



Probabilistic Safety Goals



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Background



- Decision from June 2003 RIDeM WG meeting:
 - All members will send details on existing or expected Safety Goals by August 15, 2003
- This presentation uses information from:
 - Canada, France, Hungary, Korea, UK, USA, Lithuania, Pakistan, Japan and the IAEA



General



- Few countries have presently (2005) set formal Probabilistic Safety Goals
- Probabilistic Safety Goals always derive from Qualitative Safety Goals.
- The basis for Safety Goals, when documented, is that high level safety objectives are difficult to enforce and that safety goals, related to events that can be modeled, are valid surrogates.



Probabilistic Safety Goals in Canada (1)



- A Regulatory Document, including Safety Goals, (RD-152) is in preparation.
- Safety Goals have been set for new reactors (draft RD-337, in public consultation phase)
- Two sets of Safety Goals will be set, for existing plants and for future plants
- Three Safety Goals have been chosen:
 - CDF - Frequency of Severe Core Damage
 - SRF - Frequency of public evacuation,
 - LRF - Frequency of population permanent relocation



Probabilistic Safety Goals in Canada (2)



- The CNSC considers that health effects from plant accidents are bounded by Societal effects (due to evacuation and relocation) and that radiological effects would be a small contributor, further reduced by evacuation and relocation.
- Criteria would be set for evacuation and relocation. The proposed criteria are:
 - Evacuation would be initiated by release of more than 10^{15} Bq of I_{131}
 - Relocation would be initiated by release of more than 10^{14} Bq of Cs_{137}



Probabilistic Safety Goals in Canada (3)



- Safety goals are presently set at
 - reactor level for Core Damage,
 - plant level (i.e. independent of the number of reactors sharing containment).



Probabilistic Safety Goals in Hungary (1)



- Probabilistic Safety Goals are proposed, but will not be enforced before the next revision of the Nuclear Safety Codes (date unknown).
- Three Safety Goals are proposed:
 - The “Technical Probabilistic Safety Goal” would address severe accident frequency,
 - “Radiological Probabilistic Safety Goal #1” would address short term effects on the public,
 - “Radiological Probabilistic Safety Goal #2” would address long term effects on the public.



Probabilistic Safety Goals in Hungary (2)



- The goals are defined at reactor level,
- The proposed safety goals apply to existing reactors.
- The existing values could be modified.



Probabilistic Safety Goals in the USA (1)



- The US-NRC has set three levels of Safety Goals:
 - Qualitative Safety Goals, set in general terms: “no significant additional risk..”
 - Quantitative health objectives, set in relative contribution of radiological risks to other risks,
 - Surrogate Safety Goals, able to be used in regulatory decision-making:
 - Large Early Release Frequency (LERF)
 - Core Damage Frequency (CDF)



Probabilistic Safety Goals in the USA (2)



- Work is on progress for defining what goals will be set for new reactors (SECY-05-0006).
- The current proposals are to set the goals for new reactors one decade lower than for existing reactors.



Probabilistic Safety Goals in the UK



- For any goal, two levels are defined:
 - Basic Safety Limit (BSL), beyond which the risk is considered as unacceptable,
 - Basic Safety Objective (BSO) under which the risk is considered as “widely acceptable”.
- The HSE has set four goals applicable to power plants:
 - Doses to the public,
 - Risk for the workers,
 - Large release,
 - Plant damage



Probabilistic Safety Goals in France (1)



- The French Safety Authority has published “orientation values” which are not binding.
- The goals have been used on a case by case basis, but have never been the only basis for a decision.
- The overall objective is defined in terms of “unacceptable consequences”, but “unacceptable consequences” are not specified in regulations.
- The objectives include a value for “families of events”.



Probabilistic Safety Goals in France (2)



- France considers that setting regulatory goals could have a perverse effect: Once the licensee meets the goals, it may lack incentives to improve safety, even when it can be done at low cost.
- Probabilistic safety objectives have been specifically set for new reactors (EPR project):
 - A core melt frequency at 10⁻⁵ per plant*year
 - No necessity of protecting measures for the public in case of core melt,
 - “Practical elimination” of large releases.



Probabilistic Safety Goals in Korea



- Safety goals have been proposed, but have not yet been finalized.
- Two sets of safety goals are proposed, for existing reactors and for new reactors.
- Safety goals are proposed at two levels:
 - Primary goals (CDF and LERF),
 - Subsidiary goals, such as conditional containment failure and single accident sequence frequency.



Probabilistic Safety Goals and the IAEA



- In INSAG 12, the IAEA defines two Probabilistic Safety Goals:
 - Core Damage Frequency,
 - Large Release Frequency
- It considers that new reactors should be one decade safer than existing plants.



High Level Quantitative Safety Goals (when documented)



Country	Canada	France	Korea	USA	UK
Criterion	Societal effects (evacuation and permanent relocation)	Unacceptable consequences	Cancer fatality risk to the population in the area near a NPP	Risk for an average individual in the vicinity of the plant	A person outside the site



Intermediate level (doses)



	Hungary	Korea	USA	UK
Type	Two levels	Relative Risk	Relative risk	Table dose-frequency
Numerical value	Dose to the whole body less than 500 mSv	0.1% of sum of risks from other causes	0.1% of sum of risks from other causes	For > 1 Sv: BSL = 10^{-4} BSO = 10^{-6}



Event Related (core damage) - 1



	Canada	France	Hungary	Korea
Criterion	Loss of core coolability	Core damage	Core damage	Core damage
Frequency	Existing plants: 10 ⁻⁴ limit 10 ⁻⁵ goal Future plants 10 ⁻⁵ limit	Existing plants: N/A Future plants: 10 ⁻⁵	10 ⁻⁴	10 ⁻⁴



Event related (Core Damage) - 2



	USA	Lithuania	Pakistan	UK	IAEA
Criterion	Core Damage	Core Damage	Core Damage	Plant Damage	Core Damage
Value	Existing plants: 10 ⁻⁴ Future plants: 10 ⁻⁵ (proposed)	10 ⁻⁵	10 ⁻⁵	BSL: 10 ⁻⁴ BSO: 10 ⁻⁵	Existing plants: 10 ⁻⁴ Future plants: 10 ⁻⁵



Event related (Releases) - 1



	Canada	Canada	France	Hungary
Criterion	Quantity of Cs_{137} 10^{+14} Bq	Quantity of I_{131} 10^{+15} Bq	Unaccepta ble consequen ces	Quantity of Cs_{137} : (10^{+14} Bq)
Value	Existing plants: 10^{-5} limit 10^{-6} goal Future plants: 10^{-6} limit	Existing plants: 10^{-4} limit 10^{-5} goal Future plants: 10^{-5} limit	Existing plants: 10^{-6} New plants: Practically eliminated	Existing plants: 10^{-7}



Event related (Releases) - 2



	Korea	USA	UK	IAEA
Criterion	Large Early Release	Large Early Release	Quantity of I_{131} or Cs_{137}	Large Releases
Value	Existing plants: 10 ⁻⁵ Future plants: More stringent	Existing plants: 10 ⁻⁵ Future plants: 10 ⁻⁶ (proposed)	BSL: 10 ⁻⁵ BSO: 10 ⁻⁷	Existing plants: 10 ⁻⁵ Future plants: Practical elimination



Event related (Releases) - 3



	Lithuania	Pakistan	Japan	
Criterion	Worst possible release	Off site release	Public latent or acute Fatality	
Value	10^{-7}	10^{-6}	10^{-6}	



Conclusion



- Two types of Probabilistic Safety Goals
 - Goal, without indication of the consequences if not met,
 - Goal and limit
- Several criteria
 - Quantity of I_{131} and/or Cs_{137} releases
 - Large release (not characterized)
 - Core damage (not characterized)
 - Loss of core coolability
 - Doses