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Probabilistic Safety Assessment in Argentina

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Probabilistic Acceptance Criterion

In Argentina, the radiological risk of a NPP must be assessed by the results of a Level 3 PSA during the licensing process.

It must be demonstrated that the radiological risk is acceptable; the relevant criterion is given as standard AR 3.1.3 by the Nuclear Regulatory Authority of Argentina (Argentine Acceptance Criterion).



Probabilistic Acceptance Criterion

It is based on the individual radiological risk limitation related to the dose limitation system recommended by ICRP for protection against normal exposures.

The objective is to limit the individual risk associated with **potential** exposures to values not greater than the individual risk associated with **normal** exposures.



Probabilistic Acceptance Criterion

The total risk must be lower than 10^{-6} per year and per nuclear facility for any person of the public living around the facility.



Probabilistic Acceptance Criterion

We postulate that with $N=10$ groups of accidental sequences (release categories associated with a source term) are enough for encompassing all conceivable radiological accidents.

Therefore, the risk contribution of each group to the total risk should not be higher than $R_i = 10^{-7}$ per year.

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Risk Definition

The risk of each sequence i is defined as:

$$R_i = P_i \cdot f(D_i)$$

where:

P_i is the probability of occurrence of the accident sequence i

D_i is the dose due to the accident sequence i in the representative person

$f(D)$ is the probability of death due to a dose D

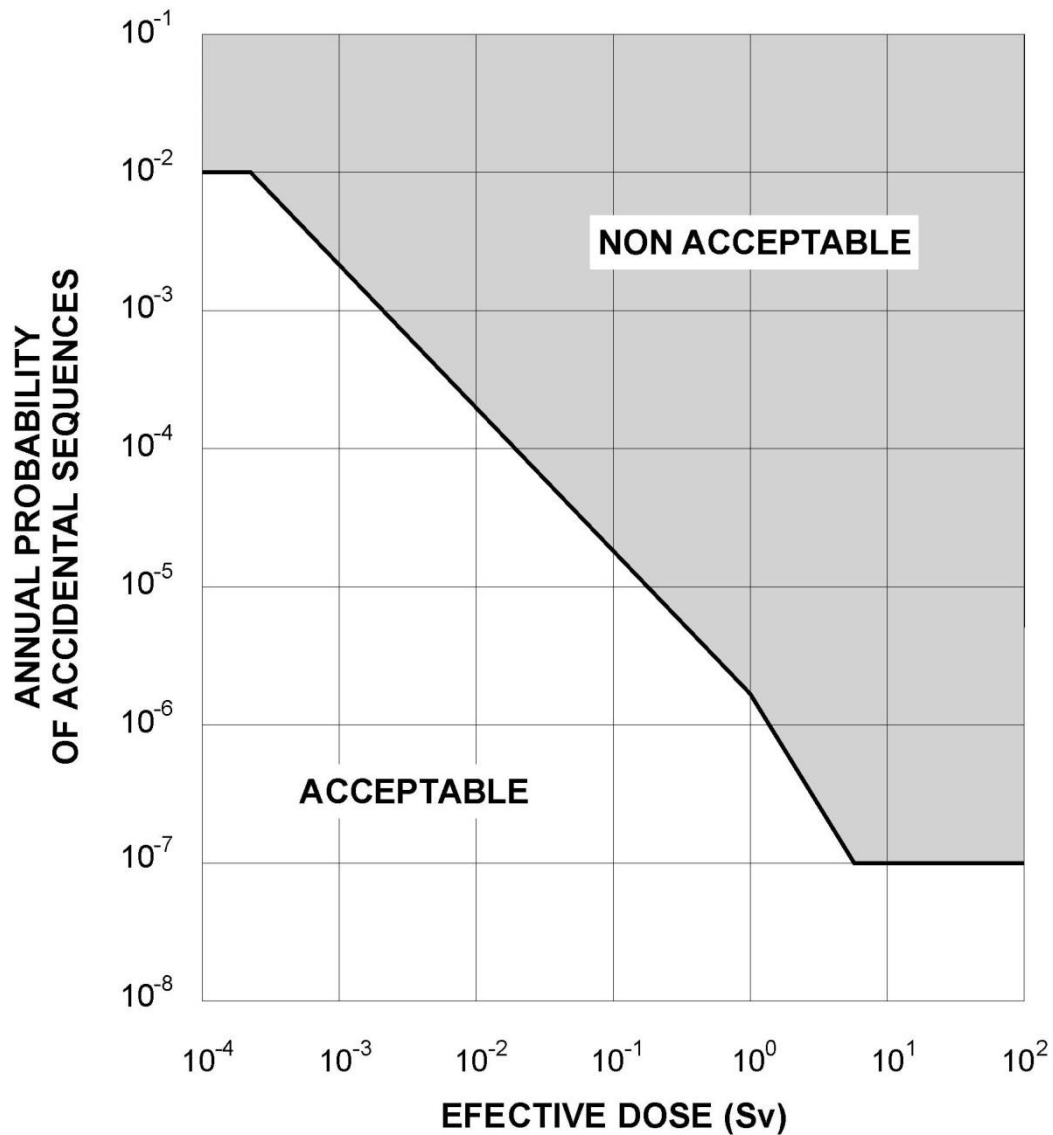


Probabilistic Acceptance Criterion

Finally, the criterion establishes that all the resulting probability and effective dose values corresponding to postulated accidental sequences should result in points plotted on the following criterion curve:



CRITERION CURVE FOR THE PUBLIC



Probabilistic Acceptance Criterion

No group of accident sequences (or release category) shall have an annual probability of occurrence such that, plotted against its effective dose, results in a point located in the non-acceptable area of the “criterion curve for the public”.



Probabilistic Acceptance Criterion

Since this is a Probabilistic Analysis, the estimation of doses must take into account the purpose of estimating risk, for instance in the consideration of meteorological conditions.

The representative person is the one located at the point of maximum risk.



For CAREM (the Argentine LW SMR) this probabilistic criterion was applied before the construction was authorized.

Note that in the criterion there is no defined safety goal for Level 1 or Level 2 PSA.

However, with the preliminary figures of CDF showing values lower than 10^{-7} , it was clear that the criterion was achieved.



At that point, a very rudimentary and conservative Level 2 PSA was applied and a Level 3 PSA estimated doses using tools already developed for Atucha II to demonstrate the fulfilment of the standard. However, it is well known that the strength of a PSA depends on its realistic (non-conservative) approach.



CAREM PSA

That is why it is expected that a new and more realistic version of the PSA will be developed in order to grant the Commissioning License.



CAREM PSA Challenges

The main challenges in the development of CAREM PSA were the following:

- Unavailability data for structures, systems and components that are first-of-a-kind
- Assessment of fault trees of passive systems
- Long term analysis



CAREM PSA Challenges

Uncertainties are reflected in the unavailability analysis of systems that are designed to work for the first time.

One important aspect is the available data.

A well-documented uncertainty treatment is essential and must be complemented with a sensitivity analysis to detect weakness points.



CAREM PSA Challenges

The use of passive system is a clear advantage because its failure probability is much lower.

However what constitutes a challenge is the assessment of fault trees because of the lack of experience in such analysis.

Certain simplification hypothesis that are valid in active systems are not acceptable if the system is passive.



CAREM PSA Challenges

The typical times involved in the development of an accident for the CAREM reactor are much longer compared to a standard PWR.

Then the time for the evaluation of unavailability of some systems are to be reevaluated.



CAREM PSA Characteristics

Much simpler design compared to a typical PWR

Lower number of systems and components



CAREM PSA Characteristics

Elimination of typical initiating events of PWR:

- Cooling pump failure,
- Large LOCA,
- Control rod ejection,
- etc.



CAREM PSA Characteristics

Passive systems that will fulfil their function during 36 h without operator intervention and even in the case of electric power failure



CAREM PSA Characteristics

Heat sink inside the containment with a capacity to manage the decay heat for at least 36 h



CAREM PSA Characteristics

Redundant safety systems following a systematic application of Defense in Deep principle



Conclusions

PSA is an essential tool in the design of new Nuclear Power Plants, particularly in the innovative ones.

In the case of Light Water Reactors, this tool is well known so its application is direct and the challenges can be solved within the state of the art.



Thank you for your attention

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Nuclear Regulatory Authority of Argentina



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