ENSAD – Energy-Related Severe Accident Database

Overview

Severe accidents in the energy sector have been identified as one of the main contributors to man-made disasters. Based primarily on the historical experience, the Paul Scherrer Institut (PSI) carries out extensive analyses of severe accidents in the energy sector. The work covers severe accident risks in fossil energy chains, i.e. coal, oil, natural gas and Liquefied Petroleum Gas (LPG), as well as hydropower and nuclear.

In 1998 ENSAD, a highly comprehensive database on severe accidents with emphasis on the energy sector, was established by PSI. The historical experience represented in this database was supplemented by probabilistic analyses for the nuclear energy, to carry out a detailed comparison of severe accident risks in the energy sector. The database allows to perform comprehensive analyses of accident risks, which are not limited to power plants but cover full energy chains, including exploration, extraction, processing, storage, transports and waste management.

Since then, the ENSAD database and the analysis have been much extended, not only in terms of the data as such but also what concerns the scope of applications. The main objectives of this activity are: (a) to carry out comparative assessment of severe accidents in the energy sector; (b) to assess the external costs associated with severe accidents within the various energy chains. Thus, the results can support policy decisions and serve as an essential input to the evaluation of sustainability of specific energy systems. Lack of estimates of external costs of non-nuclear accidents was earlier identified as one of the major limitations of the state-of-the-art of externality assessment. Uses of the database for engineering purposes are feasible but have not been fully exploited until now.

Figure 1 shows an example of few selected information that is stored in the database for individual accidents records.

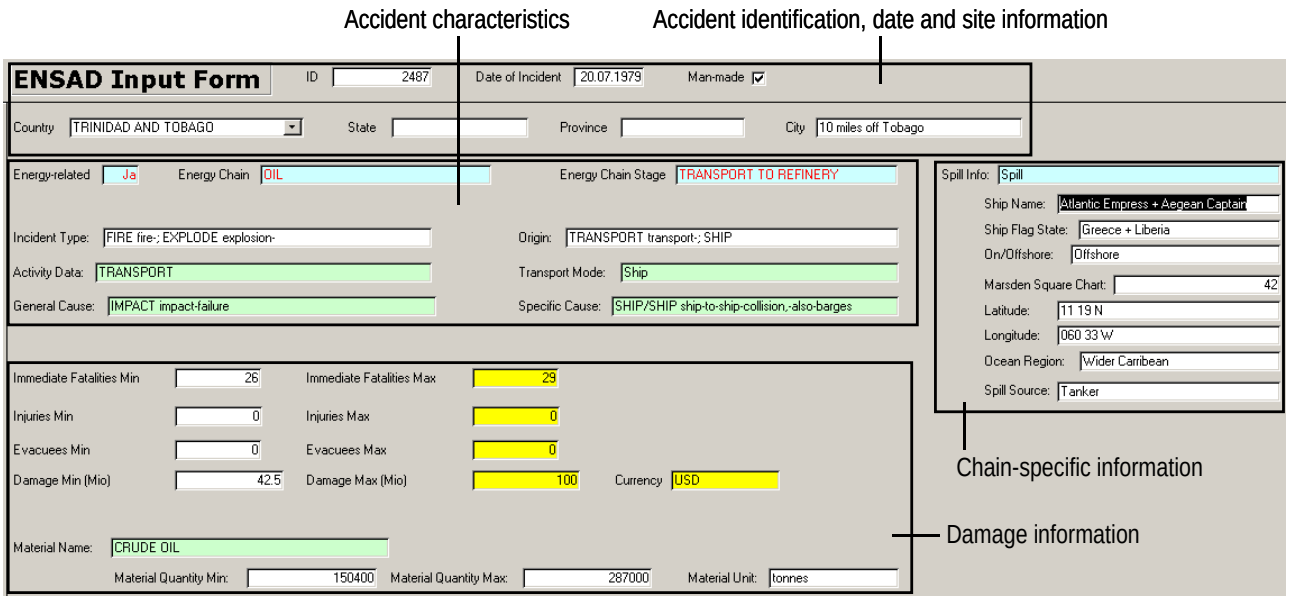


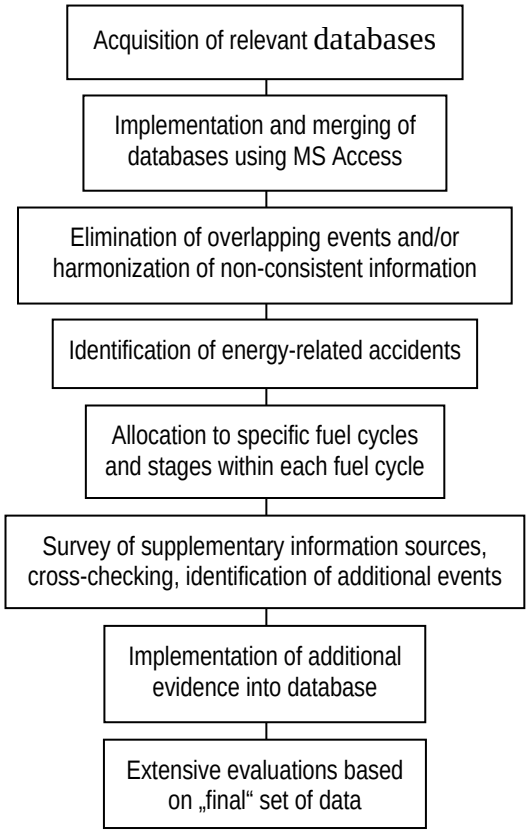
Figure 1: Overview of the number of accidents by type (natural, man-made, man-made energy-related, man-made)

Database Implementation

At an early stage of the development of ENSAD it was decided that building a severe accident database from the scratch would neither be feasible nor efficient, particularly given the actual time and resource constraints. The survey of the existing sources of information, carried out at the beginning of this effort showed that:

- Numerous sources of information exist; their availability, scope, development status and quality exhibits an enormous variation.
- Commercial and non-commercial databases are available. They normally cover man-made accidents in a variety of sectors and in some cases also the natural disasters. Very few of the databases deal explicitly with energy-related accidents. If they do, the coverage concerns one specific energy carrier, for example offshore accidents. In most cases energy-related accidents constitute a not explicitly identified subset among other accidents.
- None of the available individual databases has a satisfactory coverage to form alone a basis for the evaluation of severe accidents.
- The information assembled in the available databases even if combined, would not be fully adequate for meeting the objectives of this work. It needs to be supplemented by additional sources in order to achieve reasonable completeness and quality.

As a result of these insights the following approach was applied:



Severe accident definition

Based on the literature, there is no unique definition of a severe accident. All definitions include various consequence (damage) types (evacuees, injured persons, fatalities or costs) and a minimum level for each damage type. The differences between the definitions concern both the set of specific consequence types considered and the damage threshold.

The PSI database ENSAD uses seven criteria to define a severe accident:

1) at least five fatalities or

2) at least ten injured or

3) at least 200 evacuees or

4) extensive ban on consumption of food or

5) releases of hydrocarbons exceeding 10 000 t or

6) enforced clean-up of land and water over an area of at least 25 km^2 or

7) economic loss of at least five million USD(2000).

Whenever any one of the above criteria is satisfied, the accident is considered to be severe. However, various types of consequences are covered to differing extents because of differences in availability and quality of information. The highest degree of completeness is available for fatalities. Releases of hydrocarbons are almost exclusively used in connection with oil spills, but is of little relevance for the other energy chains considered.

Below you see some examples of potential severe accidents in the various energy chains.

Some facts about ENSAD

ENSAD contains currently 18 400 accidents. Man-made accidents comprise 12 943 or 70.3% of the total, whereas natural disasters amount to 5457. A total of 6404 energy-related accidents corresponds to 34.8% of all accidents or 49.5% of man-made accidents. Among the energy-related accidents 3117 (48.7%) are severe, of which 2078 have 5 or more fatalities. Non-energy-related accidents and natural disasters are of second priority within ENSAD. Consequently, the corresponding data are likely to be less comprehensive than the ones provided for the energy-related accidents. Figure 2 provides an overview of the number of accidents by type and by different damage indicators as included in ENSAD.

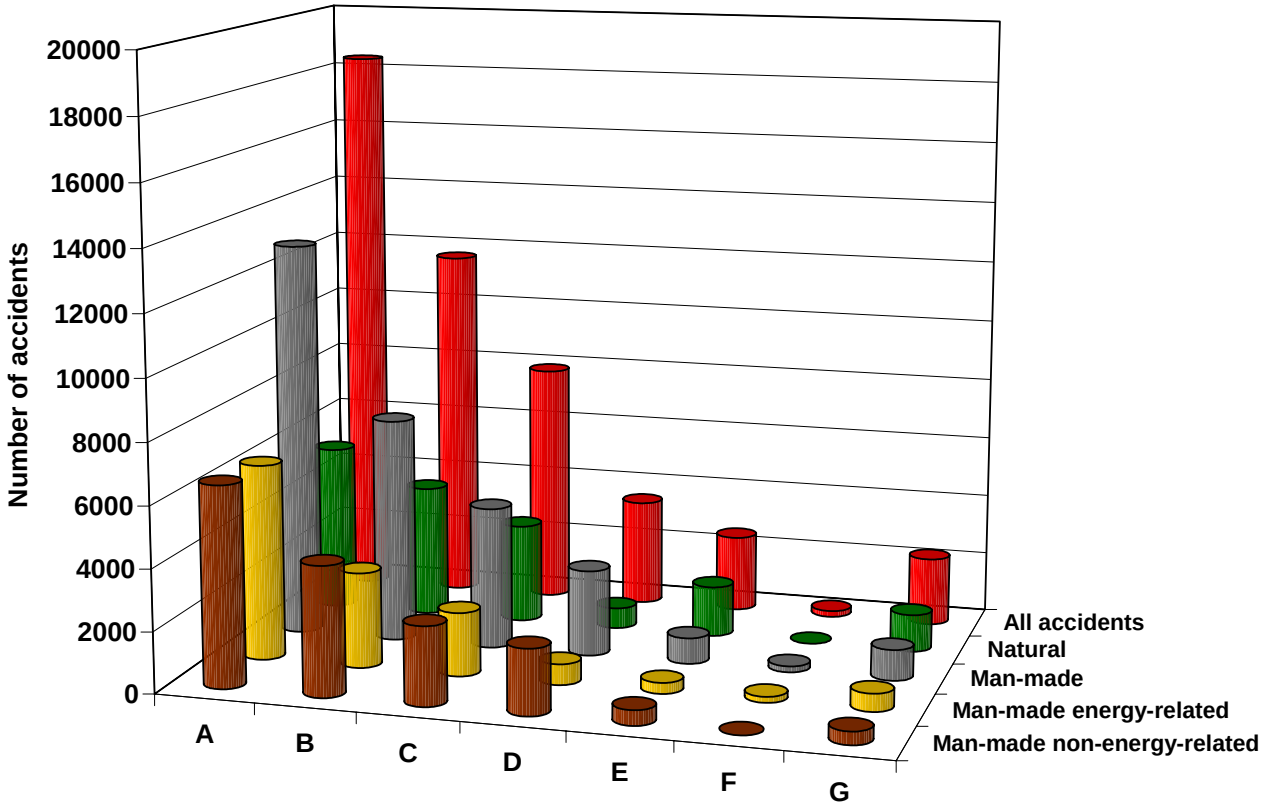


Figure 2: Overview of the number of accidents by type (natural, man-made, man-made energy-related, man-made non-energy-related) and by different damage categories (indices A-G), as included in ENSAD.

Current evaluations of ENSAD cover the years 1969-2000 because 89% of the accidents stored in the database occurred in this time period. Data for 2001 and thereafter are not yet fully representative, as there is normally a certain time lag in reporting and the publication of the data.

Figure 3 shows the number of fatalities world-wide in different types of accidents over this period of more than 30 years. Number of fatalities were significantly higher for natural disasters than man-made accidents. However, values exhibit large annual fluctuations because great catastrophes have a strong influence. Among the largest natural disasters were a storm and flood catastrophe in Bangladesh in 1970 (300 000 fatalities) and the Tangshan earthquake in China in 1976 (290 000). The largest man-made energy-related accidents resulted in fatalities one or two orders of magnitude lower. In 1975, the Banqiao/Shimantan dam failure in China caused 26 000 fatalities; in 1987, the collision of a passenger ferry and an oil tanker off the Philippines resulted in 4375 fatalities; and in 1982, 2700 soldiers and civilians died in the collision of a soviet fuel truck and another vehicle in the Salang tunnel (Afghanistan).

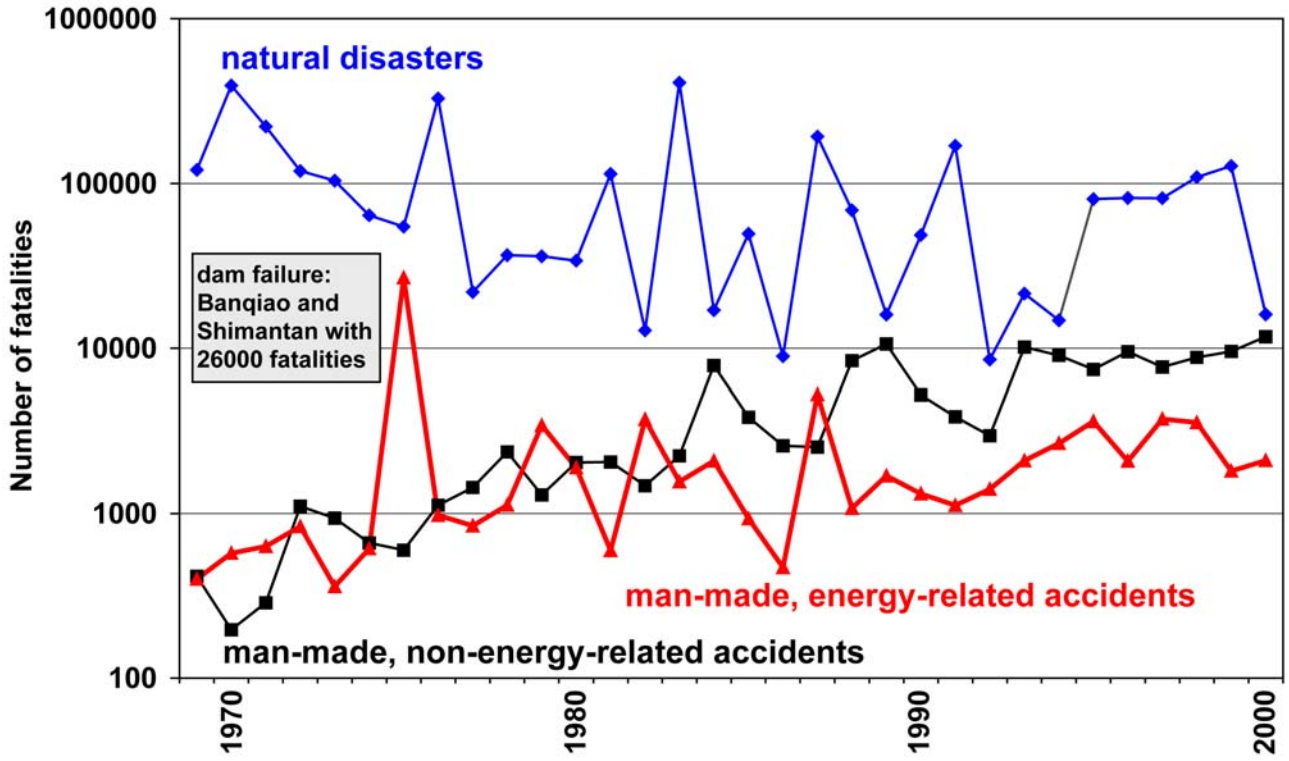


Figure 3: Number of fatalities in severe (≥ 5 fatalities) accidents that occurred in natural disasters and man-made accidents in the period 1969 to 2000.

Literature for further reading

Hirschberg S., Spiekermann G. and Dones R. (1998) Severe Accidents in the Energy Sector. PSI Report Nr. 98-16. PSI, Villigen, Switzerland.

Hirschberg S. and Burgherr P. (2002) Identifying and Assessing Errors of Commission - Results of Applying the CESA Method. In proceedings from: 6th International Conference on Probabilistic Safety Assessment and Management PSAM-6, San Juan, Puerto Rico, 23-28 June 2002, In: (Ed. Bonano E.J.) Vol. I, Elsevier, Amsterdam.

Hirschberg S., Burgherr P., Spiekerman G., Cazzoli E., Vitazek J. and Cheng L. (2003) Assessment of Severe Accident Risks. In: Integrated Assessment of Sustainable Energy Systems in China - The China Energy Technology Program. Book Series: Alliance for Global Sustainability Series: Volume 4, pp. 587-660 (Ed. Eliasson B. and Lee Y.Y.). Kluwer Academic Publishers, Dordrecht/Boston/London.

Hirschberg S., Burgherr P., Spiekermann G., Cazzoli E., Vitazek J. and Cheng L. (2003) Comparative Assessment of Severe Accidents in the Chinese Energy Sector. PSI report 03-04. PSI, Villigen, Switzerland.

Burgherr P. and Hirschberg S. (2004) Severe accidents in fossil energy chains: individual chain results and aggregated evaluations. In proceedings from: 7th International Conference on Probabilistic Safety Assessment and Management (PSAM7 - ESREL'04), Berlin, Germany, 14.6.-18.6.2004.

Burgherr P., Hirschberg S., Hunt A. and Ortiz R.A. (2004) External costs from major accidents in non-nuclear fuel chains. Work Package 5 Report prepared for European Commission within Project NewExt on New Elements for the Assessment of External Costs from Energy Technologies. Paul Scherrer Institut, Villigen, Switzerland.

Hirschberg S., Burgherr P. and Hunt A. (2004) Accident risks in the energy sector: comparison of damage indicators and external costs. In proceedings from: 7th International Conference on Probabilistic Safety Assessment and Management (PSAM7 - ESREL'04), Berlin, Germany, 14.6.-18.6.2004.

Hirschberg S., Burgherr P., Spiekerman G. and Dones R. (2004) Severe accidents in the energy sector: comparative perspective. In: Journal of Hazardous Materials, 111, pp. 57-65.