Cost categorisation suggested in the previous OECD/NEA report and approaches for the new study

Marco Cometto and Alexey Lokhov

OECD/NEA, Nuclear Development Division

Background and history

Previous joint project between the NEA Committee on Radiation Protection and Public Health (CRPPH) and Nuclear Development Committee (NDC) with involvement of the Division of Legal Affairs (LEG).

Objective: In-depth study of the methodologies for assessing the economical consequences of nuclear reactor accidents.

Ad-hoc expert group was created in 1994 and final report was published in 2000.

- Study was focused on severe accidents resulting with large dispersion of radioactivity and dealt mainly with off-site consequences of the nuclear accident.
- *"This report was of generic nature, not being specific in circumstances in any one country or group of countries".*
- *"This work focused on the development of economic consequences assessment methods and methodologies and that … no attempt was made to quantify accident economic effects".*

Perspectives and objectives

Perspectives and objectives for an assessment of nuclear accident costs

Three different approaches and perspectives in assessing the cost of a nuclear accident, from a short-term focus to a more long-term focused analysis.

- *Accident preparedness and management perspective*

  Economic analysis defined in order to define and optimise the accident management procedure to mitigate total social costs (in both short and long-term).

- *Compensation perspective*

  Estimate the total compensation amount to be paid to those affected by the accident, to evaluate whether existing provisions are adequate to third party damages compensation.

- *Power generation choice perspective*

  Define the whole societal costs of a nuclear accident and calculate the associated externalities of nuclear power generation.

➢ The methodologies employed and the cost elements to be considered depend upon the perspective taken.

➢ There cannot be a single figure for a cost of nuclear accident.

Cost elements: direct effects

Direct economic consequences were defined as "cost of implementation of the countermeasures".

- Implementation of protective countermeasures to reduce dose.
  - Population movement (transport, temporary accommodation, loss of income, loss of capital).
  - Agricultural restrictions and countermeasures.
  - Decontamination (cost of cleaning, cost of labour, health effect induced in the workforce).
- Radiation induced health effects on the exposed population and its descendent.
  - Include early, latent and hereditary effects.
  - Direct health effect cost and indirect effects (loss of earnings).
  - Epidemiological follow-up of the exposed population.
  - Non-monetary costs associated with previous points.

➢ Choice of appropriate discount rate for costs taking place at different timeframes.

- Use normal discount rate for marketable goods.
- Apply reduced discount rate for non-marketable goods (health and environmental effects) or even no discount rate for effects appearing far in the future.

Cost elements: indirect and "unquantifiable" effects

Indirect economic consequences covered "the effects produced outside the areas directly impacted by the contamination".

- Impact of non-contaminated food marketing.
- Impact on tourism and on other goods.
- Effect on the electricity market and on the nuclear program, nationally and internationally.

➢ Indirect effects were considered difficult to be quantified *a-priori* but are amendable to an *a-posteriori* evaluation.

➢ Their magnitude depends on the size of the area included in the analysis.

"Unquantifiable" effects

- Environmental and ecological damages.
  - Long-term effects of contamination on wildlife and vegetation (other than agricultural)
- Other effects that are difficult to quantify.
  - Loss of image of the company, region or even the country.
  - Broader economic consequences such as decrease in investments, depreciation of the national currency, etc.

The new NEA study on Cost of nuclear accidents

The "Cost of nuclear accidents, liability issues and their impact on electricity cost" is a transverse OECD/NEA project.

Undertaken by Nuclear Development Committee with the assistance of other committees and associated divisions of NEA:

- *Committee on Radiological Protection and Public Health*
- *Committee on Nuclear Regulatory Affairs*
- *Committee on Nuclear Law*

The project is overseen and directed by an **Ad-Hoc expert group** with representatives nominated by NEA members countries.

- Three/four meetings of the expert group are scheduled in the biennium 2013-2014.
- Two workshops organised on specific themes:
  - *Approaches to estimation of the costs of nuclear accident (28-29 May 2013)*
  - *Nuclear accident risk, liability issues and compensations schemes (12-13 Dec 2013)*
- Publication of the final report is expected by the end of 2014.

Tentative project structure

1. *Introduction*

- Short description of the most important accidents (nuclear, electricity, mining, chemical industries).
- What is specific to nuclear accidents and why they are perceived differently.

2. *Severe accidents in the history of civil nuclear power*

- Description of the accident (TMI, Chernobyl and Fukushima).
- Damages (material damages, contamination and health effects).
- Available data on broader economic consequences.

3. *Approaches to estimation of the costs of nuclear accidents*

- Different perspectives on and definition of the “cost of a nuclear accident”.
- Appraisal of existing studies.
- Definition of the methodology proposed in the current study.

4. *Generic case studies*

- Definition of representative case studies and limitations of this approach.
- Estimations of absolute costs.
- Estimation of external risks associated with nuclear power production (cost*probability).

5. *Question of funding nuclear liability*

- Review the existing liability regimes in OECD countries and their coverage.
- Mechanisms implemented in case liability amounts are beyond the liability caps legally provided.
- Other mechanisms that could internalise nuclear accident cost: practical implications.

6. *Conclusions and recommendations*

Input needed

1. ***Introduction***
   - Short description of the most important accident (nuclear, electricity, mining, chemical industries).
   - What is specific to nuclear accidents and why they are perceived differently.

2. ***Severe accidents in the history of civil nuclear power***
   - Description of the accident (TMI, Chernobyl and Fukushima).
   - Damages (material damages, contamination and health effects).
   - Available data on broader economic consequences.

3. ***Approaches to estimation of the costs of nuclear accidents***
   - Different perspectives on and definition of the “cost of a nuclear accident”.
   - Appraisal of existing studies.
   - Definition of the methodology proposed in the current study.

4. ***Generic case studies***
   - Definition of representative case studies and limitations of this approach.
   - Estimations of absolute costs.
   - Estimation of external risks associated with nuclear power production (cost*probability).

5. Question of funding nuclear liability
   - Review the existing liability regimes in OECD countries and their coverage.
   - Mechanisms implemented in case liability amounts are beyond the liability caps legally provided.
   - Other mechanisms that could internalise nuclear accident cost: practical implications.

6. Conclusions and recommendations

Input needed: methodology

Is there consensus on elements of methodology?

- Which cost elements should be considered for a given perspective?
- For elements that should be quantified: How to calculate them or account for them?
- Which region should be considered in the analysis? (e.g. site, region, country, world)?
- Inputs on discount rates, methods to quantify health-effects and human losses, etc.

OCDE/NEA, 2000 Cost categories identified

On-site Costs
Cost of decommissioning and decontamination
Loss of capital (e.g. installed capacity)
Application of countermeasures to reduce doses
Population movement
Transport away from the affected area.
Temporary accommodation and food.
Supervision of the evacuated area and monitoring of people.
Loss of income for people unable to reach the workplace.
Lost capital value and investment on land and property.
Psychological effects of worry and upheaval.
Agricultural restrictions and countermeasures (e.g. amounts of agricultural produce that are lost or restricted)
Decontamination
Cost of cleaning process, including the necessary equipment and materials, and the disposal and transportation of generated waste.
Cost of labour.
Cost of health effects induced in the workforce.

Radiation-induced health effects in the exposed population.
Cost of radiation-induced health effects
Early effects.
Latent effects.
Hereditary effects.
Direct health care costs.
Indirect costs, due to the loss of earnings during treatment and convalescence or of the total
Human capital approach: Cost of indirect impact on the economy, resulting from the temporary or permanent removal of the individual from the workforce expected future earnings in the case of death.
Non-monetary costs, such as pain, grief and suffering associated with each effect
Psychological effects.
Impact on the activity with which the installation is associated, for example the power programme.
Impact on economic factors: employment, revenues, losses of capital, etc
Long-term social and political impact.
Environmental and ecological impact.

Case studies: How do we proceed? (1)

- ✓ The purpose of case study selection is two-fold:
  - Provide a range of values of the ***cost of a nuclear accident***, under different hypothesis and according to the methodology defined.
  - Estimate what could be the ***external risk of nuclear accidents***.
- ✓ Generic case studies without explicit reference to a specific country/location.
- ✓ Limited but representative number of case studies.

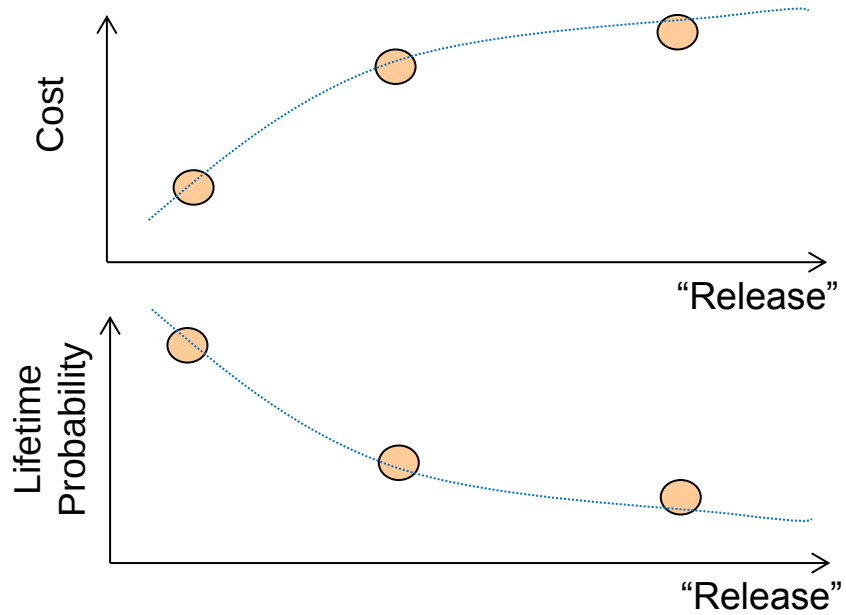
Questions:

- Should we consider other facilities or only NPPs?
- Is it possible to define "generic case studies"?
  - Reactor type and its safety level (PWR vs. BWR, older vs. modern NPP).
  - Location. Close to large city (or densely populated area) or less populated area, near the coast or inland, etc.?
  - Source terms. (E.g. no off-site release, off-site localized release of 10% (?) volatile inventory, major global release of 100% (?) of volatile inventory and x% of the core.
- Probability distributions are clearly difficult to estimate. Is there a preferred method?
  - PSA-based methodologies
  - Probability inferred from history
  - IAEA safety targets (postulated probability)

Case studies: How do we proceed? (2)

The following simplified approach comes to mind:

- Selection of a limited number of **release scenarios**.
- Determine for each a **cost range estimate**.
- These cost estimates are combined with **probability distributions** for a given facility to estimate the external risk of nuclear accident.



"Expected" External cost naïve recipe

- Multiply the curves (with a weighting factor?)
- Integrate the product over the "release"
- Normalise with lifetime electricity generation to obtain the external cost in USD/MWh

Thank you for your attention.