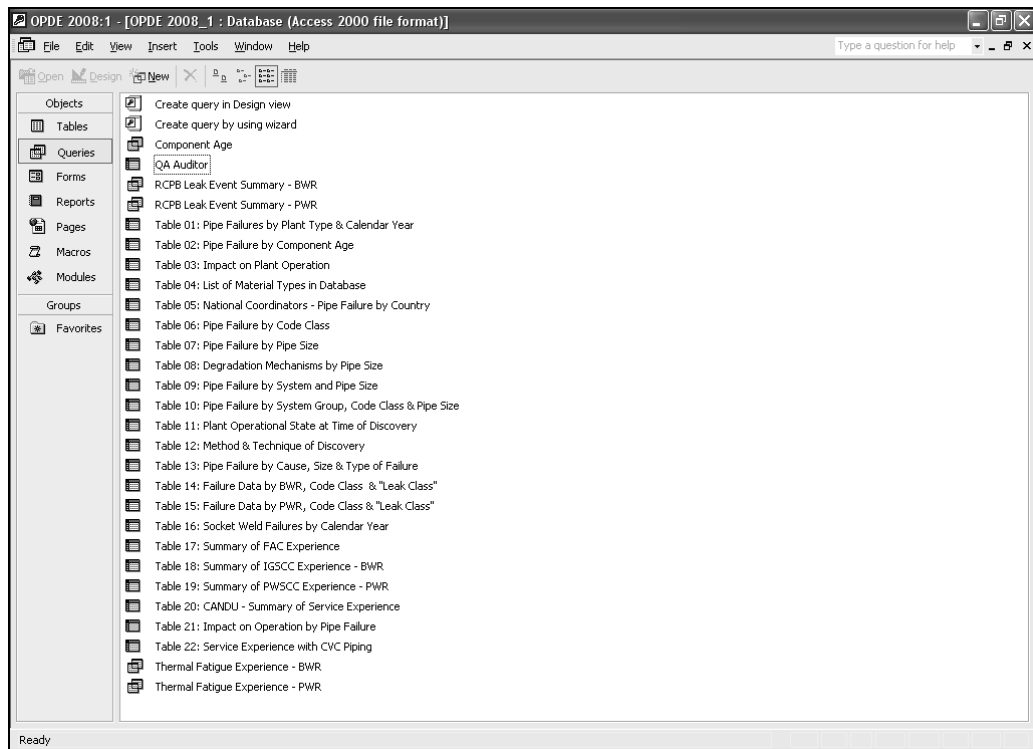


Figure 4: Database Sample Queries

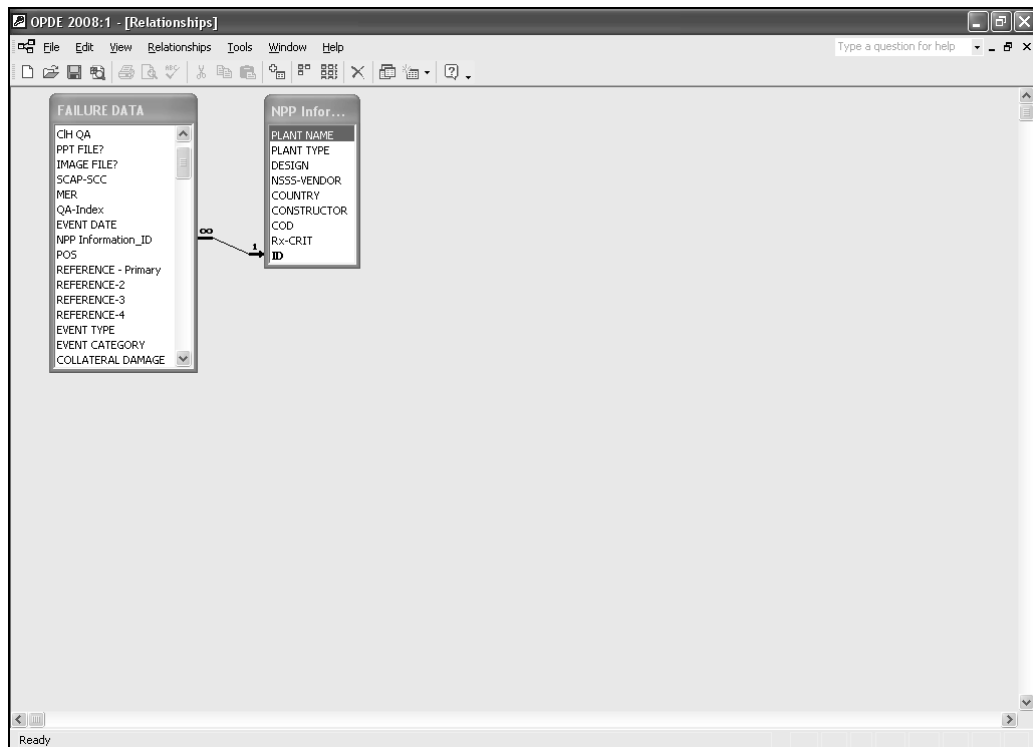


Figure 5: Database Relationships

PLANT NAME	PLANT TYPE	DESIGN	NSSS-VENDOR	COUNTRY	CONSTRUCTOR	COD	Rx-CRIT
+ Almaraz-1	PWR	WE-3	Westinghouse	ES	Entrecanales y Tavora SA	9/1/1983	4/5/1981
+ Almaraz-2	PWR	WE-3	Westinghouse	ES	Entrecanales y Tavora SA	7/1/1984	9/1/1983
+ Angra-1	PWR	WE-2	Westinghouse	BR	Gilbs & Hill / Promon Engenharia SA	12/1/1985	3/1/1982
+ Arkansas Nuclear I-1	PWR	B8WAL	Babcock & Wilc	US	Bechtel Power Corp.	12/19/1974	8/6/1974
+ Arkansas Nuclear I-2	PWR	CE-2	Combustion Eng	US	Bechtel Power Corp.	3/26/1980	12/5/1978
+ Armenia-1	PWR	VVER-440/230	AEE	AM		10/6/1979	4/1/1978
+ Armenia-2	PWR	VVER-440/230	AEE	AM		5/3/1980	1/5/1980
+ Asco-1	PWR	WE-3	Westinghouse	ES		12/10/1984	6/16/1983
+ Asco-2	PWR	WE-3	Westinghouse	ES		2/2/1986	9/1/1985
+ Barsebäck-1	BWR	AA-3	ASEA-Atom	SE	Mannesmann Rohrbau	7/1/1975	1/1/1975
+ Barsebäck-2	BWR	AA-3	ASEA-Atom	SE	Mannesmann Rohrbau	7/1/1977	3/21/1977

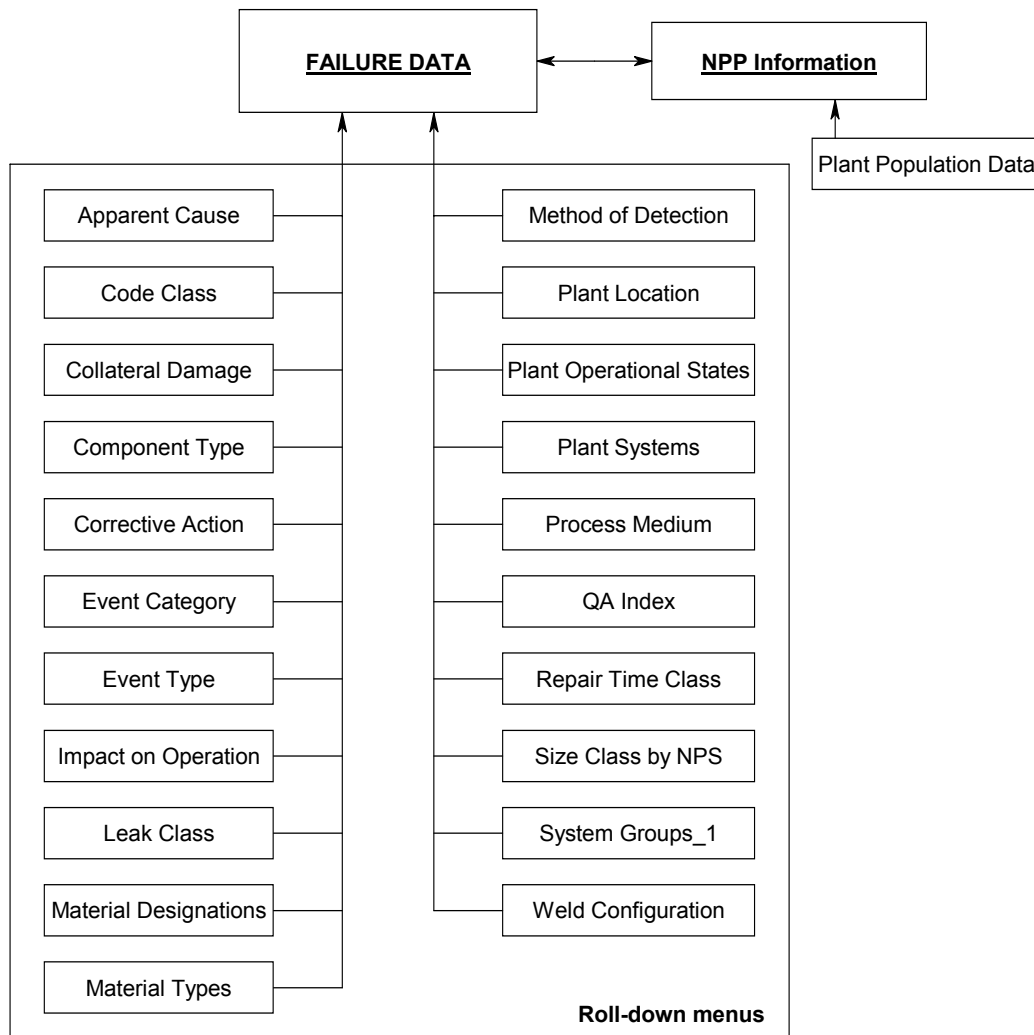
EID	NC Validation	CH QA	PPT FILE?	IMAGE FILE?	SCAP-SCC	MER	QA-Index	EVENT DATE	POS	REFERENCE - Primary
1696							2	5/2/1983	Power Operation	B2 Annual Report 1983 (Excerpted)
2130	10/22/2002	11/1/2001					1	10/6/1998	Starting Up	P2-9810-29 (10/9/98)
2016		10/7/1998					2	4/16/1983	Power Operation	B2 Annual Report 1983 (Excerpted)
2006		10/7/1998					2	10/26/1984	Power Operation	B2 Annual Report 1984 (Excerpted)
1868							1	7/17/1995	CSD - Cold Shutdown	B2-1995-321-54
1777							1	7/31/1996	CSD - Cold Shutdown	B2-RO-020/1996
1851	6/16/2005						1	8/1/1995	Refueling	B2-1995-326-66
1852							1	7/29/1997	Refueling	B2-1997-313-10
1856							1	8/1/1996	CSD - Cold Shutdown	B2-1996-321-179
1857	6/16/2005						1	8/5/1996	CSD - Cold Shutdown	B2-1996-321-180
440	6/14/2005						1	9/15/1995	CSD - Cold Shutdown	B2-1995-321-52
1867							1	7/15/1995	CSD - Cold Shutdown	B2-1995-321-65
2683	2/7/2005						1	8/1/1997	CSD - Cold Shutdown	BKAB Letter No. 1611 (1997-08-13)
1869							1	7/19/1995	CSD - Cold Shutdown	B2-1995-321-63
2680	2/7/2005						1	7/31/1996	CSD - Cold Shutdown	
2682	2/7/2005						1	7/31/1996	CSD - Cold Shutdown	
1858	5/16/2005						1	9/10/1996	CSD - Cold Shutdown	B2-1996-321-181

Figure 6: An Example of Nuclear Power Plant Information in OPDE

Implemented during 2006, an ‘Online’ version of the database (or web-OPDE) allows for data submissions over the Internet via a secure server located at the NEA Headquarters. Access to web-OPDE is restricted and password protected. Automated e-mail notifications are issued whenever an action is required by the database user. There are four user security levels:

1. NEA Administrator. The NEA IT department is responsible for security issues, including allocation of user names and passwords. The NEA Administrator has full access to the entire database.
2. OPDE Clearinghouse has access to all data and can input new data and modify data. The Clearinghouse can also download data for quality control and upload data.
3. National Coordinators can input and modify data access all their national data, and download the data with associated supporting information when so decided by the PRG.
4. Operators can input new events, modify and access their own data. The intended user at this level would be an engineer at a nuclear power plant.

The structure of the Online version of the database is identical to the Microsoft® Access version (Figure 7). Relative to the latter database version, the Online version also allows the attachment of electronic supporting documents (e.g., photographs, drawings, root case analysis reports) to a database record.



**Figure 7: OPDE Database Structure**

The database input process starts with an event report (can be a Licensee Event Report or equivalent document) and supplemented as necessary with an associated condition report, root cause evaluation report and/or structural evaluation report. Next the event is classified per the Coding Guidelines to accurately describe the applicable piping component reliability attributes and influencing factors, as well as operational impact (if any), collateral damage (if any), etc. There are 63 database fields per data record. Most of these database fields are supported by roll-down menus that consist of carefully defined keywords. These keywords act as data filters when querying the database for a particular set of records. All database applications begin by defining a query, which consist of data filter criteria that are defined using the SQL programming language.

The password protected database is distributed twice annually to respective National Coordinator on a CD. New data records can also be downloaded from the Online-version.



## 6. OPDE DATABASE 2008 VERSION

The final version of the 2<sup>nd</sup> term of the project, OPDE 2008:1 includes approximately 3600 records on pipe failure data from 321 nuclear power plants representing ca. 8300 reactor-years of commercial operation. 49% of the records relate to PWRs, 44% to BWRs and 4% to PHWR.<sup>4</sup> Tables 2 and 3 provide high-level summaries of the database content.

Nominal Pipe Size (NPS) [mm]	Number of Database Records by Failure Type		
	Non Through-Wall Crack / Wall Thinning	Active Leakage	Structural Failure
NPS ≤ 15	47	227	21
15 < NPS ≤ 25	127	882	41
25 < NPS ≤ 50	75	292	15
50 < NPS ≤ 100	214	240	14
100 < NPS ≤ 250	314	310	39
NPS > 250	544	180	29
Total:	1321	2131	159

**Table 2:** High-Level Summary (i) of Database Content

Degradation / Damage Mechanism	Number of Database Records by Failure Type		
	Non Through-Wall Crack / Wall Thinning	Active Leakage	Structural Failure
Corrosion (incl. crevice corrosion, pitting, galvanic corrosion, microbiologically induced corrosion)	45	272	5
Design, construction & fabrication errors	79	239	9
Erosion-corrosion & flow-accelerated corrosion	190	327	50
Stress corrosion cracking (incl. ECSCC, IGSCC, PWSCC, TGSCC)	837	273	0
Thermal fatigue (incl. thermal stratification, cycling and striping)	62	63	3
Vibration fatigue	60	810	48
'Other' (incl. erosion-cavitation, fretting, severe overloading/water hammer, strain induced corrosion cracking (SICC), 'classification pending')	48	147	44
Total:	1321	2131	159

**Table 3:** High-Level Summary (ii) of Database Content

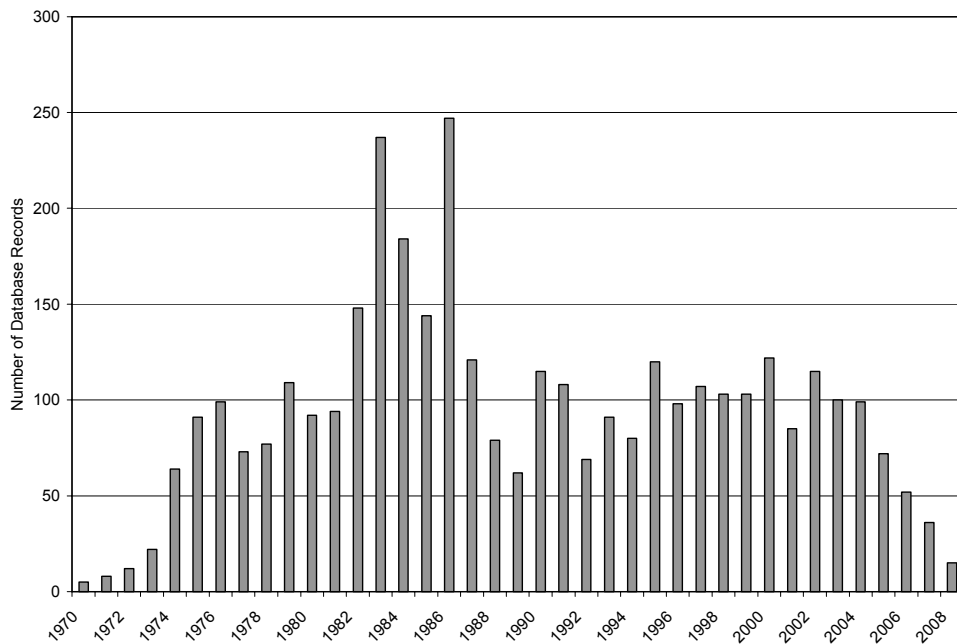
<sup>4</sup> The PWR event population includes events in WWER reactors in Czech Republic and Finland.

For an event to be considered for inclusion in the OPDE database the NC must screen the event for eligibility. However, the collected information reflects the different national reporting thresholds as well as different in-service inspection requirements and practices. Therefore the level of service experience coverage differs between the countries that are represented in the project.

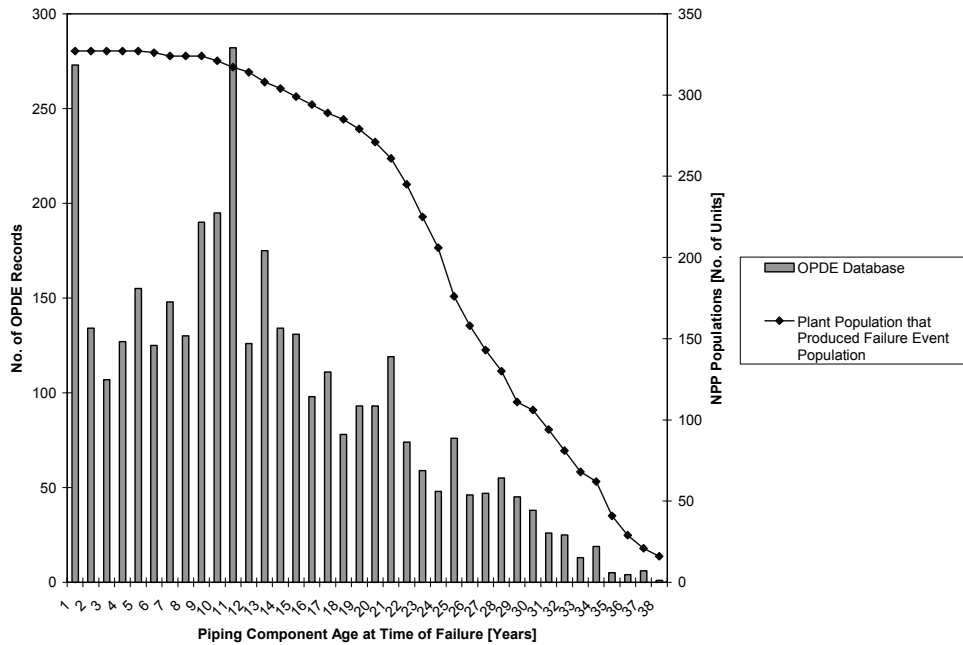
In the database through-wall flaws are characterised by “Quantity Released”, “Leak Rate Class”, and “Flaw Size.” Event reports may not always include details about a through-wall flaw such as duration, leak/flow rate or total quantity released. Knowledge about piping system design and operating pressure and temperature and flaw size usually enable best estimate quantitative assessment to be made of the magnitude of a pressure boundary breach.

Examples from the database are illustrated in Figures 8 to 12. All of these Figures only based on raw data from the database and do not include any analyses.

In Figure 8 the lack of events in the early 1970s is indicative of the low number of plants which had been commissioned. The outliers in the early 1980s are due mainly to the stress corrosion cracking issues in BWR plants. The flow assisted corrosion issues in the PWR class 4 systems from the 1980s are not included in the database. The apparent difference in the trends shown in Figures 8 and 9 is related to the difference in the number of plants in operation for a given year, which has increased over the period covered by the database.

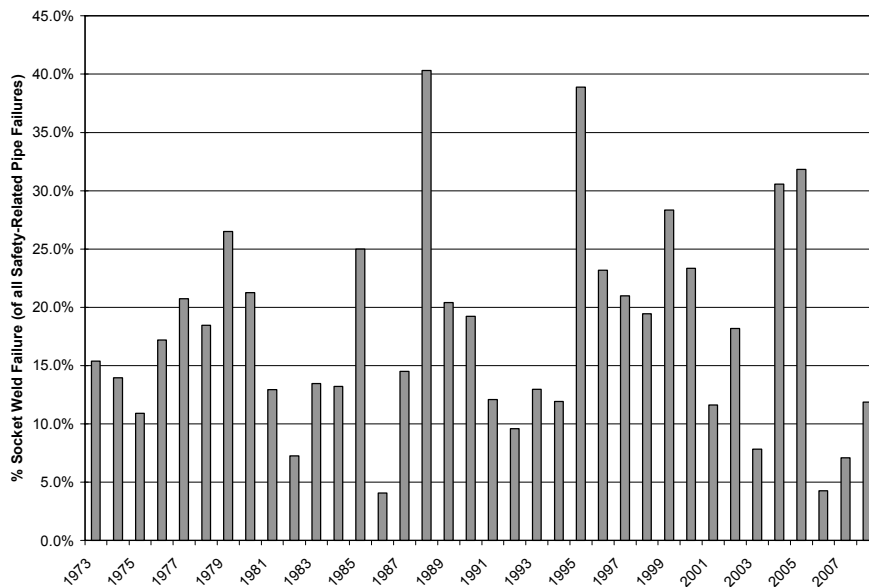


**Figure 8:** Pipe Degradation & Failure by Calendar Year



**Figure 9:** Pipe Degradation & Failure as a Function of In-Service Time [Years]

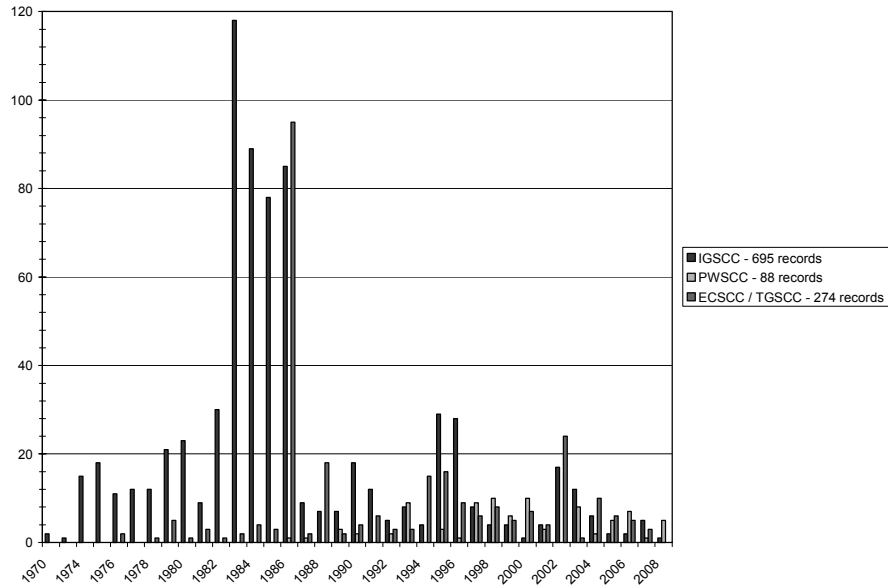
Figure 9 shows the event population as a function piping component age at the time of failure. Included in Figure 9 is the plant population that produced the pipe failure event population as recorded in the OPDE database. It is important to recognise that Figure 9 does not portray any possible effects of plant age on the potential degradation susceptibility of piping.



**Figure 10:** Socket Weld Failures in the database

Figure 10 shows that socket weld failures continue to cause plant outage and loss of MWh produced. The chart shows the number of socket weld failures as the percentage of all pipe failure in safety-related piping systems.

Figure 11 shows that stress corrosion cracking is still an issue for nuclear power plants. This Figure includes BWR SCC experience (IGSCC), PWR SCC experience (PWSCC), and LWR experience (ECSCC and TGSCC, mainly of small-bore piping systems).



**Figure 11:** SCC as a Function of Time



## 7. WORKSHOPS AND DATABASE APPLICATIONS

At the June 2004 National Coordinators Meeting hosted by the Nuclear Research Institute, REZ (Czech Republic), the Project Review Group (PRG) decided to organise a Workshop on OPDE database applications. The OPDE database is user-oriented and application-oriented. The PRG has worked extensively on these two aspects while designing the structure of the database and defining its technical content. Prior to the end of the 1<sup>st</sup> Term it was considered that the National Coordinators and their organisations could give valuable insights on this work by reporting on actual or planned applications.

The objective of the Workshop, held in Seoul, Republic of Korea on 8 December 2004, was to discuss applications of the OPDE database. The Workshop addressed two questions:

- How has OPDE database been used?
- What can OPDE database be used for?

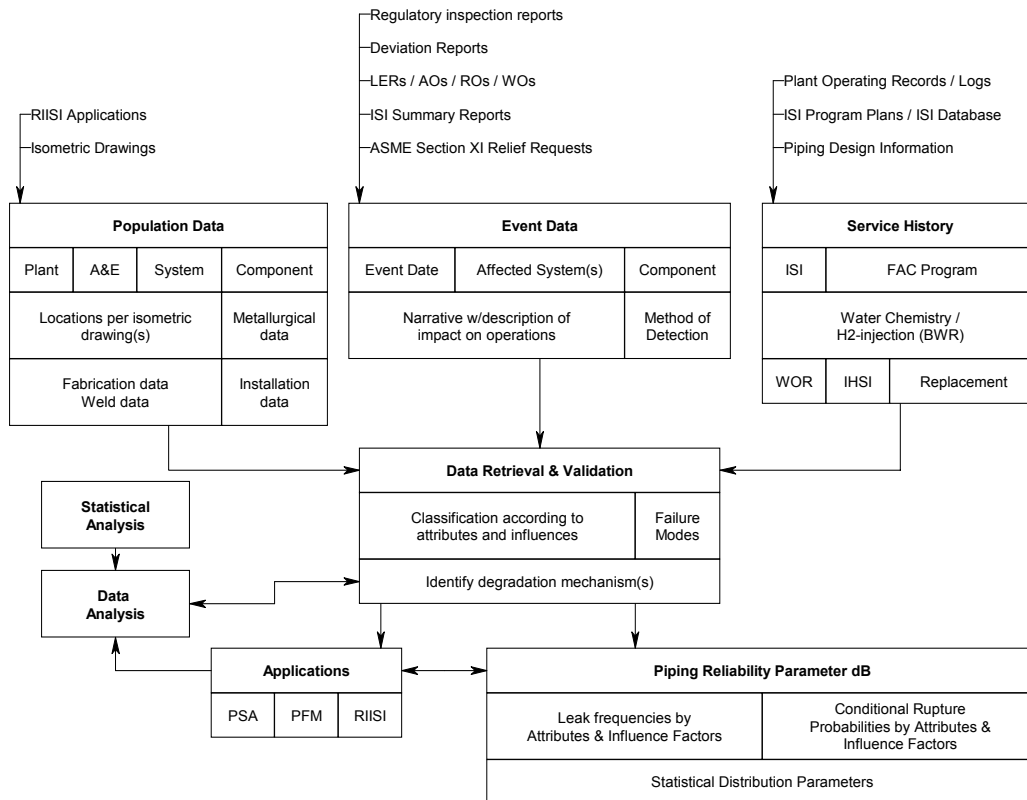
The Workshop Proceedings are documented in OPDE/SEC(2004)4 (March 2005). These proceedings include 11 presentations covering three types of applications:

- 1) Qualitative evaluations of failure trends and patterns,
- 2) Risk-informed applications in support of RI-ISI programme development or probabilistic safety assessment, and
- 3) Advanced applications supporting material science research.

The main conclusions concerning possible applications are reproduced in Appendix A.

Applications are initiated by members. In order to promote use of the database in member countries the PRG has arranged a number of half day workshops and training session in connection with PRG meetings. In addition to these several opportunities have been to present the OPDE database at international meetings and conferences. Examples of these contributions are listed in Chapter 10.

As an example of national initiatives to pursue database applications the Nordic PSA Group with representatives from utility groups in Finland and Sweden has launched a multi-year research and development effort to develop a piping reliability parameter handbook to support future risk-informed applications involving piping reliability. Figure 12 illustrates the flow of information for a typical database application.



**Figure 12:** Flow of Information for a Typical Database Application

## **8. DATABASE ACCESSIBILITY**

OPDE is a restricted database and its access is limited to participating organisations that provide input data including nuclear power plants. An “OPDE Light” database is available to enable contractors performing database related activities for project member organisations to access the necessary information. “OPDE Light” includes an excerpt of information from OPDE in which all proprietary information has been excluded. Respective National Coordinators are responsible for distribution of “OPDE Light” in their country.



## **9. CONCLUSIONS AND FUTURE PLANS**

### **9.1 Conclusions**

During the first term the original objectives of the project were achieved and an operational database was launched successfully. Participating organisations committed to continued involvement in the project.

One of the main activities of the 1<sup>st</sup> and 2<sup>nd</sup> Terms of the project was continuous database maintenance. That is populating the database with new information as it becomes available. The database format was simplified and finalised during the 1<sup>st</sup> Term and has not been changed.

The current database is run under Microsoft<sup>®</sup> Access. A recognised limitation or problem with the Access software is the incompatibility of the different software versions. During the 1<sup>st</sup> Term of the project the database was distributed to participating organisations on a CD in three versions (Access 97/98, Access 2000 and Access 2003). To improve and streamline database input and database distribution a web based user interface was introduced during the 2<sup>nd</sup> term of the project. Data input is independent of Microsoft<sup>®</sup> Access. The 'Online' version of database is located at NEA Headquarters in Issy-les-Moulineaux (France) and project participants have access via a secure server.

### **9.2 Third Term (2008-2011) Planned Activities**

In addition to continued database maintenance, the 3<sup>rd</sup> Term of the Project will focus on enhancing the user interface of the Online Version to allow for database searches and report generation.

The Project will continue to encourage and promote practical database applications. The Project will therefore continue to arrange workshops in member countries as requested to promote use of the database, industry involvement, and training of personnel.

Problems of the concurrent use of different versions of Microsoft<sup>®</sup> Access by the member organisations continue, and the distribution of CDs has become much more complicated and tedious. The conversion to an entirely web-based system both for entering new events and also for downloading the database will be investigated during the third term.

The Clearing House, now that the structure of the database is fixed and most of the validation of old data is complete, will develop the database making it more user-friendly than is the case for a standard application of Microsoft<sup>®</sup> Access. This is important since the database should be available to a wider range of users and not be limited to those who are proficient in using Microsoft<sup>®</sup> Access.”



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## APPENDIX A: LIST OF POTENTIAL DATABASE APPLICATIONS

Workshop on database applications and possible improvements to the database held in Seoul, Republic of Korea, on December 8, 2004.

### Applications

- Trend analyses of degradation processes: general and related to specific systems or components
- Identification of new degradation mechanisms
- Effectiveness of ISI programmes – flaws not detected by prior inspections
- Effectiveness of mitigation measures
- Understanding of root causes of failures
- Hazard plots
- Comparison of service data and probabilistic fracture mechanic calculations using different codes
- Leak rate versus flaw size correlations
- Flooding risk assessment
- LBB
- Risk informed inspection – support to expert panels
- Piping damage frequency
- Piping rupture frequency for PSA
- Aging management programme
- Source of information for solving practical piping problems
- Source of information for specifying locations for measurements such as temperature
- Classing of piping
- Recommendation for content of incident reports
- Experience feedback, operational experience
- Input to Structural reliability codes
- LOCA frequencies
- Significance determination process
- Accident sequence precursor
- Generic structural integrity
- Proactive materials degradation assessment

### Advancing the OPDE database

- Inclusion of pipe stress data in database
- Roles of service data versus statistical estimation versus PFM input
- Inclusion of passive component failures in risk informed applications
- Pipe failure parameter handbook
- Operating temperatures for PWSCC