Workshop on fuel cycle safety
Past, present and future

Some lessons learned form the past incidents in the French FCF’s

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Summary

- Treatment of incident data for safety improvements in IRSN
- SAPIDE: the supporting data base
- Current situation of SAPIDE
- Some statistics on Recent French domestic incidents
  - Is safety in progress?
  - Is INES a relevant statistical indicator?
  - Can safety indicators be derived from incidents?
  - Is incident based OEF efficient?
Incident data generation

- **Incident declaration criteria**
  - What is an incident?

- **Variability along time and licensees**
  - Initial instructions to the licensees dated 1983
  - The corresponding criteria were mainly based on “visible” consequences
  - Various practices among the licensees
  - Introduction of INES in 1987
  - International agreement on INES level in 1991

- **In 2003, the Safety Authority undertook a rationalization**
  - Issuance of standard criteria and test period
  - Applicable to all the licensees (FCF’s, R&D labs, Facilities under D&D)
  - Finalization and entry into force of updated criteria in 2005
Incident data generation

- **Three sets of Incident declaration criteria for the facilities**
  - Safety
  - Radioprotection
  - Environment
  - 10 criteria for each domain

- **Specific criteria for transport systems**

- **Three independent INES (safety, radioprotection, transports)**

- **Declaration within two days**

- **Incident report within two months**
  - Standard summary

Provide a consistent basis for OEF
Standard criteria
Deeper analysis of causes
Corrective actions
Data Collection in IRSN

- The IRSN documentation is stored in a data base (SAPIDE)
  - Available on the IRSN Intranet

- Capture process involves double check for all the incidents
  - Coding is proposed by the SAPIDE administrator (consistency)
    - Based on the incident report
  - Coding is validated by the facility supervisor (relevance)
  - Detailed analysis for the most significant incidents

- Data are made available to all the IRSN actors
  - Facility supervisors
  - Experts (fire, Human factors, containment, criticality, etc.)
  - A monthly information bulletin is issued

- SAPIDE data base sheets include
  - Descriptive fields (Context, root causes, impacted components)
  - Attached documents (declaration, reports, follow-up letters, etc.)

- Recovered past data were introduced in SAPIDE
  - SAPIDE operation started in 2004 with ~3200 sheets
SAPIDE data sheets description

- **General coding technique is close to FINAS coding**
  - Root causes + List of key words for involved components and phenomena

- **Observed consequences on safety**
  - Dedicated scale for assessing the impact on defense in depth
    - 7 levels (0-VI) for evaluation of the degradation of protective barriers
    - The code refers to the SAR and not to the source term
    - “independent” on the type of facilities
    - Aims at characterizing the observed failure in operation → OEF

- **Observed consequences on persons**
  - 7 levels (0-VI) to refine the analysis
  - Additional fields for qualitative and quantitative approaches

- **Observed consequences on environment**
  - 7 levels (0-VI) to refine the analysis
  - Additional fields for qualitative approaches
    - Impacted media
    - Type of pollution
SAPIDE data sheets description

- No systematic evaluation of potential consequences
- **Risk of missing the precursor events**
  - Identification of precursors should require detailed analysis
  - Example of reactors
  - Strongly depending on design and operation for FCF’s
- **Test of a standard methodology for the incidents of the year 2000**
  - Statistical basis = ~ 150 incidents
  - Easy to implement
  - Did not provide significant results
  - Recoding revealed the method was “expert dependent”

Thus ...

- The declaration and reports are circulated among experts
- The monthly bulletin extend the number of involved people
- Some recurrences of similar incidents have already been detected
SAPIDE current situation

- **~ 4000 sheets available**
  - French domestic BNI (facilities)
    - FCF facilities
    - R&D laboratories
    - Reactors under D&D
  - Non declared events (since 2006)
    - from periodic operation reports
  - French defense related facilities
    - For generic topics
  - Foreign incidents
    - Originated form FINAS
    - Data collected in congresses

- **Incidents dates from 1960 to 2007**
  - Complete coding for the 2000 - 2006 period
  - Partial coding for the 1960 - 2000 period
    - Actual impacts on safety, persons and environment are coded
Observed statistics of OEF (for French domestic BNI)

- **Number of incident per year:**
  - 0 lead to releases exceeding or close to the limits since ~20 years
    - To be forgotten urgently!
  - ~1 requires immediate actions
    - Lessons learned for emergency management systems
    - Keep training and skills of personals in addition to the drills

- ~10 are analyzed in detail and a detailed report is issued to SA
  - Immediate inspection
  - Focus the attention (public, follow-ups, etc)

- ~100 - 150 declared incidents
  - Our raw material for OEF
  - Limitations of resources for detailed analysis
  - Importance of appropriate storage and sorting capabilities
  - Lessons learned to be drawn for criteria optimization
General statistics (French BNI 1950 - 2006)

- Evolution of the number of declared incidents
  - A degradation of safety?
  - Oscillations correlated to identified events
    - Start up of new facilities
    - Generic problems
    - Test period of new declaration criteria

- Uncertainties in the past data
  - Declaration criteria
  - Data collection procedures

Such a simple comparison of numbers cannot identify any generic or precursors incidents ...

But comparison of actual gravities provide additional information to our question
Evolution of the number of the most significant incidents

- Data extracted from SAPIDE (declared incidents)
- Reconstructed actual gravity level for incidents before the year 2004
  - On line elaboration since 2004
- Extraction process based on text processing of the reports
- Completed by detailed analysis for some incidents (~100)
- Similar task achieved for the actual impacts on personnel & environment

- Displayed statistics for Actual gravity > 4
  - 1 event rated level VI (fire in the storage silo in La Hague)
  - Rate IV = one protection barrier failed
  - Rate V = more than one barrier failed
  - Independent on the risk

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And the remaining incidents (in SAPIDE...)

- Evolution of the minor incidents
  - Scale divided in three levels
    - Deviations
    - Formal deficiencies
      - E.g. test not performed in due time,
      - Inappropriate working procedure, etc..
    - Failure of on equipment or item (including prescriptions)
  - Uncertainties for past incidents are much larger here

- Stabilized data collection procedures since ~1995
  - The apparent global increase of incidents corresponds to
    - More stringent declaration criteria
    - Decrease of significant incidents
    - More attention paid to defense in depth

- OEF is to be based on (very) minor events
  - Importance of criteria (“quantity vs quality”)
  - Importance of incident data treatment
INES gravity scale

- INES scale was designed for public information
  - Used in France since 1987
  - International scale since 1991
  - Evolution in 2004 in France

- INES rating include objective and non objective criteria

- What are the observed evolutions?
- What are the correlations?
- Is INES relevant for statistics?

- Usable data in SAPIDE for the period 2000 - 2006
Historical evolution of INES rated incidents

- Data aggregation for incidents after 2004
- Aggregated INES = max (safety, persons, environment)
- INES ratings data have not been checked for incidents before 2000
- Level 2 = 1 incident per year
- 2004 = irradiation in a radiositope preparation facility
- 2005 = contamination of one injured person
- 2006 = deficiencies in safety criticality management
- Number of incidents rated Level 1 is almost constant
- Number of incidents rated level 0 with variations parallel to the variations of minor incidents

Does this provide indications on the evolution of safety?
Correlations between INES and actual gravity

- Actual gravities have been consolidated
  - impact on safety
    + impact on persons
    + impact on environment

- INES level 2 are not displayed as not statistically significant (3)

- Overall correlation is good (khi² test)
  - But... significant dispersions
Origin of the observed correlation

- The transition period (2002-2004)
  - New criteria under test
  - New decrees or re-assessment
  - Regulation of chemical discharges

- Towards a more normal correlation

- Generalization of INES

- A trend towards a more stringent implementation and improved correlation?

- Handle INES ratings with care for characterizing the progress in safety
Facility related indicators

- Observing “low level signals” require refined indicators
- Take into account the variety of processes and risks
- Take into account the operation practices of the licensees

- First test with the trend in the numbers of yearly incidents
  - Handling small numbers
  - Cancel the poor correlations

- Reasonable agreement with expert judgments

- Identified Side effects
  - No reference to any absolute value
  - No consideration on gravity or type
The trends in the yearly incident numbers

Trends in number of presignificant incidents / quality of the correlation

Diameters are proportional to the considered numbers of incidents

Good Practices?

Non conclusion area

To be examined?

Trends in numbers of incidents with consolidated gravity >4 (i/yr)
Incident gravity related indicators

- How to take into account “what is declared”?

- The observed distributions of actual gravity are variable among the facilities
  - Reminder:
    - Actual gravity only depends on the impact on the defense in depth
  - Identifying the proportion of deviations and “formal” deficiencies
    - Aims at quantifying the focus of the licensee to “low signals”
  - Identifying the number of actual deficiencies
    - Aims at identifying the actual misses in operation

- Need for aggregating the gravities
  - Aggregated gravity = sum of the three impacts - (1)*
  - *: One level less for incidents that only lead to chemical releases
  - To take into account the transition period
Gravity related indicator (one attempt)

- Distribution of the aggregated gravities for the 2000 - 2006 period

- The deviations and “formal” incidents
  - Attention of the licensee to low level signals
  - Around 10%

- The actual misses
  - What is to be avoided
  - Around 11%
Gravity related indicator (results)

Significant impact of the transition period

Pre alert?

Following SA notice in 2003

Safety upgrades following reassessment

!!!
One observation

- A negative correlation between minor incidents fraction and significant incidents
  - Opposed to the common sense
  - Gravity could be not a matter of random

- The same phenomenon is observed for aircraft crashes
  - MIT report on airlines safety 1998

- Protection against incidents by minor incidents ??
  - A proof of the positive role of OEF ?

... To be continued