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Report of Study Group 3.4

A Guideline

***"Using or Creating Incident Databases for Natural Gas
Transmission Pipelines"***

Rapport du Groupe d'étude 3.4

Une Directive

***« Utiliser ou Créer des Bases de Données des Incidents
concernant les Canalisations de Transport de Gaz Naturel »***

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ABSTRACT

This report details the work undertaken by Study Group 3.4 during the triennium 2003–2006. The initiative that launched the work of this study group came during the 22nd World Gas Conference, where it was noticed that the use of pipeline incident information often is not fit for purpose.

A comparative analysis has been carried out considering the most frequently used and reliable high pressure gas pipeline incident databases. The four main objectives of the analysis are described in the following:

- Determine the differences and similarities of existing databases
- Create a reference model to be used when developing a new pipeline incident database
- Assess if harmonization of existing databases is possible
- Provide recommendations regarding the above

RÉSUMÉ

Ce rapport expose en détail le travail entrepris par le Groupe d'étude 3.4 au cours de la période triennale 2003-2006. L'initiative à l'origine du travail de ce groupe d'étude a vu le jour au cours de la 22^e Conférence Mondiale du Gaz, à la suite de la constatation que souvent les informations sur les incidents concernant les canalisations n'étaient pas utilisables pour le but recherché.

Une analyse comparative des bases de données les plus utilisées et les plus fiables sur les incidents concernant les canalisations de gaz à haute pression a été effectuée. Cette analyse avait les quatre objectifs suivants :

- déterminer les différences et les similitudes entre les bases de données existantes ;
- concevoir un modèle de référence pour créer une nouvelle base de données des incidents concernant les canalisations ;
- déterminer s'il est possible d'harmoniser les bases de données existantes ;
- donner des recommandations en ce qui concerne ce qui précède.

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1. INTRODUCTION

During the 22nd IGU World Gas Conference held in Tokyo 2003 it was noticed that many presentations used different existing pipeline incident databases (PID) as reference. Very often references were made to the US Department of Transportation (DOT) [1] database and the European Gas pipeline Incident data Group (EGIG) [2] database.

In some cases, the pipeline incident frequencies derived from the DOT database was compared with the frequencies derived from the EGIG database and, based on the observed differences, conclusions were drawn about the quality of the databases. In some risk analysis, pipeline incident frequencies were used without consideration of the data referenced and the background of associated frequencies.

The EGIG members in particular observed that there was a substantially increasing demand for the EGIG report. It was noted that the EGIG information was being used to assess risk associated with oil pipelines in South America or offshore pipelines in the Gulf of Mexico. Given the limitations of the database, it was concluded that the EGIG data was misused and for some cases the “damage” is considered irreparable.

Therefore the EGIG companies has taken the initiative and proposed to International Gas Union (IGU) the implementation of a comparative analysis covering the most frequently used pipeline incident databases and the preparation of a guideline of how and when to use which database. This proposal was presented and approved at the first Working Committee 3 (WOC-3) meeting in September 2003 in Bilbao, Spain.

1.1. Scope of the work

Early work looked at a comparison of incident databases covering the whole gas chain. However, due to the relatively short period of time that was available to conclude the project, the study group has limited itself to “only” pipeline incident databases pertaining to onshore high pressure gas pipelines. Some of the databases do contain offshore incidents, however, the main focus of this report is on the onshore gas pipelines. Another reason for this limitation in scope is the knowledge that the safety of a gas transmission system is mainly dominated by cross country onshore pipelines and not by other parts of the gas chain.

Not all pipeline incidents directly affect the safety of the pipeline. The following 4 levels of incident are often indicated and categorised:

1. **unintentional release** of the product causing a directly unsafe situation, e.g. holes and ruptures (with and without ignition);
2. **pipeline damage** affecting the pipeline integrity which could result in a directly unsafe situation, e.g. scratches, dents and gouges;
3. **coating damage** causing an integrity problem in the long term, e.g. external corrosion;
4. **near miss** not affecting the integrity of the pipeline but which could result in a level 1, 2 or 3 incident; unnoticed ground activities in the vicinity of the pipeline.

From literature it is known that there is a relationship between the number of incidents at each incident level. This relationship is referred to as “the Iceberg Theory” [6] and is visualised in Figure 1.

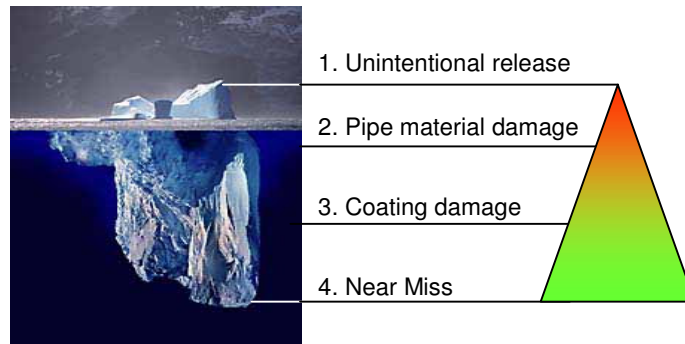


Figure 1: Iceberg Theory

The databases that were taken into account within the scope of IGU Study Group (SG) 3.4 covers only level 1 pipeline incidents. Due to major differences in definitions, descriptions and circumstances it is not reliable to compare results from all four incident categories derived from different databases with each other. However, most pipeline owners and operators have pipeline integrity management systems in place that enable the evaluation of all levels of pipeline incidents.

The scope of work for IGU SG 3.4 was approved by the WOC 3 of IGU (transmission) and the main elements are:

- Determine the differences and similarities of existing databases;
- Create a reference model to create a new pipeline incident database;
- Determine if harmonization of existing databases is possible;
 - Provide recommendations regarding the above (including promotion of the results).

As the suggested activities to promote this guideline is considered to be applicable to all published IGU reports, the study group has decided to integrate this part of the work as a separate appendix to this report (see appendix 9.1).

1.2. Participants

Company	Country	Name	Membership
ENAGAS, S.A.	Spain	Mr. D. Velez Vega	Active
E.ON Ruhrgas AG	Germany	Mr. A. Hilgenstock	Active
Gassco, AS	Norway	Mr. O. Rasmussen	Active
Gasunie	The Netherlands	Mr. R. Bolt	Active, chairman
SNAM Rete Gas	Italy	Mr. A. Cappanera	Active
Transcanada Pipelines	Canada	Mr. B. Rothwell	Active
XG Gas Transmission	Algeria	Mr. A. Taberkokt	Active
National Energy Board	Canada	Ms. K. Duckworth	Guest member
OPS	USA	Mr. R. Little	Guest member
PRCI	USA	Mr. H. Haines	Guest member
PRCI/Kiefner & Associates, Inc	USA	Ms. C. Kolovich	Guest member and consultant
APIA; Pipeline Operators Group (POG),	Australia	Mr. P. Tuft	Corresponding
Fluxys	Belgium	Mr. A. Niemirowski	Corresponding, after 2004 vacant
R&K Consulting	Russia	Mr. B. Krivoshein	Corresponding
TGS	Argentina	Mr. E. Espineira	Corresponding
UKOPA	UK	Mr. R. Owen	Corresponding

Table 1: Members IGU Study Group 3.4

Especially Mr. R. Minson from E.ON Ruhrgas is kindly acknowledged for his valuable contribution to the comparative analysis.

1.3. Approach

After an exploratory meeting with active members, the scope of work and the approach was discussed and approved. In order to understand the importance of and need for pipeline incident information, the study group identified and described in section 2 the users of pipeline incident information.

The next phase was to develop an inventory of which databases that are available (internet search) and all characteristics of the identified databases were explored and organized. Based on this inventory, the goals, definitions, database architecture, collecting process and statistical elaboration of pipeline incident databases were described, ref. sections 3.1 to 3.5. In section 3.6, more information is given on the most frequently used worldwide pipeline incident databases. The information given in this section was prepared in close cooperation with the database owners themselves.

This information was the basis for carrying out the comparative analysis as shown in section 4. The analysis demonstrates very clearly the similarities and differences between all the investigated databases.

Based on the comparative analysis, the study group has developed a description of the importance of using fit for purpose pipeline incident databases, ref. section 5.

In section 6 the IGU pipeline incident database reference model is given, as well as recommendations for harmonisation of existing databases.

1.4. Meetings

An overview of the meetings is given in the following table 2.

Meeting number	Date	Place	Issues
Study Group meetings			
1	13-14 January 2004	Beetsterzwaag – The Netherlands	Exploratory
2	26-27 April 2004	Milan - Italy	First inventory of available databases and comparative analysis
3	30 Sept.- 1 Oct. 2004	Calgary - Canada	Discussion progress/ comparative analysis.
4	10-11 March 2005	Washington DC - USA	First ideas about harmonisation and a database reference model
5	21-22 September 2005	Essen - Germany	Discussion/first draft report
6	19-20 December 2005	Madrid - Spain	Discussion/final report.
Special task expert meetings			
A	31 August 2004	Moscow - Russia	Extra input from Russian delegate
B	9 March 2005	Washington DC - USA	Database expert meeting
C	22-23 August 2005	Algiers - Algeria	Extra input from Algerian delegate
D	28 November 2005	Birmingham	Check draft report with UKOPA database representative

Table 2: Study Group 3.4 meetings

The meetings 1 to 6 are described as working meetings and the meetings A to D were meetings with a special task.

2. IMPORTANCE OF AND NEED FOR PIPELINE INCIDENT INFORMATION

2.1. General

Statistics indicate that high pressure gas pipelines are inherently safer for the public than other modes of gas transportation. The gas transmission industry in particular assures high safety performance for its pipelines by paying great attention to safety issues, to environmental protection and to reliability during all the phases of the service life of a pipeline.

However the gas transmission industry is increasingly requested to demonstrate this safety performance in response to requests from regulating authorities or from the public with regard to new or existing pipelines. These requests are dealt with by ensuring open and detailed communication.

In this respect, data and information regarding the incidents, the corresponding failure mechanisms and the resulting consequences, as well as information related to the industrial facilities and its operations, have become of increased importance to open and effective support in this communication process.

In this environment information regarding incidents needs to be used by and communicated between the various parties and disciplines within the same company, between other pipeline operating companies or outside the companies, while using the most appropriate analysis methodologies with the aim of establishing the safety performance with regard to people and the environment or to analyse plant or system performance.

The need for this type of information is clearly evidenced by the great quantity of such information being issued around the world. Websites, paper publications, symposia, handbooks, and PhD Theses etc. which deal with safety matters very often use incident statistical data for supporting their conclusions.

Various comprehensive databases exist throughout the industry. Government authorities and pipeline operating companies collect data on pipeline incident and their causes. These "incident databases" and the data they contain, together with analysis of any incidents which occurs, are essential for the authorities, operating companies and engineering companies as well as for the general public to both demonstrate and ensure that pipelines remains a safe and reliable means of transporting gas.

Data collection can be mandatory or voluntary and it is possible to distinguish between three main types of databases:

- database owned and compiled by a single company that collects information regarding its own network and analyses the data;
- database managed by the authority/regulatory body that collects information regarding the networks of the companies under its regulatory responsibility;
- database compiled through a co-operation agreement between a group of national and international companies.

The incident databases will be designed according to its specific use and the need of the company/companies collecting the data. For instance, a database may be intended for both internal and external use and consequently the database must allow for performing data analysis at different detail levels; the structure of the incident database will greatly vary for each different situation as the architecture of the database must be fit for purpose.

The importance and need for these incident databases for the different stakeholders mentioned above are discussed in the following paragraphs.

2.2. Users of Pipeline Incident Information

2.2.1. Authorities and Regulatory Bodies

For the authorities, data and information regarding incidents are fundamental. The analysis of the incident data should advise on the need to maintain or improve the existing legislation or standards and, where necessary, on the need to propose new initiatives.

Using the information, authorities can play an ever more active role in identifying deficiencies or gaps in the legislation or requirements regarding external safety for individuals and the protection of the environment. The technical knowledge which is gained from analysing the incident databases represents a powerful tool in order to identify the areas where more focused attention is required.

The incident information can also strongly support the strategy behind countries energy supply market, allowing a benchmark among different industrial energy sectors, where energy demand and energy source are linked with safety for individuals and observance of environmental standards.

2.2.2. Gas Pipeline Operating Companies

The overall responsibility to comply with regulatory requirements relating to the construction, operation and maintenance of hazardous liquid and gas pipelines is the responsibility of pipeline operating companies in each country.

Additionally, when regulatory requirements do not exist, prudent operating companies can apply regulations from other countries or internal company practices and procedures.

In order to manage this responsibility, accurate statistics can be an effective tool for the management of different activities and some examples of possible applications are given in the following:

- *Construction of new pipelines*
In order to obtain all the permits necessary for constructing new pipelines the gas pipeline operating companies are required to prepare and submit documentation adequately demonstrating the safety of the new projects. This documentation normally includes an analysis of the possible hazards and the effects on safety and on the environment due to the presence of the new pipelines linked with the route selection.
- *Improvements to or demonstration of the safety of existing pipelines*
Information on the most frequent types of incidents and the category of pipelines most frequently affected, enables pipeline operating companies to gain a better understanding of the causes of incidents, to monitor trends and to diagnose problems that may indicate the need for targeting solutions or additional actions or protective measures.

Using these facts, pipeline operating companies can demonstrate to authorities, regulatory bodies and the public the safety levels of the network and monitoring

effectiveness. This knowledge can also optimise their maintenance and inspection programs by concentrating efforts on these critical areas.

- *Evaluation of safety management system performance*
The information obtained from the incident databases can be used to measure the performance of a Safety Management System (SMS), to verify that the policies regarding safety and environmental protection adopted are effective, to demonstrate to all the stakeholders the reliability of the transmission system, to characterise the overall health of the industry and to determine if the resource allocations adopted are functioning effectively.
- *International benchmarking*
Groups of companies can decide to exchange incident data, improve communications regarding safety performance, create a “safety language” and carry out benchmarking analyses. In order to make this possible, a common viewpoint is required and a standard definition of the data to be collected and the analysis to be performed.

2.2.3. General Public

Historically, communication relating to pipeline safety aspects has been “what the technical experts told the outside world”. It would typically be largely one-way communication where the public had little or no input in determining the acceptability of the safety levels, or in making safety management decisions.

However, the public no longer willingly accepts, without question, the decisions of the “safety experts”. The public is requiring to be allowed to give input into safety decisions that affect the environment and the community, sometimes showing a strong opposition often referred to as the NIMBY (not-in-my-backyard) syndrome. This, along with increased regulatory requirements for safety communication, has created a need for an improved and better understanding and management of the safety communication process and the factors that influence risk perception.

Greater awareness of the general public concerning the safety of pipelines transporting hazardous products has led to the need on the part of pipeline operating companies to assure the public that the condition of these pipelines is adequately known, that current regulations and industry practices are adequate and are being implemented and that the need for additional protection has been explicitly and responsibly considered.

These assurances given to the public should also include information about the operational history of the pipeline and its safety record in general. A valuable tool in demonstrating these safety aspects is a comprehensive incident database which clearly indicates the safety record of the pipelines: an appropriate use of the database statistics can support a positive and reassuring dialogue with the local public.

2.2.4. Consultants/Contractors/Engineering Companies

Due to requirements from regulating authorities and pipeline operating companies, consultants, contractors and engineering companies rely more and more on statistics obtained from pipeline incident databases to evaluate and optimise their pipeline designs.

The data is important for design activities in order to evaluate hazards to which a given pipeline is subject, thus enabling improvements in the design of the pipeline and its protective measures by taking into consideration the relevant failure scenarios.

It is also important to optimise recommended maintenance programs by concentrating efforts where the relevant threats are greatest, thus guaranteeing the safety levels while ensuring that pipelines stays a competitive alternative for gas transportation.

3. WORLDWIDE PIPELINE INCIDENT DATABASES

The following chapters will describe the basic principles of pipeline incident databases as well as selected gas transmission pipeline databases in countries across the world.

3.1. Basic Principles of Pipeline Incident Databases

3.1.1. Goals of Pipeline Incident Databases

The objectives for collecting incident data have to be clearly stated before the data collection process starts. The database aims can differ according to technical and legislative scenarios.

For instance, the information could be necessary for analysing:

- Safety Performance;
- Quantitative Risk;
- Structural Integrity;
- Availability;
- Benchmarking.

The definition of these needs is fundamental in order to collect relevant information, adopting the most suitable database architecture for the intended use.

In any case, due consideration should be given to the principle of “lessons learnt” from previous incidents (both within and outside the organisation) during operation of the installations concerned.

3.1.2. Definitions

The main characteristics of the databases can be summarised in three essential points:

- Incident definition (failure mode and consequences);
- Database population and boundary;
- Reference period.

The incident definition can be based on the failure mode (e.g. loss of containment or unserviceability of the system) and/or on the magnitude of consequence. This definition heavily influences the content of the database and limits its application field (e.g. its “fitness for purpose”).

The database population is any detailed information with regard to the pipeline network. The database boundary is defined, in general, according to life cycle phases of the gas transmission activity (construction, operations and abandonment) and the installations taken into consideration (e.g. onshore versus offshore, pipeline only or including equipment). Most of the databases focus on the incidents which occur during the operating phase.

Two examples of different kinds of equipment boundaries are EGIG and DOT (see following chapters). In the European database (EGIG) the incident definition is more selective than the DOT definition. EGIG only considered incidents relating specifically to pipelines, while in the US database (DOT) include incidents related to valve stations, etc.. On the other hand the DOT database disregard the occurrence of small leakages due to a financial threshold and a definition of “significant consequence” (i.e. fatality or injury).

The reference period has to be established according to: the incident definition, the equipment boundary and the collection process.

All the above elements (incident definition, life cycle phases, equipment, reference period) have to be verified and analysed with great care when different databases are compared.

3.1.3. Database architecture

The databases can also have different structures and data details depending upon the individual goals of each pipeline incident database.

Nevertheless, two main kinds of information are generally collected:

- Information about the incident;
- Information about the equipment population.

The information about the incident usually covers:

- the incident causes
- the equipment involved
- the size of the damage
- the detection modality
- the consequences

In most of the existing databases, the information about equipment population relates to the pipeline network length. Very often the pipeline exposure (length of a pipeline times its exposure duration) is also used. In some of the databases, this length is reported for different classes of relevant parameters (e.g. diameter, year of construction, wall thickness and so on).

Using the above information the most common elaborations cover:

- the evaluation of the importance of the damage caused;
- the incident trend versus time due to different threat scenarios (related to the reference period of the database or as a moving average);
- the likelihood/number of casualties per threat scenario.

3.1.4. Collecting process

The quality of the data gathered in a database has to be ensured through a suitable collection process:

- The origin of the data has to be documented and traceable;
- The data has to originate from similar equipment type, technology and operating conditions;
- The data has to be recorded in the correct format.

During and after the data collection exercise, the data needs to be analysed to check consistency and correct interpretations.

The quality control process has to be documented. Whether the data collection is compulsory or voluntary the quality of the data can be very high if the company defines appropriate tools for avoiding “poor” or incomplete information. One of these tools is the adoption of a management system where rules and responsibilities for collecting and elaborating the data are defined inside the company.

3.1.5. Statistical elaboration

A sufficient amount of data has to be collected in order to give an acceptable statistical confidence level.

Data covering several years of operation may be needed before sufficient data has been accumulated to give confidence in analysis results and relevant decision support. Data collection shall therefore be seen as a long-term planned activity and should be executed with appropriate goals in mind. At the same time, clarity as to the causes of failure is the key to prioritising and implementing corrective actions that will result in sustainable improvements in reliability, leading to improved profitability and safety.

The above elements must be analysed with great care, in all cases and by all the users, before using the data information since each of them can strongly influence the validity of the evaluations: the misinterpretation of one element could lead to wrong conclusions.

The same attention must be paid when different databases are compared with each other. The risk is that simplistic and incorrect conclusions can be drawn when incompatible statistics are compared with each other without a complete understanding of the origin and nature of the data. For example it is not correct to assume that the “incident frequencies” published by different database owners are directly comparable just because they have the same “units” of incidents per kilometre per year.

In this case it is strongly advisable to set up a comparison method in order to link or translate each piece of information from one database to another. The method could be based on an analytical approach and on engineering judgement but should, in any case, be clear and open, avoiding or indicating all the possible “grey” areas from which misunderstandings can arise. One of the goals of this guideline is to highlight where the differences lie and how to correctly compare statistics from different sources.

3.2. Databases

In the following sections selected pipeline incident databases, covering onshore high pressure gas pipelines are described taking the above points into consideration:

- **North America:**
 - Natural Gas Gathering and Transmission System Incident database, managed by Department Of Transportation (DOT);
 - Statistics about pipeline incidents, managed by National Energy Board (NEB)- Canada;
 - Pipeline Incident Database British Columbia, managed by OGC (Canada);
 - Statistical Series managed by Alberta Energy and Utilities Board (EUB - Canada).
- **Europe:**
 - Gas Pipeline Incidents, managed by European Gas pipeline Incident data Group (EGIG);
 - Pipeline Fault Database, managed by UKOPA.
- **Australia:**
 - Developmental Pipeline Incident Database, APIA (Australia)

The summaries of these databases were provided by the respective countries and database owners. Additional contributions from Argentina, Algeria and Russia are included in attachment 9.2.

3.2.1. USA

3.2.1.1. General

The U.S. Department of Transportation was established in 1966 by an act of Congress. The Department of Transportation consists of the Office of the Secretary and eleven individual operating administrations that govern forms of transportation that include aviation, roadways, railways and pipelines. Pipelines are regulated by the Office of Pipeline Safety (OPS) under the Pipeline and Hazardous Materials Safety Administration (PHMSA). Prior to 2005, OPS functioned in the Research and Special Projects Administration (RSPA).

Pipeline incidents that meet at least one of the following criteria must, by law, be reported to the U.S. Department of Transportation (DOT), Office of Pipeline Safety. The criteria for reporting are stated in the Code of Federal Regulations, Title 49 Transportation, Part 191, Paragraph 191.3. A report is required if the incident results in any of the following:

An event that involves a release of gas from a pipeline or liquefied natural gas from an LNG facility and

1. A death or personal injury necessitating in-patient hospitalization; or
2. Estimated property damage, including cost of gas lost, of operator or others, or both, of \$50,000 or more.
 - 2.1. An event that results in the emergency shutdown of an LNG facility.
 - 2.2. An event that is significant in the judgment of the operator, even though it did not meet the criteria of Paragraphs (1) and (2).

The DOT has been collecting incident data on natural gas transmission pipelines since 1970. The reporting format and the criteria that triggered a report underwent a change in 1984 and again in 2002. The basic "regulated" infrastructure consists of about 325,000 miles of pipelines. These range from 2.375 to 42 inches in diameter. Some miles of gas pipeline exist that are not historically regulated by the OPS that are therefore exempt from reporting requirements and not represented in the database.

This pertains primarily to certain offshore and onshore gas gathering lines, certain LPG systems and LNG facilities. The infrastructure data is obtained from the annual reports submitted to the DOT by each operator, Form 7200.2-1, which is included as an attachment. Thus, although emergency shutdowns are covered under (2), LNG facilities are exempt from completing the annual report containing population data.

3.2.1.2. Reporting attributes

Attributes of each operating company's pipelines are to be reported on a 'miles of pipeline' basis. The attributes included are number of miles by type of material, by nominal size, by decade of installation and by class location. Although these attributes are more detailed than many databases they are not as detailed as those contained in the EGIG database.

The \$50,000 cut-off is different from any other country's database, and as a result the number of leaks reported in detail is much smaller than any of the other databases. These leaks are accounted for on an annual basis in the annual report which tabulates the total number of leaks eliminated/repaired during the calendar year.

A reportable incident must be submitted on standard DOT form 7100.2. This form requests the following data:

- Operator name and address
- Time and date of the incident
- Location of the incident
- Type of leak or rupture
- Consequences (includes fatalities and injuries as well as loss of product, property damage and whether an explosion occurred)
- Elapsed time until area was made safe
- Telephone report information
- Pressure at the time of the incident as well as the Maximum Allowable Operating Pressure (MAOP) and how the MAOP was established under the rules

The remaining two pages of form 7100.2 request detailed information about the origin of the incident and the attributes of the pipeline involved (nominal pipe size, wall thickness, grade of pipe and seam and valve type). Several other sections require the operator to submit detailed information relating to the cause of the incident. Lastly, a narrative description is included on the form that requests any additional information that is relevant to the incident being reported.

3.2.2. Canada

3.2.2.1. General

The National Energy Board (NEB or Board) is an independent regulatory tribunal that was established in 1959. It reports to Parliament through the Minister of Natural Resources. The main responsibilities of the NEB are found in the *National Energy Board Act* (NEB Act). These include regulating the construction and operation of pipelines that cross international or provincial borders, as well as tolls and tariffs. Another key role is to regulate international power lines and designated interprovincial power lines. The NEB also regulates natural gas imports and exports, oil and electricity exports, and some oil and gas exploration on frontier lands, particularly in Canada's North and certain offshore areas. The Board has additional regulatory responsibilities under the *Canada Oil and Gas Operations Act* (COGO Act) and under certain provisions of the *Canada Petroleum Resources Act* (CPR Act).

The National Energy Board (NEB) is responsible for application and enforcement of the *Onshore Pipeline Regulations 1999* (OPR), the *Processing Plant Regulations* (PPR), the other Acts and Regulations as listed on the NEB website pursuant to the *National Energy Board Act* (NEBA) and the *Canadian Oil and Gas Operations Act* (COGOA). In addition, through a Memorandum of Understanding (MOU) with Human Resources and Skills Development Canada (HRSDC), the NEB is responsible for application and enforcement of the *Canada Labour Code Part II* (CLC Part II), the *Canada Occupational Health and Safety Regulations* (COHSR) and the *Oil and Gas Safety and Health Regulations* (OGOSH). Under these statutes and regulations, companies are required to provide the NEB with various notifications and reports.

Under the NEB Act, a pipeline is defined as:
a line that is used or to be used for the transmission of oil, gas or any other commodity and that connects a province with any other province or provinces or extends beyond the limits of a province or the offshore area as defined in section 123, and includes all branches, extensions, tanks, reservoirs, storage facilities, pumps, racks, compressors, loading facilities, interstation systems of communication by telephone, telegraph or radio and real and personal property, or immovable and movable, and works connected to them, but does not include a sewer or water pipeline that is used or proposed to be used solely for municipal purposes.

These acts and regulations affect the full life cycle of a pipeline, from application, through construction to abandonment. For ease of comparison, this document will focus on the reporting requirements related to pipelines regulated under OPR of the NEB Act.

Under Section 52.(1) of the OPR, a company shall immediately notify the Board of any incident relating to the construction, operation or abandonment of its pipeline and shall submit a preliminary and detailed incident report to the Board as soon as is practicable. Incidents are further defined as an occurrence that results in:

- the death of or serious injury to a person;
- a significant adverse effect on the environment;
- an unintended fire or explosion;
- an unintended or uncontained release of LVP hydrocarbons in excess of 1.5 m³;
- an unintended or uncontrolled release of gas or HVP hydrocarbons;
- the operation of a pipeline beyond its design limits as determined under CSA Z662 or CSA Z276 or any operating limits imposed by the Board [7].

In addition to the legal reporting requirements, NEB-regulated pipeline companies have been requested to voluntarily report the following:

- Number of work injuries to company employees (not already submitted as per the OPR) working on federally regulated facilities.
- Number of work injuries to contractor employees (not already submitted as per the OPR) working on federally regulated facilities.
- Total worker hours from company employees working on federally regulated pipelines.
- Total worker hours from contractor employees working on federally regulated pipelines.
- Safety training hours from company employees working on federally regulated pipelines.
- Number of liquid spills >1.5m³ on federally regulated facilities.

Please segregate the spills as follows:

1. hydrocarbon spills resulting from construction / maintenance activities (such as spills of hydraulic fluid, equipment fuel lubrication fluids, valve operator fluid, engine oil, etc).
2. pipe content spills resulting from breaks or leaks from the pipe body, flanges, mechanical fittings, tanks, etc.

The voluntary reporting in conjunction with the mandatory reporting forms the basis of the data provided in the annual Performance Indicator report: Focus on Safety and Environment – A Comparative Analysis of Pipeline Performance [3].

3.2.2.2. Pipeline Incident Database (PID)

The current database (PID) was developed specifically for pipeline incidents and was implemented in 2001. An Excel spreadsheet was used to log incidents that occurred prior to 2001. PID has a fairly sophisticated search function and enables the user to run reports with pre-defined criteria and user defined criteria. Incident information is entered into the database as the information is received. The boxes in the database contain either fixed drop down lists or drop down lists that enable the user to add information, such as a location. Entries into the database are periodically audited by the PID administrator to ensure consistency of the data entered.

The incident tab is illustrated in Figure 2. This tab captures the basic incident data. The equipment tab illustrated in Figure 3 captures data specific to the failed component. The drop down list in this tab includes all equipment associated with pipelines including equipment at compressors, pump and meter stations, tank farms, etc. Other tabs included in PID but not illustrated are a cause tab, which provides the immediate and basic causes of an incident, and a recommendation tab, which tracks any recommendations resulting from an incident.

Pipeline Incident Database - PRODUCTION

File Edit Data Reports Utilities Window Help

Incident

Incident Location Weather Occurrence Type Release Loss Reports Action Details Acts/Regs Investigative Body Multimedia

Incident #: File #: Added:

Reported To: Changed:

Received by: TSB #:

Reporting Company: Reportable:

Category Type:

System Type:

Pipeline System Component:

Facility Name:

Pipeline Name:

Total Estimated Cost:

Assigned To:

Description:

Idle Mode

Print to report

Figure 2: The incident tab of PID

Pipeline Incident Database - PRODUCTION

File Edit Data Reports Utilities Window Help

Equipment

Equipment Pipe Coating Repair

Incident: Added:

Start: Changed:

End:

Type: MAQP: Year:

Subtype: Schedule: Manufactured:

Manufacturer: Installed:

Vendor: In Service:

Model: Depth of Cover:

Size / Rating: Service Fluid:

NPS: Cathodic Protection:

Material: Standard:

Material Grade: Specification:

Description:

Idle Mode

Figure 3: The equipment tab of PID.

The structure of the database enables the NEB to sort incidents into categories and publish the results in the Performance Indicator report: *Focus on Safety and Environment – A Comparative Analysis of Pipeline Performance*. For example, data can be analysed so that the number of pipe body releases that occur in a given year is segregated from the other incidents, then can be further sorted into the cause of the pipe body failure. The NEB uses Annex H of the Canada Standards Association – Oil and Gas Pipeline Systems standard (CSA Z662-03) to classify the causes of incidents related to the pipe body. The Annex provides six general categories: metal loss; cracking; external interference; material, manufacturing or construction; geotechnical failure, and other.

The database was designed to allow users to sort data for a variety of outputs. There are limitations on the complexity of the reports generated by the NEB. The NEB will be exploring methods to enhance its reporting capabilities and plans to work with agencies, such as EGIG, to ensure consistency of data collection to enable meaningful comparisons of incidents.

3.2.3. Europe (EGIG)

3.2.3.1. General

In Europe there is no mandatory European obligation to report pipeline incidents in an European database. In the European standard EN 1594 (Gas supply systems - Pipelines for maximum operating pressure over 16 bar) functional requirements are given for the individual companies.

However, in 1982 six European gas transmission system operators took the initiative to gather data on the unintentional release of gas in their pipeline transmission systems. This co-operation was formalised by the setting up of EGIG (**E**uropean **G**as pipeline **I**ncident data **G**roup) [2].

The objective of this initiative was to provide a broad basis for statistical use, giving a more realistic picture of the frequencies and probabilities of incidents than would be possible with the independent data of each company considered separately.

In 2005, a total of twelve companies were participating, comprising all of the major gas transmission system operators in Europe. The participating companies are:

- DONG (Denmark);
- ENAGAS, S.A. (Spain);
- E.ON Ruhrgas AG (Germany);
- FLUXYS (Belgium);
- Galp Transgás Energia (Portugal)
- Gasum (Finland)
- Gasunie (The Netherlands);
- GRT Gaz (France);
- National Grid (UK)
- SNAM RETE GAS (Italy);
- SWISSGAS AG (Switzerland);
- Transgas (Czech Republic)

Considering the number of participants, the extent of the pipeline systems and the exposure period involved (from 1970 onwards for most of the companies), the EGIG database is a valuable and reliable source of information. The regional differences are not taken into account so that the result of the database presents an average of all participating companies.

The EGIG participation is on a voluntary basis and restricted to only European gas transmission companies. The EGIG group consists of pipeline experts from all the participating gas transmission companies.

The main parts of the EGIG database are:

- System database; contains various system lengths of the pipelines;
- Incident database; contains various incident data relating to the pipelines in the system database.

Annually each EGIG member sends all requested EGIG information (system lengths and incident information) to the EGIG project manager. The project manager makes all EGIG data anonymous and carries out quality checks. During the annual EGIG meeting, all EGIG members give a commentary on their EGIG information. The data is verified and finally approved and inputted into the formal EGIG database.

An extensive EGIG report is written every three years on the basis of the EGIG database. This report contains overviews of system information, incident information, analysis and diagrams. Every EGIG member receives a full copy of the (anonymous) updated EGIG database annually. The EGIG website [2] is updated with the latest information annually. The full EGIG report and the most recent publications can be downloaded (free) from this website.

3.2.3.2. System database

All EGIG members collect all the requested EGIG system information as shown below in figure 4 annually from their companies.

EGIG - [Data Form System]

Bestand Bewerken Invoegen Records Help

Year: 2001 Company: A

Diameter (inch)		
Unknown	0	3162
D0-4	737	969
D5-10	3106	3773
D12-16	3153	1233
D18-22	2657	68
Total		18858

Year of Construction		
Unknown	46	
< 1954	0	
1954-1963	1726	
1964-1973	10356	
1974-1983	4124	
1984-1993	1834	
1994-2003	772	
Total		18858

Type of Coating		
Unknown	533	
Coal tar	13558	
Bitumen	451	
Polyeth	1584	
Epoxy	2626	
Other	106	
Total		18858

Cover (cm)		
Unknown	1376	
C-100	0	
C0-80	3051	
C80-100	8396	
C100+	6034	
Total		18857

Grade of Material		
Unknown	59	173
Grade A	0	5298
Grade B	2733	147
X42	1340	0
X46	4022	25
X52	4981	78
Total		18856

Wall-Thickness (mm)		
Unknown	86	
W0-5	989	
W5-10	8063	
W10-15	8270	
W15-20	1431	
W20-25	0	
W25-30	18	
W30+	0	
Total		18857

Pressure (bar)		
Unknown	0	
P16-25	2723	
P26-35	1028	
P36-45	144	
P46-55	1717	
P56-65	46	
P66-75	12881	
P75+	320	
Total		18859

Record: 1 van 215

Formulierweergave

Start Stavang... Van Dale... F:\IGU... Revisie b... Chapter... Microsof... PowerPoint-... EGIG - [... 15:28

Figure 4: Screen-print of the EGIG system information

3.2.3.3. Incident database

All EGIG members also collect detailed information on all pipeline incidents that comply with the following EGIG incident criteria annually from their companies:

- There is an unintentional release of gas;
- The incidents always relate to an onshore gas transmission steel pipeline (this does not apply to production pipelines):
 - with a design pressure greater than 15 bar;
 - outside the fences of installations;
 - excluding associated equipment (e.g. valves, compressors) or parts other than the pipeline itself.

In figure 5 a screen-print is given of all the requested EGIG incident information.

The screenshot shows a software window titled "EGIG - [Mutatie en Invoerscherm : Formulier]". The window contains a form for recording pipeline incidents. At the top, there are fields for "Company:", "Date:" (9/05/1989), "Reference:" (H89/1), and "Sort of incident:" (GM). Below these are sections for "Component:", "If External Interference" (with sub-fields for Activity, Equipment, and Protective measures), "If Construction or Material Defect", "If Ground Movement", "If Corrosion", and "If Other cause". A large section titled "All Causes" contains numerous sub-fields for detailed incident data, including Cover [cm], Cover class [cm], Damage, Size of leak area [cm2], Type of leak, Ignition, Explosion, Damage, Fatalities, Injuries, Detection, Diameter [inches], Diameter class [inches], Wall thickness [mm], Wall thickness class [mm], Design factor [-], Pipetype, Grade, Construction year [year], Construction year class [year], Design pressure [bar], Design pressure class [bar], Operating pressure [bar], Operating pressure class [bar], Test pressure [bar], Type of cathodic protection, and Coating. At the bottom, there are three text boxes labeled "Information 1 [text]", "Information 2 [text]", and "Information 3 [text]". The window also shows a "Record:" field with a value of 1 and a total of 1059 records. The taskbar at the bottom displays various icons and the system clock showing 10:56.

Figure 5: Screen-print of the EGIG incident information

Damage information is recorded in classes, depending on the leak size:

- **PINHOLE/CRACK**: diameter of defect equal to or less than 2 cm;
- **HOLES**: diameter of defect more than 2 cm and equal to or less than the diameter of the pipe;
- **RUPTURES**: diameter of defect more than the pipe diameter.

The incidents are divided according to the initial cause into the following types:

- External interference (damage caused by a third party);
- Corrosion;
- Construction defect/material failure;
- Hot-tap made by error;
- Ground movement;
- Other and unknown causes.

Depending on the type of the incident, additional information is recorded. An overview is given in figure 6.

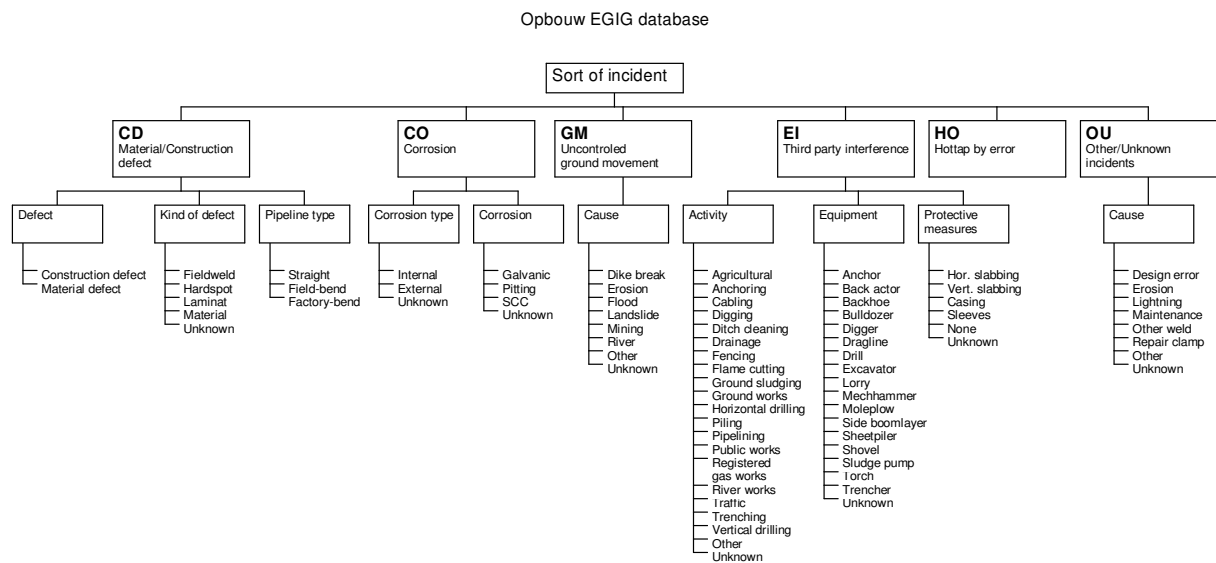


Figure 6: Structure of the EGIG incident database related to the initial cause.

In addition to the above-mentioned cause-related information, general information is also collected. A screen-print is given in figure 7 and more detailed information is given in table 3.

All Causes			
Cover [cm]:		Detection:	Unknown
Cover class [cm]:	100+	Diameter [inches]:	
Damage:	Hole	Diameter class [inches]:	<4
Size of leak area [cm ²]:		Wall thickness [mm]:	
Type of leak:	Hole	Wall thickness class [mm]:	00-05
Ignition:	No	Design factor [-]:	
Explosion:	No	Pipetype:	Unknown
Damage:	No	Grade:	Grade-B
Fatalities:	No	Construction year [year]:	
Injuries:		Construction year class [year]:	unknown
Design pressure [bar]:		Design pressure class [bar]:	Unknown
Operating pressure [bar]:		Operating pressure class [bar]:	16-25
Test pressure [bar]:		Type of cathodic protection:	Impr
Coating:	Polyeth		

Figure 7. Screen-print of the general incident information.

Parameter	Dimension	Classes
Cover	[cm]	
Cover class	[cm]	0-50; 50-80; 80-100; <100; 100+; Unknown
Damage		Crack; Hole; Rupture; Unknown
Size of leak area	[cm ²]	
Size of leak		PinHole/Crack; Hole; Rupture; Unknown
Ignition		Yes; No
Explosion		Yes; No
Damage		Yes; No
Fatalities		Yes; No
Injuries		Yes; No
Detection		Client; Co_Staff; Contract; Distr_Co; Landowner; Oli; Other; Patrol; Public; Riverplo; Unknown
Diameter	[inch]	
Diameter class	[inch]	<4; 6-10; 12-16;18-22; 24-28; 30-34; 36-40; 42-46; 48+
Wall thickness	[mm]	
Wall thickness class	[mm]	0-5; 5-10; 10-15; 15-20; 20-25; 25-30; 30+; Unknown
Design factor		
Pipetype		Long weld; Seamless; Spiral; Unknown
Grade		Grade A; Grade B; X42; X46; X52; X56; X60; X65; X70; X80; Other; Unknown
Construction year		
Construction year class		<1954; 1954-1963; 1964-1973; 1974-1983; 1984-1993; 1994-2003; 2004-2013; Unknown
Design pressure	[bar]	
Design pressure class	[bar]	16-25; 26-35; 36-45; 46-55; 56-65; 66-75; 75+; Unknown
Operating pressure	[bar]	
Operating pressure class	[bar]	16-25; 26-35; 36-45; 46-55; 56-65; 66-75; 75+; Unknown
Test pressure	[bar]	
Type of CP		Impr; Sacr; Both; None
Coating		Asphalt; Bitumen; Coaltar; Epoxy; Polyeth; Unknown

Table 3. General information collected per incident.

3.2.4. Europe (UKOPA)

3.2.4.1. Background

One of the key objectives of UKOPA [11] is to develop a comprehensive view on risk assessment and risk criteria as they affect Land Use Planning aspects adjacent to high hazard pipelines. The main multiplier in pipeline risk assessments is the per unit length failure rate which directly relates to the extent of risk zones adjacent to the pipelines. Regulators and consultants who carry out risk assessments for UK pipelines have generally relied on US and European data to provide the basis for deriving failure rates due to the shortage of verified published data relating to UK pipelines.

3.2.4.2. Purpose of the database

The purpose of the database is to:

- estimate leak and pipeline rupture frequencies for UK pipelines, based directly on historical failure rate data for UK pipelines
- provide the means to estimate failure rates for UK pipelines for risk assessment purposes based on analysis of damage data for UK pipelines
- provide a more realistic and rigorous approach to the design and routing of pipelines
- provide the means to test design intentions and determine the effect of engineering changes (e.g. wall thickness of pipe, depth of burial, diameter, protection measures, inspection methods and frequencies, design factor etc.)

3.2.4.3. Key advantages

The database is designed to reflect the ways in which the UKOPA operators design, build, operate, inspect and maintain their pipeline systems. Although the pipeline and failure data are extensive, there are pipeline groups (e.g. large diameter, recently constructed pipelines) on which no failures have occurred; however, it is unreasonable to assume that the failure frequency for these pipelines is zero. Similarly, further pipeline groups exist for which the historical failure data are not statistically significant.

The UKOPA database contains extensive data on pipeline failures and on part-wall damage, allowing prediction of failure frequencies for pipelines for which inadequate failure data exist. Using Structural Reliability Analysis it is possible to determine the range of defect dimensions that will cause a specific pipeline to fail; analysis of the statistical distributions of actual defect dimensions from the part-wall defect data allows the probability of a critical defect to be determined and failure frequencies for any credible failure mechanism to be calculated. This approach has been used extensively and successfully by one of the contributing companies in recent pipeline uprating projects.

3.2.4.4. Incident definition

A product loss incident is defined in the UKOPA database as:

- an unintentional loss of product from the pipeline
- within the public domain and outside the fences of installations
- excluding associated equipment (e.g. valves, compressors) or parts other than the pipeline itself

3.2.5. Australia

3.2.5.1. General

Australian pipeline incident data is collected by the Pipeline Operators Group (POG) of the Australian Pipeline Industry Association (APIA) [5]. Most pipelines in Australia are operated by POG members but provision of data is voluntary.

The existing POG incident database contains records commencing from 1965. The existing data set is quite small (less than 150 incidents), partly because reporting is known to have been incomplete but mainly because the incident rate in Australia is an order of magnitude lower than in other parts of the world. (The reasons for the lower rate have not been fully investigated but the difference is far too great to be explained by under-reporting. It is likely that the very low population density contributes to a low rate of external interference incidents and the relatively young age of most pipelines contributes to a low rate of corrosion failures.)

A more concerted effort to collect data commenced in 2004, including a greatly expanded range of information on both pipelines and incidents. The type of information now collected reflects the requirements of the Australian Standard for pipelines. AS 2885 is a risk-based standard that puts considerable emphasis on protection of pipelines against external interference in particular, and hence the incident data template includes information which in due course should provide a basis for assessing the effectiveness of the risk management approach. However, if the low incident rate continues it may be some decades before statistically useful information is available.

An incident is defined as:

1. Any damage to the coating or pipe caused by mechanical equipment.

2. Any defect which causes the MAOP to be de-rated, or causes leakage (not including minor leaks at flanges), or requires mechanical repair by either reinforcement or cut-out and replacement.

Data is recorded in a Microsoft Access database administered by the APIA secretariat. While the database structure is comprehensive, reporting is currently limited and some further work may be necessary in due course to permit efficient extraction of data in a form that is suitable for statistical analysis.

Analysis of incidents to date has yielded average failure rates with limited breakdown by location class as well as subdivision by cause (external damage, corrosion, etc) and severity (rupture, leak, etc). Future updating of summary data is likely to be at intervals of 3 to 5 years; incident rates are too low to justify annual re-analysis.

3.2.5.2. Pipeline Data

For every pipeline operated by a POG member the following data is expected:

- From/To
- Commissioning date
- Product
- Capacity summary
- Pipe and materials details (diameters, wall thicknesses, design pressures, materials, location classes, with lengths of each)
- Coating details
- Mainline valve details
- Compressor station details
- Meter details
- SCADA and communications details

3.2.5.3. Incident Data

Data requested for each incident comprises:

- Pipeline ID (reference to separate pipeline data table)
- Incident details. Severity (rupture, leak, gouge, etc), date/time, ignition, location, incident description, incident type (external interference, corrosion, material defect, etc).
- Pipeline details in vicinity of incident. Diameter, thickness, grade, location class, depth of cover, design pressure, hydrostatic test pressure, operating pressure at time of incident, temperature, age, fracture toughness.
- Damage details. Length, width, depth, circumferential location, other position details (relative to girth & seam welds, bends, etc).
- Risk assessment background. Was the threat identified? Was it considered adequately controlled?
- External interference protection. Concrete slab or encasement, distance to nearest warning sign, buried marker tape, fencing, patrol frequency, land ownership (private, public, road, etc), landowner contact, one-call service (available, used), development approvals, etc.
- Details of incident due to external force. Type of force (machinery, ground movement, erosion, etc), type of mechanical equipment (excavator, auger, etc), size of equipment (tonnage), responsible party.
- Details of incident due to corrosion. Type of corrosion (internal, external, SCC), external/internal coating type, external/internal coating condition, cathodic protection details (system type, pipe-soil potential), internal fluid quality, corrosion inhibitor.

- Repair methods. Type (cut out/replace, welded sleeve, clamp, coating repair, etc).
- Injuries and costs. Number of fatalities or injuries, damage value, product volume lost, period of failure to supply (or reduced supply), repair cost, consequential losses.

4. COMPARATIVE ANALYSIS OF EXISTING PIPELINE INCIDENT DATABASES

In order to be able to successfully compare the results of the different pipeline incident databases it is necessary to gain a further understanding of their makeup. Factors such as different definitions of the term “incident” and considered target systems as well as data collection methods explain why a direct comparison between statistics produced by different organisations can be difficult to perform or may lead to misleading interpretation.

A significant amount of literature was reviewed for the purpose of the comparative analysis. A list of these references can be found in [7]-[40].

Differences not only in the scope and detail of the raw data collected but also in the analysis methods applied lead to further differences when it comes to reporting the safety performance results for a particular period, incident type or pipeline class. Furthermore climatic, geographic and demographic factors as well as technical factors such as age of the pipeline systems and different construction and operation standards also need to be carefully considered when attempting to perform a comparative analysis between two or more different pipeline safety statistics.



Canada	NEB	National Energy Board Canada
USA	DOT	US Department of Transportation – Office of Pipeline Safety
United Kingdom	EGIG	European Gas Pipeline Incident Data Group
Denmark	UKOPA	UK Onshore Pipeline Operator's Association
Finland	Gosgortehnadzor	Russian Association for Licensing
Netherlands	APIA	Australian Pipeline Industry Association
Germany		
France		
Greece		
Spain		
Portugal		
Italy		
Russia		
Australia		

Table 4: *International and National Pipeline Incident Databases*

The goal of this section of the guideline is to highlight the differences and similarities between the incident databases and reports so that more informed comparisons of data can be performed and to highlight the areas where, when changes are made to the databases themselves, the comparability of the data sets can be greatly increased.

It is not intended to compare the safety performance of the individual pipeline systems. In the following sections a comparison between the major pipeline safety databases as listed in Table 4 will be made by analysing the different external factors which affect the pipelines, the incident definitions, the categorisation of incident parameters (data collection) and the reporting and analysis of incident data.

4.1. External Factors Affecting the Safety Performance of Pipelines

There are many factors which affect the safety performance of pipeline systems. For example, design, construction and maintenance standards and practices as well as system age and local environmental conditions like soil types and ground water salinity levels all affect the condition.

Table 5 compares two further external factors, namely population density and geographic conditions to which pipelines in different regions of the world are exposed. Although this table does not account for regional variations, it does give an indication of the scope for differences in boundary conditions affecting pipeline systems around the world.

The effect of high population density on the number of incidents caused by third party interference is clearly shown in the EGIG statistics where third party interference ranks as the most frequent cause of product release incidents. Some pipelines are also subjected to extreme environmental conditions in mountainous and permafrost regions whereas others may be subjected to high diurnal and/or seasonal temperature fluctuations. Although it is impossible to quantify exactly the extent to which each of these factors affect pipeline safety in each region, it is important to consider such factors when comparing or using statistics from different organisations.

Database	Population Density			Extreme Geographic Conditions		
	low	medium	high	desert	mountains	permafrost
Western Europe (EGIG, UKOPA)			X		X	
United States (DOT)		X		X	X	X
Canada (NEB)	X				X	X
Australia (APIA)	X			X		
Russia (Gosgortekhnadzor)	X				X	X

Table 5: *Population Density and Extreme Geographic Conditions per Region*

4.2. Pipeline System Information

The term “pipeline system information” refers to the data which is collected about the pipeline systems included in the pipeline incident database. Database owners usually have two report forms which must be completed by the operators. One form collects pipeline system information (usually on a yearly basis) about the pipelines being operated by the different pipeline operating companies and the other collects detailed information about specific incidents. For example the DOT has an “Annual Report Form” for the pipeline system information and an “Incident Report Form” for the pipeline incident information.

By collecting pipeline system information it is possible to monitor trends such as a tendency towards larger diameter, higher pressure pipelines and to normalise the incident data. An example of normalisation is the common practice of dividing the number of incidents by the number of kilometre years to calculate a benchmark which is not affected by the yearly increase in the total length of the pipeline network.

Table 6 compares the Pipeline System Information collected by EGIG, UKOPA, DOT and APIA. A star (*) indicates that the parameter is not explicitly collected on the form but can be implicitly deduced e.g. EGIG does not collect product or pipeline type information because EGIG only collects incident data for natural gas transmission pipelines. EGIG, UKOPA and APIA all collect type of coating data meaning that the bare/coated criterion is redundant.

PIPELINE SYSTEM INFORMATION	EGIG	UKOPA	DOT	APIA
PIPELINE DETAILS				
Year of Construction / Installation	X	X	X	
Date Commissioned		X		X
Length	X	X	X	X
Diameter	X	X	X	X
Wall Thickness	X	X		X
MAOP		X		X
Operating Pressure	X			X
Depth of Cover	X	X		
Class (Location)	*	X	X	X
Type / Grade of Material	X	X	X	X
Pipeline Type (Gath, Trans, Distr)	*	*	X	X
Cathodic Protection	*	X	X	
Product	*	X	*	X
COATING DETAILS				
Bare / Coated	*	*	X	*
Type of Coating	X	X		X

Table 6: Comparison of Collected Pipeline System Information

As can be seen in the table, all organisations collect data about the age of the pipelines (year of construction, installation or commissioning), pipeline length, pipeline diameter, type of material, pipeline type and transported product. It is worth noting that EGIG does not record any information about the class location (however, design factor is collected) as it collates information from several different countries, some of which do not use a class location system because they apply a deterministic approach. Depth of cover is not recorded in UKOPA's pipeline system information but is collected for faults. APIA does not collect information about depth of cover or cathodic protection on its "New Pipeline Information" form. The DOT "Annual Report Form" does not collect any information about wall thickness, pressure, depth of cover or type of coating which makes the DOT data very hard to compare with other statistics.

Furthermore the simplistic approach of entering the miles of pipe which fit into differing broad categories for grade of material (steel, cast iron, plastic, other), cathodic protection (protected, unprotected), nominal size (unknown, 4" or less, over 4" up to 10", ..., over 28"), year of

installation (by decade) and class location, although making the form easy to fill out, leads to an unnecessary loss of information.

The above table has only used a subset of the total number of parameters actually collected on the different forms and is by no means exhaustive. The parameters listed in this table should be considered as a minimum requirement when developing a new incident database so that compatibility with the existing pipeline incident databases can be ensured. Chapter 6, "IGU Pipeline Incident Database Reference Model" provides further information with regard to creating a new pipeline incident database.

4.3. Incident Definitions: Incident Consequence and Target Systems

The most significant factor hindering the direct comparison of pipeline incident data is the way in which the different authorities or database managers define an incident. Although unintentional release of gas (also product loss, loss of containment) is a common criterion in the definitions, other consequences and events are often included which, when combined with differing target systems (pipeline system scopes), lead to difficulties when comparing data sets. The criteria for the inclusion of incidents in the Pipeline Incident Databases are summarised in Tables 7 and 8.

	CONSEQUENCES					
	Unintentional Gas Release	Death or Injury	Fire or Explosion	Environmental Impact	Property Damage Exceeding \$50,000	Other
EGIG	X					
UKOPA	X					Part-Wall Damage
DOT	X	X			X	Emergency Shutdown of LNG Facility, Significant Incident
NEB	X	X	X	X		Pipeline Operated Beyond Design Specifications
APIA	X					Damage or Defects Requiring Repair or MAOP Derating, Near Misses
Gosdortehnadzor		X				

Table 7: Incident Definitions by Consequence

By choosing the unintentional release of gas as the single criterion for the definition of an incident on steel transmission pipelines with an operating pressure over 15 bar, EGIG is able to

unambiguously collect data about incidents which have the greatest potential to cause harm to the public. UKOPA extends the scope of its database beyond that of EGIG to include data about incidents involving part-wall damage. This approach of collecting data on less critical but more frequently occurring events is also applied by NEB (pipeline operated beyond design specification) and APIA (coating or pipe damage, near miss) and is particularly useful for the analysis of safety issues associated with high consequence low frequency events [1].

According to the DOT incident definition [2] an event involving the unintentional release of gas is only then an “incident” when it involves either (i) a death, or personal injury necessitating in-patient hospitalisation; or (ii) estimated property damage, including cost of gas lost, to the operator or others, or both of \$50,000 or more. These additional conditions lead to a reduction in the number of events classified as incidents and, consequently, to a reduction in the number of reported incidents. This in turn leads to difficulties in comparing DOT data with data from other institutions.

The Russian Institution for Licensing (Gosdortekhnadzor) requires reports to be filed for incidents involving injury or fatality.

For an event to be classified as an incident, it not only has to fulfil the conditions laid out in the incident definition but it must also occur on or involve the target system of a safety database i.e. it must occur within the pipeline system scope of the safety database as summarised in Table 8. Of all the safety databases, EGIG has the most focussed scope as it only considers onshore natural gas transmission steel pipelines with an operating pressure greater than 15 bar. Incidents involving installations, associated equipment or parts other than the pipeline itself are not included. With this clear definition, EGIG is able to demonstrate the safety performance of European gas transmission pipelines and provide a benchmark for individual operators transporting gas on the European continent.

As UKOPA collects incident data about Major Accident Hazard Pipelines (MAHP) as defined in The Pipeline Safety Regulations 1996 this data also includes incidents occurring on plastic pipelines and on pipelines transporting media other than natural gas.

DOT, NEB, APIA and Gosdortekhnadzor all include incidents on pipelines transporting products other than natural gas and offshore pipelines which would not be included in the EGIG statistic if they occurred in Europe. Incidents related to European offshore pipelines would typically be reported in the Parloc database [4]. The Parloc database has not been included in the comparative analysis as the database contains incidents for offshore pipelines only.

The gas supply chain can be divided into gathering, transmission and distribution networks. Each part of the chain represents a specialised field, each of which has very different requirements and is subject to different threats. Offshore gathering lines may be at risk from internal corrosion and anchoring, while high pressure onshore transmission lines may be threatened by external corrosion or excavation activity. Distribution systems may be at risk from road works. The inclusion of gathering or distribution system incidents in an analysis of transmission system incidents would also lead to misleading results when comparing different incident databases.

	PIPELINE SYSTEM SCOPE					
	Installations Included	Pipe Material	Transported Medium	Pressure Range	Onshore / Offshore	Part of Gas Chain
EGIG	No	Steel	Natural Gas	PN > 15 bar	Onshore	Transmission
UKOPA	No	Steel, Plastic, Other	Mainly Natural Gas		Onshore	Transmission
DOT	Yes	Steel, Plastic, other	Natural, Flammable, Toxic or Corrosive Gases		Onshore & Offshore	Gathering, Transmission, Distribution
NEB	Yes	Steel	Natural Gas and Other Gas and Liquids		Mainly Onshore	Transmission, Some Gathering
APIA	Yes	All	Natural Gas and Other Gas and Liquids		Onshore	Gathering, Transmission
Gosdortehnadzor	Yes	Steel	Natural Gas, Oil and Other		Onshore & 1 Offshore Pipeline	Transmission, Gathering, Distribution

Table 8: Pipeline System Scopes Used in Incident Definitions

Table 9 highlights the differences in the system boundaries of several Pipeline Incident Databases. In doing so, it demonstrates the importance of considering the influence of these boundaries on the total number of reported incidents when performing comparative analyses or applying the data to perform risk and safety analyses.

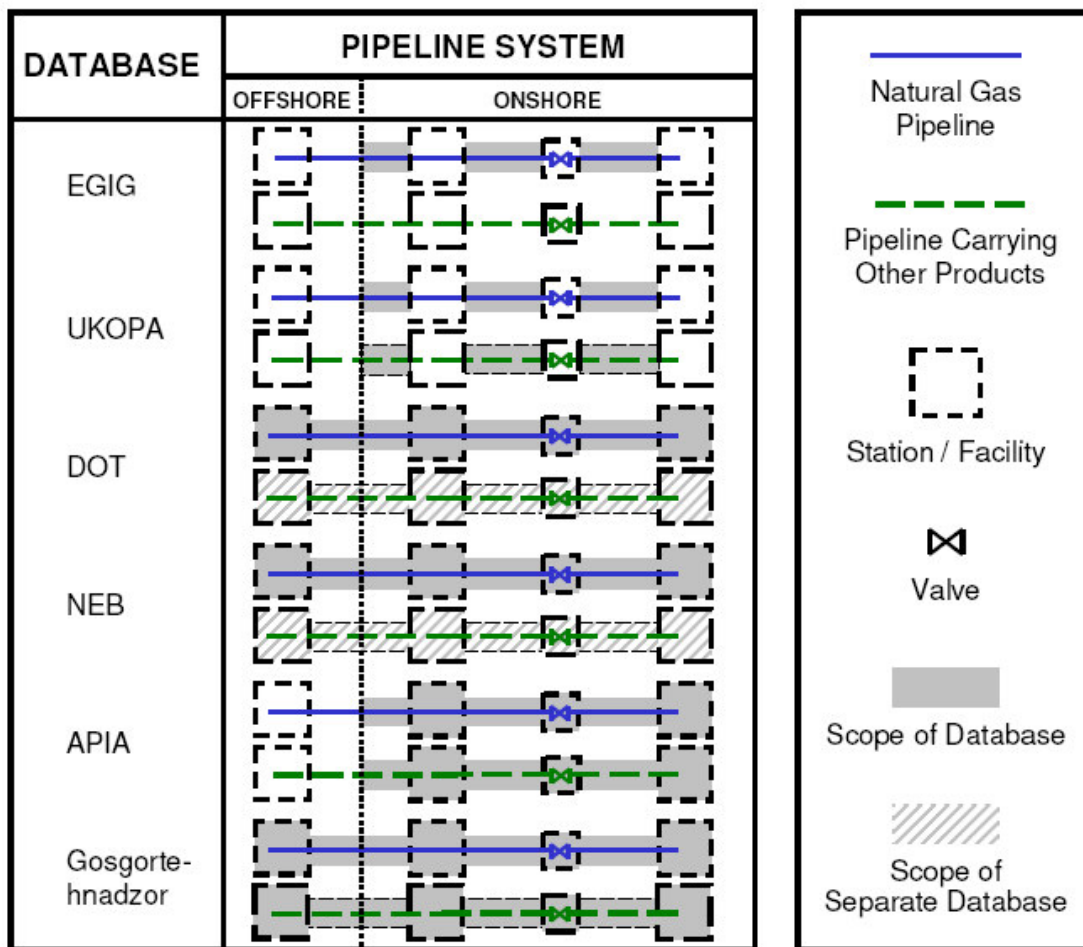


Table 9: Pipeline Incident Database System Boundaries

4.4. Categorisation of Incident Parameters

When an incident occurs, report forms are completed by the pipeline operator recording the details of the incident. Apart from collecting information about the pipeline specifications and other boundary conditions, a major focus is naturally placed on collecting data about the size and type of damage and on data related to the causality of the incident. When collected on a large scale, such incident data provides the statistical basis for safety and risk analyses, trend detection and the assessment of accepted best practices. As each statistic categorises these topics differently, this can lead to difficulties when comparing data from different databases.

Figure 8 shows a Bow-Tie Incident Model which illustrates the causal relationship between the root causes, pipeline failure and subsequent consequences. An incident **scenario** has been traced through the diagram to show how there are often several stages in an incident which stem from a **root cause** (or causes) and can lead to **pipeline failure** (gas release). Events which occur as a result of the pipeline failure are then the **consequences** of the incident. The model has been purposely left in an abstract form as the way in which the root causes, pipeline damage and consequences of incidents are categorised differs with each database. The model as such provides an overview of the topics discussed in this chapter.

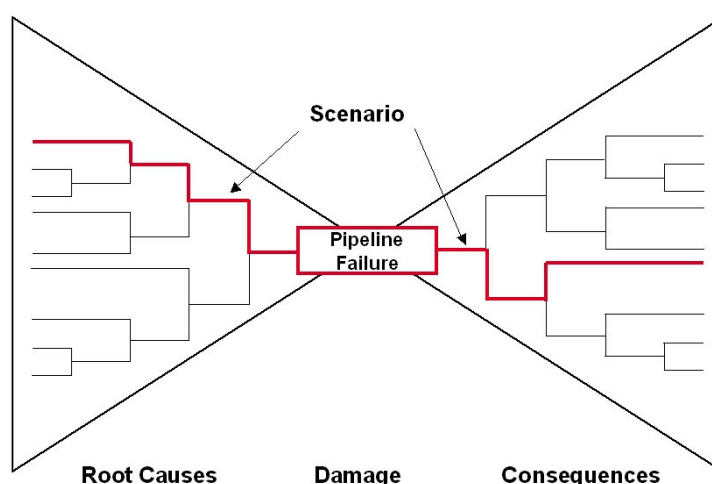


Figure 8: Bow-Tie Incident Model

4.5. Categorisation of Incident Causes

The causal data collected by all organisations enables an analysis of the major threats posed to transport pipelines. Table 10 summarises the types of cause that each safety statistic covers and groups them into five major classes: corrosion, material, external, natural and other. Although the subclasses in each group vary somewhat there is a strong correlation between the types of root cause information covered by all safety statistics. This enables reliable comparisons of causal data from different statistics and can highlight different trends in different countries. For example, in densely populated areas third party interference is more of a concern than in sparsely populated areas.

Database	Corrosion	Material	External	Natural	Other
EGIG	internal corr., external corr., stress corr., cracking	material and construction defects	third party interference	ground movement, floods	hot tap by error, lightning other/unknown
UKOPA	internal corr., external corr.	girth weld defect seam weld defect pipe defect	external interference	ground movement	other unknown
DOT (25 root causes)	internal corr., external corr., stress corr., Cracking	material and weld	excavation other outside force damage	natural forces, earth movements, lightning, heavy rains/floods, temperature and high winds	equipment and operation other
NEB	internal corr., external corr., stress corr., Cracking	material defects construction damage girth weld failure	external interference	natural forces	operational other
APIA	internal corr., external corr., stress corr., cracking	material construction design error	external forces	earth movement lightning erosion	blasting electrical surge or induced voltage other
Gosgortehnadzor	stress corrosion cracking	weld defects	third party interference	earth movements permafrost moving dunes	other

Table 10: Incident Causes

4.6. Damage Classification

After establishing the causes of the incident, it is necessary to collect information regarding the damage caused. Table 11 shows how most safety databases use linguistic terms to classify the damage. The use of linguistic terms makes comparisons between certain statistics difficult because associations between the linguistic terms used can only be approximate. UKOPA is an exception in that it records the critical dimensions of the defect and then uses classes (e.g. 6 – 20 mm, 110 mm – full bore) when presenting the damage data in its report.

There is, however, a trend of providing three damage classes of increasing magnitude. EGIG and Gosgortehnadzor use the terms “pinhole/crack”, “hole” and “rupture”. NEB and APIA use “leak”, “puncture” and “rupture”. DOT uses very similar terms to NEB and APIA but categorises “leaks” as “pinholes”, “connection failures” or “punctures” and “ruptures” as “circumferential weld separations”, “longitudinal tears” or “cracks”. The term “puncture” for example describes how the defect was caused but gives no indication of size and technically can also be classified as a “leak” or as a “hole”.

Database	Pinhole / Crack	Hole	Leak	Puncture	Rupture	Other
EGIG	X	X			X	size of leakage in cm ²
UKOPA						product loss incidents: 0 - 6, 6 - 20, 20 - 40, 40 - 110, 110 - full bore, full bore and above part-wall damage incidents: defect dimensions
DOT			X		X	leak (pinhole, connection failure or puncture (diameter)), rupture (circumferential or longitudinal (propagation length)), N/A, other
NEB			X		X	
APIA			X	X	X	gouge, deformation, coating damage, near miss
Gosgortehnadzor	X	X			X	

Table 11: *Categorisation of Damage*

4.7. Categorisation of Incident Consequences

The uncontrolled release of gas is an event which can have severe consequences. When investigating incidents, a common method is to develop an event tree which describes the causal relationships between root causes and significant consequences. Due to the number of possible scenarios it is necessary to restrict the data collection to the major groups of “people”, “ignition”, “environment” and “property” as can be seen in Table 12.

All organisations collect data about injuries and fatalities in the rare cases that they do occur. This is vital data to illustrate the excellent inherent safety performance of pipelines as a transport mode. EGIG, DOT and APIA explicitly record whether the incident involved ignition (fire, explosion) and EGIG and NEB include a category for environmental damage. DOT collects data about the total costs made up from gas loss, operator damage and public/private property damage

costs. NEB and APIA also collect similar cost information regarding property damage, consequential loss of value and repair costs.

Database	Injury	Fatality	Fire	Environmental Damage	Cost	Other
EGIG	X	X	X	X	-	overpressure
DOT	X	X	explosion, gas ignited	-	property damage, consequential loss of value	evacuation
UKOPA	-	-	X	-	-	-
NEB	people	people	X	X	production, property	-
APIA	X	X	X	-	consequential loss of value, repair cost	period of failure to supply
Gosgortekhnadzor	X	X	-	-	-	-

Table 12: Incident Consequences

4.8. Reporting of Data

Owners of incident databases handle the information they publish differently:

- EGIG, UKOPA and NEB publish periodical reports which present the results of statistical analyses of the data contained within their databases. They do not publish the raw data collected from the databases.
- The DOT raw data is available online from the Office of Pipeline Safety website. A brief report for all the incidents is supplied yearly, categorizing the incidents by cause. Totals are also included for property damage, fatalities and injuries
- The APIA database is in development and is still being populated with data. Hence, no formal report is available to date. However, some preliminary information is available [Reference 6].
- The data from the Russian Gosgortekhnadzor incident database is not publicly available and was made available to the IGU Study Group for this report.

Data pertaining to the extent of the databases such as the total number of incidents and the total exposure of the pipelines (measured in kilometre years) is important to establish the reliability of the statistical data. As the number of records naturally increases in a sample so too does the confidence interval of any statistically derived results. The oldest statistics are UKOPA (1961), EGIG (1970) and DOT (1985) which can show trends over several decades. These statistics all show a reduction in the frequency of gas releases per 1000 km-yr over their respective reference periods. The EGIG and UKOPA reports also give five year moving average values to highlight short term trends by filtering out older incidents. That gives an excellent measurement for the increased safety performance of the grid due to newly applied methods (such as management methods like Pipeline Integrity Management Systems (PIMS)).

In addition to the analysis of the key safety performance indicator “incident frequency”, analyses of incident causes and consequences are performed. The EGIG and UKOPA reports show trends relating to incident frequency by cause and compare historical with recent data. An important conclusion of an ageing analysis performed in the EGIG report is that ageing does not occur in the time window of the EGIG data collection. More detailed analyses of external interference and external corrosion are also provided. The EGIG and UKOPA reports both calculate the percentage of incidents which occur from ignition.

5. IMPORTANCE OF USING FIT FOR PURPOSE PIDS

A decade ago it was not deemed appropriate to publish information on pipeline incidents. This was considered to be “washing one’s dirty linen in public”. But society has changed and the current attitude of pipeline owners is to collect the right information on pipeline incidents and show transparency on the subject of pipeline safety (see chapter 2).

The main reason for this attitude change was the increasing use of pipeline information on optimisation of the internal business processes (costs versus safety performances, design parameters, maintenance parameters) but other stakeholders were also interested in the safety of gas pipelines. Examples of stakeholders are national and regional authorities, property developers, fire brigades and the general public.

It is the experience of many pipeline operating companies that when no pipeline safety information is available and the stakeholders need to have this kind of information, they will perform a best estimate. This best estimate is used in all kinds of reports and publications and has led in the past to absolutely wrong conclusions and recommendations. Sometimes it caused unnecessary public panic which was harmful for the image of gas transmission by pipelines.

However there are two sides to every question. As mentioned in the introduction, there is today a lot of information available on pipeline incidents in a variety of formats. The easiest and most widespread way of obtaining pipeline incident information is by using the internet. But this raises the question of the quality and reliability of the published information and if the information is “fit for purpose”?

Table 13 provides the results of some “Google” internet searches..

Google search on “all words”	Number of result
incident database	9.940.000
pipeline incident	1.720.000
pipeline incident database	356.000
natural gas pipeline incident database	235.000
high pressure natural gas pipeline incident database	158.000
failure frequency	20.600.000
pipeline failure frequency	715.000
natural gas pipeline failure frequency	414.000
high pressure natural gas pipeline failure frequency	307.000
high pressure natural gas pipeline failure frequency leak	125.000
pipeline incident frequency	304.000
gas pipeline incident frequency	204.000
natural gas pipeline incident frequency	174.000
high pressure natural gas pipeline incident frequency	127.000
high pressure natural gas pipeline incident frequency leak	43.300
pipeline incident statistics	335.000
gas pipeline incident statistics	343.000
natural gas pipeline incident statistics	266.000
high pressure natural gas pipeline incident statistics	188.000
high pressure natural gas pipeline incident statistics leak	47.500

Table 13: Internet Search Results

From the above table it is obvious that it is very difficult to select the information that is “fit for purpose”. In chapter 4 we have seen all the differences and similarities in publicly available pipeline incident databases.

Using generic pipeline incident databases is sometimes the only alternative, but, on the other hand, using generic Pipeline Incident Databases will also give generic conclusions. Repairing a damaged image of the gas sector is very difficult and takes a long time. Developing a standardized database framework to allow various stakeholders to select the right data for the right purpose is, therefore, highly recommended.

It is in the interests of all involved parties that the correct data is used for the right purpose. It is therefore necessary for all involved parties to do what is possible and practicable to minimise the chance that wrong data is being used from the widely available set of pipeline incident data.

Recognising the importance of using appropriate pipeline incident databases, it is highly recommended for pipeline owners and pipeline incident database owners to make the effort to standardize and harmonise their databases.

6. IGU PIPELINE INCIDENT DATABASE REFERENCE MODEL

While the goal is to achieve global harmony among databases, historical data collected to different criteria prevent such a harmonization. As the effort continues to make this happen, it is recommended that the criteria for any new database be kept as close as possible to existing database requirements.

6.1. Guideline to Creating New Pipeline Incident Database (PID)

Five aspects are essential in creating and utilizing an incident database. These include:

1. Determination of the data boundary
2. Population system information, mileage data
3. Definition of an incident
4. Occurrence of an incident
5. Data handling

6.1.1. Determination of the Data Boundary

The recommendation for data boundary collection as a minimum is to define “hardware”, life cycle phases and medium.

- A. “Hardware” boundaries should at a minimum allow for separation of incidents relating to the pipeline only, pipeline equipment, pipeline facilities, offshore versus onshore pipelines. Other “hardware” boundaries may include elements such as pressure regimes, diameter categories and pipe material.
- B. The life cycle phases of the gas transmission activity should at a minimum allow for separation of incidents occurring during construction, operations and abandonment.
- C. The third element of the boundary should be defined as a minimum by gas or liquid. Further classification may include dry gas, wet gas, sour gas and refined products.

Regardless of the scope of the data boundary, it is essential that the data is clearly discernable to provide the means to filter out each aspect for the comparison to other databases.

6.1.2. Population

The database population is any detailed information with regard to the pipeline network. At a minimum the following pipeline information should be collected in order to perform statistical analyses within the database itself and to enable the calculation of failure frequencies for comparison within the database and to other databases (normalization of the data).

1. Nominal pipe size
2. Wall thickness
3. Grade of pipe
4. Year of construction
5. Type of coating
6. Maximum operating pressure (MOP)
7. Depth of Cover

For all the above attributes it is essential to collect the length of each attribute within the database population. Avoiding the use of ranges to represent pipeline attributes where ever possible is recommended and where sufficient data is unavailable, ranges similar to those used in

other databases should be used. The definition of the ranges could limit the possibility of comparisons across other databases.

If the definition of “hardware” has been extended to pipeline equipment and pipeline facilities the number of valve stations, number of compressor stations and metering stations, etc. should be included at a minimum.

Regardless of the scope of the population data, it is essential that the data is clearly discernable to provide the means to filter out each aspect for the comparison to other databases.

6.1.3. Definition of an Incident

For the pipeline body, an incident should be defined as a minimum as any event resulting in an uncontrolled release of gas.

For a pipeline facility, a different definition for incident may be appropriate.

6.1.4. Occurrence of an Incident

6.1.4.1. Cause Recommendations

The following 7 categories should be used as a minimum to define the possible causes of incidents. These 7 causes include corrosion, third party interference/damage, material/weld/construction defects, natural forces, equipment, incorrect operations and other/unknown.

1. *Corrosion*: Both external and internal corrosion should be included as causes of pipeline incidents. It would also be recommended, as is present in existing databases, that the corrosion be further categorized as localized or general corrosion, and as galvanic, microbiological, or stress corrosion cracking (SCC).
2. *Proposal to change “third party” to “external” Third Party Interference/Damage*: Historically, third parties have been the leading cause of pipeline incidents. It is important to note with each incident, the party that was involved, whether it be the operator’s contractors, another operator’s contractor, a farmer, landowner, etc.
3. *Material/Weld/Construction Defects*: This category would include any manufacturing defects such as hardspots or laminations as well as girth or longitudinal weld failures. Noting the type of weld in which the failure occurred is also beneficial from a statistical standpoint.
4. *Natural Forces*: Obviously, certain events of nature cannot be prevented, yet they are a cause of pipeline incidents. Incidents classified in this category may include failures due to earth movement, heavy rains or floods, lightning, erosions, land slides, high winds, and extreme temperatures, i.e. frozen components.
5. *Equipment*: This category is applicable only to those databases that have extended their boundary beyond just the pipeline. These types of failures are typically caused by components of the pipeline system, such as control or relief equipment, broken couplings, or stripped threads.
6. *Incorrect Operations*: This category is for any incident that results from improper procedures of the pipeline operators.

7. *Other/Unknown*: It is possible that the cause of some incidents will be an odd chain of events or a miscellaneous type incident and will not fit into one of the above categories. In rare instances, the cause of an incident may not be able to be determined.

6.1.4.2. Incident Data Collection

At a minimum the data must mirror the information described in 6.1.2 where it is only specific to the location of the incident. In addition to those 7 attributes, the following should be included:

- 1 Date and time of incident
- 2 Design factor
- 3 Method of detection
- 4 Pressure at the time of the incident
- 5 Define the size of the hole in the pipeline in terms of its equivalent diameter

6.1.4.3. Incident Consequences

Analysing the effect of incidents on public safety and the environment provides a means to discern between those events that tend to cause catastrophic consequences. As a minimum, the following data should be collected to define the consequences of an incident.

- Fatality
- Injury
- Ignition/explosion
- Evacuation

6.1.5. Data Handling

6.1.5.1. Method of Data Collection

While it is recommended that the data be collected electronically, the method of data collection is not of utmost importance, the key is that the procedure is defined and repeatable and is an integral part of the pipeline safety management system with commitment on all management levels. This must be done to ensure the accuracy of the database. The data should be updated on a yearly basis at a minimum.

To ensure a homogeneous set of data, detailed descriptions of all elements and attributes of the database should be clearly defined and communicated to all the providers and users of information from the database.

6.1.5.2. Mode of Data Storage

Regardless of the form of data collection, it is necessary to store the data electronically. The complexity of the storage is dependent upon the resources available and the programming skills available. A simple Excel spreadsheet can handle the data storage although working with the data for statistical purposes will be cumbersome. Data storage that allows for “filters” to be conducted is the necessary way of analysing the data across databases. For example, it may be necessary to filter out pipeline facility failures to allow for the comparison to a database that does not collect such data.

6.1.5.3. Processing of the Data

The collection of pipeline attribute data by length allows for the calculation of an incident rate which is the only accurate means to compare the rates across databases. The incident rate should be defined as the number of incidents occurring per km-year. However, it is necessary to be aware of other pipeline attributes in order to make a sensible comparison regarding safety. For example, the impact of failures on large diameter pipe is far more significant than on small diameter pipe, rural areas versus urban areas, etc. The most recent data should be considered due to the

impact of modern safety management systems, therefore it is recommended that the incident rates are calculating on a moving five year scale, provided enough data is available.

6.1.5.4. Publishing of the Data

Periodic reports containing summaries and analyses of the data can be made publicly available depending on the objective of the database owner. However, it is not recommended to make raw data available without providing caution statements on its limitations. For specific analyses, raw data could be made available on a case by case basis. The intent of this is to prevent the misinterpretation of the data.

6.2. Recommendations for the Harmonization of Existing PIDs

The three largest databases that were analysed for harmonization include the European, the Canadian and the U.S databases. Each of these databases are summarized in Chapter 3. The actual incident forms or computer databases will for the interested reader typically be available through the internet, see reference list in section 8 of this report.

The largest obstacle facing harmonization of the existing PIDs is the different reporting requirements established for each database as well as the different database boundaries. Hence, it is misleading to directly compare number of incidents across databases.

6.2.1. Normalization of Statistical Data

It is important that the data from different databases and different systems is normalized to enable some comparisons across databases (e.g. by normalizing with the length of the pipeline system). This allows different pipeline attributes to be considered such as length of segment, operating pressure, diameter, wall thickness, etc.

However, careful consideration should be made on characteristics that cannot be directly compared across databases such as geographic differences, design criteria, safety management systems, operating history, minimum regulatory requirements, etc.

6.2.2. Recommendations for Harmonization

6.2.2.1. Recommendations to EGIG

Because the EGIG database is in alignment with the guidelines in Chapter 6.1.1, 6.1.2, 6.1.3 and 6.1.5, only recommendations are made in accordance with Chapter 6.1.4:

1. HO (hot tap by error) should be moved to a sub-category of Third Party Damage.
2. A new category entitled "Incorrect Operations" should be added.
3. The GM category (ground movement) should also be made more broad by changing the category to Natural Forces to account for all incidents that occur that may be weather and ground related.
4. Evacuation should be considered as a consequence of a pipeline incident to indicate the severity of the incident and the effectiveness of the emergency response plan.

6.2.2.2. Recommendations to the DOT

For the DOT, the existing database meets the guidelines of Chapter 6.1.3, 6.1.4 and 6.1.5. Therefore the following recommendations are made in accordance with Chapters 6.1.1 and 6.1.2:

1. The reporting criteria for an incident should reflect the definition in 6.1.3 - for the pipeline body, an incident should be defined as a minimum as any event resulting in an uncontrolled release. For a pipeline facility, a different definition for incident may be appropriate.
2. It is recommended to include of wall thickness, maximum operating pressure, depth of cover and type of coating on a length basis.

6.2.2.3. Recommendations to the NEB

- The NEB database meets the guidelines in Chapter 6.1.1, 6.1.3, 6.1.4 and 6.1.5. A recommendation in accordance with Chapter 6.1.2 is as follows: It is recommended to include collection for pipeline diameter, grade of material, year of construction, wall thickness, maximum operating pressure, depth of cover and type of coating on a length basis.

7. CONCLUSIONS

There is an increasing demand for reliable pipeline incident information, as an increasing number of other parties are using the information for a variety of different purposes. A huge amount of information is available on the internet but selecting the right data for the right purpose is almost a “mission impossible”.

The study group investigated a range of available pipeline incident database sources and concludes that, with regard to high pressure pipelines, the most comprehensive frequently used and reliable PID's are:

- DOT database
- EGIG database
- NEB database

Studying the details of the most comprehensive, accurate and frequently used pipeline incident databases, it is concluded that there are many significant differences in boundaries, population, definitions and classifications and that the statistical results are not easily comparable.

Knowing all the details and limitations of the most frequently used pipeline incident databases and the purpose and use of pipeline incident information, an IGU pipeline incident database reference model was developed. The reference model highlights the overlap which is required for comparing results across different PID. Therefore, applying this reference model is believed to greatly improve and ease the comparison of pipeline incident information.

The ability to filter data is found to be necessary as the existing databases do not have the same boundary definitions.

The IGU pipeline incident database reference model also enables the creation of new PID by providing guidance and definitions for information necessary.

From discussions with the owners of the most frequently used databases concerning the details of their databases, it is concluded that harmonisation is possible/feasible with relatively few changes to DOT, NEB and EGIG. The harmonisation can be done without loss of historical data.

Based on the work performed in preparing this report and the above mentioned conclusions, the following recommendations are given:

- Start the harmonisation process as soon as possible;
- Use this IGU guideline when creating new pipeline incident databases to ensure compatibility with major (harmonised) pipeline incident databases like DOT, NEB and EGIG);
- It is highly recommended that when raw data is made available, a guideline should be provided describing precisely the boundaries and limitations of the database and how to analyse the data.
- When publishing results of the database, it is important that the boundaries of the database are clearly defined.

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9. APPENDICES

9.1. Implementation of IGU SG3.4 Results

This section describes IGU SG3.4 recommendations on future activities relating to the strategy for publication, distribution, communication and implementation of the guideline for “using or creating incident databases for natural gas transmission pipelines” as described in the previous sections of this paper.

As previously described, there is currently a wide range of publicly available databases and other sources of pipeline safety performance information available, such as websites, reports, numerous publications, handbooks, etc.

Pipeline safety performance information is finding an increased use by the general public, operating companies, engineering companies and regulators. The available information is being used for a wide range of applications such as demonstration of safety performance, evaluation of safety measures, benchmarking of countries and individual companies, etc.

The primary objective of this guideline is to assist in the selection, use and interpretation of data on pipeline safety performance with the aim of preventing misinterpretation and misuse of available data, and thereby prevent projecting an incorrect or inadequate representation of pipeline safety performance to all relevant applications.

Consulting the guideline will raise awareness for the basis and limitations associated with currently available data sources and thereby reduce the likelihood of misuse and misinterpretation of the available pipeline safety performance information. The guideline will assist both for comparative use and for assessment of the safety performance of specific pipelines or projects. The guideline provides valuable information for all users of pipeline safety performance information. In addition, the guideline contains valuable guidance on how to define any new pipeline safety performance database, increasing the added value and future use of the collected information.

Considering the above, the aim is to make this guideline widely recognised in the pipeline industry. The success of this guideline depends on implementation activities targeting a wide audience within the pipeline industry in general, such as pipeline and safety professionals, key organisations within the area of pipeline design and pipeline safety, in addition to standardisation agencies and law makers.

The following notes present a series of recommendations for further activities to ensure successful communication and implementation of the guideline. IGU SG 3.4 recommends that a separate IGU implementation activity should be launched, following IGU acceptance.

Presentation of the guideline at the 2006 World Gas Conference (WGC) is considered to be the initial marketing and implementation activity.

1. The guideline should be presented at relevant industry conferences. Presentation at IGU WGC and International Pipeline Conference (IPC) are currently planned for 2006.
2. Publication in international journals. A formal IGU letter of request should be distributed, together with an article suitable for publication, to relevant international professional journals such as World Oil, Pipeline World, etc. (ref. annex 2)
3. Selected key-words should be included in as many www search engines as possible, such as Google, Alta-Vista, Yahoo, etc.

4. An abstract, the full guideline and a technical presentation should be posted on the IGU website and on IGU member companies' websites (ref. annex 1, 2 and 3)
5. IGU should encourage participating companies to facilitate presentations of the guideline both (i) internally and (ii) externally to relevant safety and pipeline professionals (ref. annex 3)
6. Hyperlink to the guideline should be included in databases containing pipeline safety performance information, including as a minimum all databases discussed in the guideline (ref. Section 6)
7. Participating IGU companies should inform relevant local universities and educational institutions about the guideline.
8. The IGU should issue and promote the use of the guideline to relevant organisations worldwide such as CONCAWE (liquid pipelines), UKOPA, Det Norske Veritas (DNV), Lloyds, Germanischer Lloyd, EGIG, etc.
9. IGU should promote the use of the guideline as a reference for all assessments and evaluations involving the use of pipeline safety performance information for all member companies.
10. Participating IGU companies should inform local consultants within the area of pipeline safety about the guideline and promote its use where relevant.
11. Participating IGU companies should inform national law makers and regulators about the guideline and its value for enhancing the quality and use of pipeline safety performance information as part of pipeline risk management.

IGU should initiate dialogue with relevant standardisation agencies to promote the development of a formalised international standard for pipeline safety information based on the guideline.

9.2. Other Pipeline Incident Database Information

9.2.1. Argentina

Overview

The Argentine Government does not keep statistical data of gas pipeline incidents. Depending on the circumstances, the Government may apply penalties to the gas transportation companies. It is within the scope of the transportation companies to implement the follow-up of the incident and to develop related statistical data.

Although the authorities do not collect information on gas pipeline incidents individual companies keep records of gas pipeline incidents.

The government has implemented SERVICE QUALITY BENCHMARKS for gas transportation companies. These benchmarks are devised to monitor the performance of gas transportation and distribution companies and to maintain safety and reliability standards in line with international parameters.

One of the benchmarks set by the government is the TIME of response to emergencies, which relates to the obligations that Licensees have to fulfil in the event of an incident within their systems.

This benchmark is defined as:

“Maximum time in which the Licensee shall restore the service interrupted as a result of the incident, starting from the moment in which the incident occurs until the restoration of normal service in the affected area”.

The specific objective of this benchmark is to encourage the development of an appropriate system that responds efficiently to emergencies within established times, to improve the safety of the system and to reduce risks for involved people and facilities, defining the scope of the obligation of transportation companies to provide service continuity in the event of emergencies.

Development of the benchmark

Two aspects will be contemplated:

- the Immediate Response Time (**IRT**) which will comprise initial actions as well as the reporting of the incident to the Regulating Entity and
- the Service Restoration Time (**SRT**) in which the time measurement will be extended until normal service is restored in the affected area.

IMMEDIATE RESPONSE TIME (IRT)

IRT is the time comprised from the moment at which the licensee becomes aware of the incident up to the arrival to the area of the licensee’s responsible personnel to perform the Immediate Action; this time will be lower than 2 (two) hours.

Upon arrival to the area the deadline for submitting the Preliminary Report of the incident to the Regulating Entity will be less than 2 (two) hours.

Immediate Action involves: the prompt intervention of qualified personnel to perform an assessment and determine the required emergency course of action.

Authorised Personnel implies: licensee’s personnel or staff authorised by the licensee for this purpose.

SERVICE RESTORATION TIME (SRT)

This benchmark will measure the time from the discovery of the incident until the restoration of the licensed service, whether through a definite solution or alternative or provisional measures.

	Circumstances	SRT
LEVEL 1	Accessible area.	36 hrs.
LEVEL 2	Impassable land - due to weather conditions.	3 days.
LEVEL 3	Small lake, swamp, rivers and mountainous soil	6 days

Table 14: Service restoration time

The service restoration time (SRT) benchmark comprises the time allocated to IRT, whenever both parameters are considered independently. The times mentioned above do not apply to exceptional cases such as the Strait of Magellan’s, abundant rivers, great swamps, natural reserves established by competent authorities or high mountain areas.

Although both SRT and IRT time benchmarks indicated above are considered reasonable, in the event that they cannot be complied with, the transportation companies must submit to the Regulating Entity a description of the circumstances which caused the delay and all the aspects beyond the company’s responsibility. The Regulating Entity will then assess the circumstances in order to consider an exception.

Frequency

The Licensee will comply with these benchmarks at all times while the ENARGAS will carry out a final evaluation on a yearly basis.

Non-compliance situations

Any of the following situations will constitute non-compliance:

- The Licensee has failed to send the preliminary report to the Regulating Entity within the two-hour deadline after arrival to the place of the incident.
- The Licensee has failed to respond in line with the established immediate response time (IRT) with the arrival to the area of the responsible personnel who will carry out the Immediate Action.
- The Licensee has overextended the time allowed for service restoration in conformity with SRT parameters.

In all cases mentioned above, and in observance of due process regulations, the Company is subject to the penalties stipulated in the provisions of Chapter X of the Transportation License Basic Rules.

For informative purposes we are enclosing data related to incidents in the last twelve years in Transportadora de Gas de Sur (TGS):

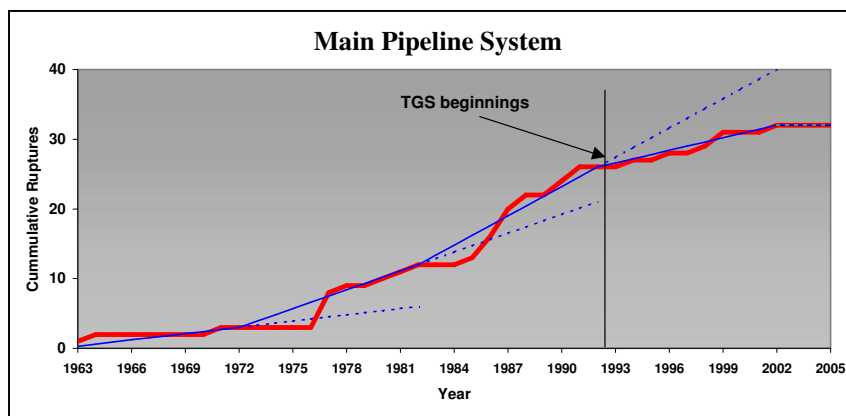


Figure 9: cumulative number of ruptures

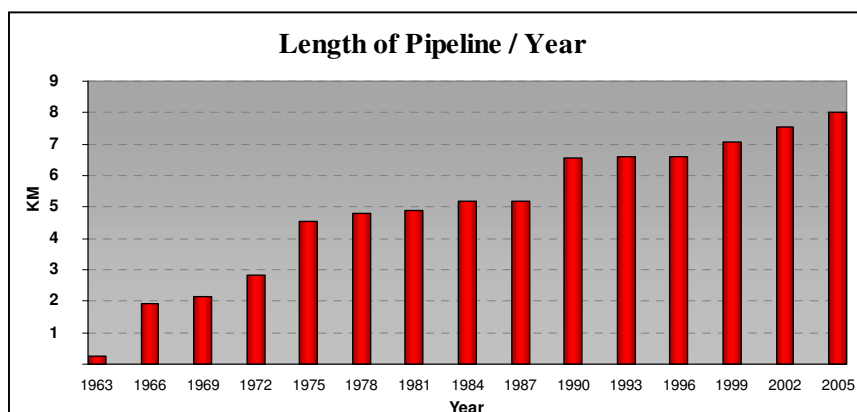


Figure 10: Annual system length (1000 km)

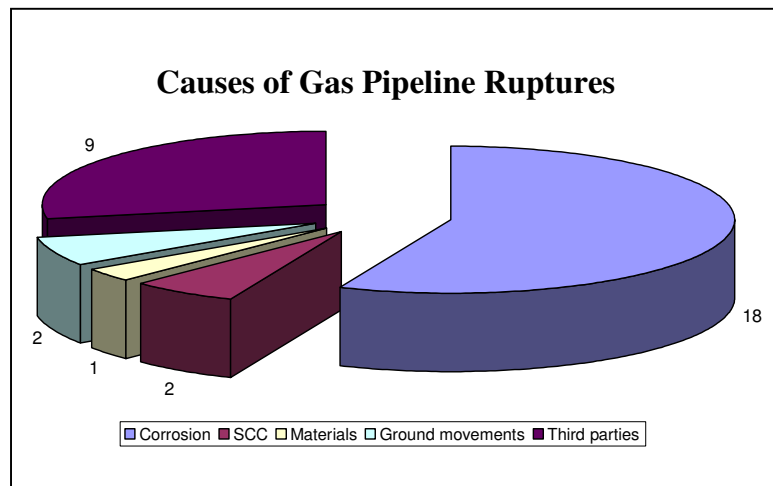


Figure 11: *Causes of pipeline ruptures*

9.2.2. Algeria

In Algeria, reporting pipeline incidents by companies which belong to the **M**ine and **E**nergy **M**inister's sectors, used to manage their own incident database. An incident is defined as any damage to the pipeline requiring an intervention of the gas operator. Recently a new directive from the **M.E.M** mandates them to report daily the incident reports. This report contains national uniform pipeline incident information, such as:

- Incident nature;
- Source information;
- Cause of the incident;
- Physical injuries and fatalities;
- Damage (material, environment).

Sonelgaz/STG.GRTG.spa is a gas transmission company, having a total network length which exceeds 5400 Km, with an operating pressure over 4 bars (up to 70 bars) and is covering natural gas demand, in a big part of Algeria's territory.

Before giving the way how the company used to report its incidents, it's useful to define how the incidents databases are classified:

- The ones which are related to the pressure reduction gas stations;
- The ones which are related to the pipelines.

The collection of the incident information is done by an internal procedure of the company and are classified by Types:

- Exploitation (e.g. corrosion, gas equipment failures);
- Third party;
- Others (e.g. flood, earthquake, landslide).

For each incident, the report gives the location, the cause and the consequence by giving the type of incident/damage such as leakage, mechanical damage, rupture, injuries and fatalities.

All the above listed information is gathered, stored inside the company and is available to carry out statistical/technical analysis. The analysis of these information permits the engineering structures of the company to make corrective actions concerning the:

- design;
- construction;
- operation and maintenance;
- Improvement of the technical specification of the gas equipments (notably in the gas equipment's purchase.

The opportunity of the new directive of the M.E.M will certainly allow:

- the exchange of the pipeline incident information between companies, which will improve the statistical/technical analysis (large and various incident database);
- using the same incidents definitions;
- Sharing experience of the other companies on how they manage their incidents.

9.2.3. Russia

General provisions

The operation of main gas pipelines is regulated by the Federal Law «The Industrial Safety of Hazardous Industrial Facilities».

At the state level, measures relating to protection are regulated by the Federal Services responsible for Ecological, Technological and Nuclear Supervision (Rostekhnadzor).

The investigation of accident at the federal level is performed in conformity with «Regulation of the Order of Technical Investigation of the Causes of Accidents at Hazardous Industrial Facilities ».

Accident investigation

The Russian gas company – JSC «Gazprom» controlling the Industrial Safety (IS) of gas pipelines observes the following principles:

- The requirements regarding accident investigation, records, analysis and accident reporting are stipulated by Federal Standards;
- The corporate “Instruction of Investigation and Record of Accidents and Incidents at Hazardous Industrial Facilities” of JSC Gazprom.

The technical investigation of the causes of each accident is performed according to the Federal Law «The Industrial Safety of Hazardous Industrial Facilities». The technical investigation is performed to detect the causes of the accident with the maximum possible certainty, to take measures to eliminate its consequences and to restore the work capability of the facility, determine material loss, develop the necessary measures and opportunities to prevent similar accidents at the facility in question and other facilities and enterprises.

JSC Gazprom has a unified alert system and a system for distributing information when an accident happens within a gas transportation system. The source of primary information about the accident may be a report by industrial or patrol personnel, an organisation performing a diagnostic examination of the facility, supervision bodies or passers-by. As we can see from the schedule, the ways of distributing information about the accident depend on its character and consequences.

The technical investigation of the causes of the accident is performed by a special committee headed by the territorial authority of Rostekhnadzor. The committee includes the representatives of relevant federal authorities and/or the local government, the representative of the company at whose facility the accident took place, and a number of other Specialists.

The period of investigation for accidents should not exceed 10 days. The work of the committee results in a Technical Accident Investigation Certificate.

At the federal level, accidents in Russia, including in main pipelines, are recorded in general computer records by Rostekhnadzor in real time.

Recording, data keeping and accident reporting

LLC Gaznadzor, the Inter-Corporate Control Body of JSC Gazprom, performs the recording, processing and datakeeping (archiving) of the data as regulated by JSC Gazprom at the corporate level.

The investigation materials for each accident include a number of additional documents, in addition to the Investigation Certificate.

The accident data is put into the electronic database, data about officially negligent organisations, time of restoration of the technological process, time of shutdown of the facility and other data is also included. The data input is performed in dialogue mode (see figure 12).

Характер	Очаг	Разруш. элем.	Последствия	Заменённые	Виновные	Акт	Травмированные	Поражение зданий	
Объект	Положение	Проект. констр.	Фактич. констр.	СМР	Испытания	Режим	Условия	ЭХЗ	Источник отказа
Дата отказа	8 января 2000 г.								
Шифр отказа	Авария								
Вид отказа	с возгоранием продукта								
Вид объекта	ГРС (АГРС)								
Режим работы объекта	эксплуатация								
Объект	газораспределительная станция								
Узел	узел редуцирования газа (ГРС(АГРС))								
Производственное объединение	Самаратрансгаз								
Производственное подразделение	Средневожское ЛПУМГ								
Наим-е магистр-газ-да или месторожд									
Наим-е газ-да (г-да - отвода)	ГРС №2								
Территориальная принадлежность	На территории России								

Figure 12: Screen-print of the incident information system

The accident causes are:

- defective pipes and pipeline fittings,
- defective equipment of MP,
- defective construction works,
- accidental mechanical damage during operation,
- violation of operating conditions and modes,
- external corrosion, including stress-corrosion,
- internal corrosion and erosion,
- natural hazards,
- other (sabotage, fatigue damage and others)..

The base provides for the potential to sort out and analyse the accidents with the submission of the results as unified table forms of different types.

In order to make the operative and strategic decisions for the process of managing the industrial safety of main pipelines, the materials covering accident reporting should be submitted every three months to the Management of JSC Gazprom in unified table forms.