Statement
By
The Honorable Larry W. Brown
Member
Defense Nuclear Facilities Safety Board

Presented at the Workshop on
Safety Decision Making Under Uncertainty
September 21-23, 2010
Washington, DC

Hosted by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP),
Vanderbilt University

SAFETY DECISION MAKING UNDER UNCERTAINTY: ONE BOARD MEMBER'S PERSPECTIVE[1]

Good morning. Before I begin I would like to thank Dr. David Kosson and the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) for inviting me to participate in this workshop.

Our hosts have asked us to explore "the need to address uncertainty in … model prediction and uncertainty regarding the use of model prediction results in the decision-making process."

Now because I am a lawyer, my first question is the definition of terms. So I ask you – How do you think a lawyer would define uncertainty? I began by looking up the term "uncertainty" in my copy of Black's Law Dictionary. ***Had it been there*** -- it would have been after the "unclean hands doctrine"[2] and before "unconditional pardon."[3] Hopefully, 'unclean

---

[1] The views expressed are solely my own and no official support or endorsement of these remarks by the Defense Nuclear Facilities Safety Board is intended or should be inferred.

[2] The unclean hands doctrine says "a party cannot take advantage of his or her own wrong by seeking equitable relief or asserting an equitable defense -- if that party has violated an equitable principle, such as good faith."

hands' is not related to the practitioners of probabilistic risk assessment (PRA) nor will the use of PRA require an unconditional pardon.

But more to the point – how does uncertainty relate to my responsibilities as a Member of the Defense Nuclear Facilities Safety Board. For that explanation I begin with the Board's statute which says:

> The Board shall review and evaluate the content and implementation of the standards relating to the design, construction, operation, and decommissioning of defense nuclear facilities of the Department of Energy (including all applicable Department of Energy orders, regulations, and requirements) at each Department of Energy defense nuclear facility. The Board shall recommend to the Secretary of Energy those specific measures that should be adopted to ensure that the public health and safety are adequately protected. The Board shall include in its recommendations necessary changes in the content and implementation of such standards, as well as matters on which additional data or additional research is needed.[4]

Defense nuclear facilities are unique in the hazards they pose. Whether we talk about nuclear weapons assembly or disassembly or the legacy of ninety million gallons of high level radioactive waste, there are no equivalents in either consequence or risk that can be used as a baseline or metric. This conference asks us to address uncertainty in the decision making process. My predecessor, Dr. Herb Kouts, stated the decision making principle as well as I think it can be said. He said "protective measures aimed at accident prevention and accident mitigation must be in place and reliable, directed to ensuring that members of the public are not exposed to radiation doses of any appreciable amount, and that workers are protected from injury."[5]

Many of you know this, but I want to reemphasize it. DOE writes, approves, and implements the nuclear safety orders, regulations and requirements used at DOE's nuclear facilities. The Board's role is oversight; and one of its roles is to point out (1) where those directives are inadequate, (2) when DOE directives have not been adequately implemented, and (3) when specific changes to the directives are necessary to protect public health and safety. Said another way – DOE is self regulating, and the Board provides independent oversight.

So from my oversight perspective, uncertainty is when DOE is operating outside its directives. This in my view is – and has been the case – when probabilistic or quantitative methods are used to justify DOE activities.

The existing DOE nuclear safety policy, SEN 35-91, dated September 9, 1991 says in section 3, Goals:

---

[3] An unconditional pardon "releases the wrongdoer from punishment and restores the offender's civil rights without qualification."

[4] 42 U.S.C. § 2286a(a)(1).

[5] "Uses and Misuses of Probabilistic Safety Assessment at DOE's Defense Nuclear Facilities" presented at the PSA-99, International Topical Meeting on Probabilistic Safety Assessment, Willard Inter-Continental Hotel, Washington, DC, August 23, 1999, by Dr. Herbert Kouts, Member, Defense Nuclear Facilities Safety Board

> DOE recognizes there are large uncertainties in the data and available methods for assessing risk levels especially with respect to potential health effects from nuclear facility operations. Therefore, reasonable analyses based on available data using standardized approaches may be employed while more rigorous approaches and better data are developed.
>
> DOE safety goals are aiming points and are not substitutes for compliance with DOE Directives and nuclear safety-related rules.
>
> The adoption of safety goals should not be construed as a requirement to conduct probabilistic risk assessments [PRA].

The use of probabilistic methodology by DOE was tried and evaluated in several ways during the 1990s. Indeed, federal government agencies responsible for management of safety and health were required by the 1993 Executive Order to "consider, to the extent reasonable, the degree and nature of the risks posed by … activities within its jurisdiction."[6] At that time, the NRC was well along the path towards implementation of PRA. Individual commercial nuclear power plants had begun the ten year effort to study PRA in response to NRC's 1988 generic letter GL-88-20. And later, in 1995, NRC issued their PRA policy statement.

In parallel with NRC's implementation of PRA during the 1990s, DOE applied probabilistic safety analyses to selected activities to evaluate its utility.

Such an analysis was done for the K-Reactor at Savannah River and for some of the larger DOE research reactors. These methodologies and computations benefitted from NRC's large data banks on commercial reactors. However, the commercial data was not specifically relevant to the specialized activities at DOE nuclear facilities and resulted in large uncertainty margins. As a result, the improvement of safety at DOE reactors did not benefit very much from this effort.

In the early 1990s, DOE also conducted what was called the *Tri-Lab Study* to determine whether the safety of operations on the B-57 and B-83 weapon systems could be improved through the use of quantitative risk assessment. Because there was so little data upon which to base the study, it relied heavily upon experts to estimate both consequence and probability, and it concluded that the "real benefit of the [probabilistic] methodology was to be found in reduction of risk through improvements in design processes and safety features."[7]

Again, in 1994, Los Alamos National Laboratory, the Sandia National Laboratory, and the Pantex Plant conducted a comparison study on disassembly of the B-61 nuclear weapon. This study compared two methodologies: a combination of deterministic analysis and simplified probabilistic methodologies which some have called a "Semi-quantitative estimation of risk" – compared to a complete Probabilistic Risk Assessment. The study concluded that the expense

[6] Executive Order 12866, *Regulatory Planning and Review.*

[7] "Uses and misuses of probabilistic safety assessment at doe's defense nuclear facilities", presented at the PSA-99, International Topical Meeting On Probabilistic Safety Assessment, Willard Inter-Continental Hotel, Washington, DC, August 23, 1999, by Dr. Herbert Kouts, Member, Defense Nuclear Facilities Safety Board

and time required for the full PRA was not justified when compared to the simpler semi-quantitative method.

The conclusion that I take from this record is that DOE at one time studied and concluded that DOE activities are so diverse and the existing data is so sparse that the expense of a credible PRA is not justified. And that is why DOE Orders continue to require the use of deterministic methods to define the selection of measures necessary to protect workers and the public.

Since DOE has not established a standard for the application of PRA to the safety at its activities, I am left as a Member of the oversight board, without a metric upon which to determine compliance with directives when DOE representatives rationalize protective measures using probabilistic or quantitative methods. Nonetheless, in the last decade, DOE's use of quantitative or probabilistic methods has become increasingly common.

Let me read an example from a recent report presented to the Board on the subject of hydrogen generation hazards, known as Hydrogen in Piping and Ancillary Vessels (HPAV), at the new Hanford Waste Treatment Plant. The contractor had chartered an Independent Review Team (IRT) to evaluate the contractor's design approach, and this is what the IRT said:

> The new design approach combines probabilistic and deterministic techniques. The IRT understands this to be a precedent setting effort by DOE to use risk insights to inform design choices for hazardous facilities. This approach has gained wide acceptance in the commercial nuclear industry with the encouragement of the Nuclear Regulatory Commission, the Nuclear Energy Institute, the Electric Power Research Institute, and the national standards setting organizations such as ASME and the American Nuclear Society. There is consensus among these organizations that the risk-informed approach has led to both improved levels of safety and better allocation of resources towards those areas most important to safety. The IRT lauds DOE for this initiative. The experience gained will aid DOE in its efforts to develop guidance on future uses of risk insights to inform safety decisions.[8]

This does not sound completely unreasonable. We are all seeking increased levels of confidence in the safety of DOE's nuclear activities. To quote a letter written in 2003 to the Secretary of Energy by former Board Chairman Conway, "The Board recognizes that unrealistic conservatism can undermine the process for the development and implementation of safety controls. Consequently, the Board had encouraged DOE to take advantage of opportunities to reduce this type of conservatism in the development of [Documented Safety Analyses]."[9]

The Board has a longstanding interest in "Safety Decision Making Under Uncertainty," particularly as it relates to DOE's use of risk assessment at defense nuclear facilities.

The Board observed the DOE's increased use of quantitative risk assessment techniques that began in the early 1990s. This increased use was not viewed by the Board as objectionable

[8] Report by Independent Review Team to Bechtel National Corporation "Hydrogen in Piping and Ancillary Vessels (HPAV) Implementation and Closure Plan," document number 24590-WTP-RPT-ENG-10-021, Rev 0 dated August 19, 2010, Section 1.13 'Use of Conservatism to account for uncertainty.'

[9] Letter from Board Chairman John Conway dated September 23, 2003.

in itself; the Board's concern was that DOE was using quantitative risk assessment methods without having in place a clear policy and set of procedures to govern the application of these methods at facilities that perform work ranging from assembly and disassembly of nuclear weapons to nuclear waste processing and storage operations. In 2002 a significant Defense Board staff effort began when the Board directed that they investigate DOE's use of risk assessment technologies in nuclear safety applications.

Over the ensuing several years, the Board encouraged DOE to develop policies and guidance on PRA, but frankly, the directives remained unchanged. Board letters and related DOE correspondence are available on both the Board's and DOE's website detailing this exchange.

Finally, on July 30, 2009, the Board issued Recommendation 2009-1, *Risk Assessment Methodologies at Defense Nuclear Facilities*. The essence of this recommendation was that DOE should establish a policy on the use of quantitative risk assessment, establish related requirements and guidance in the DOE directives, evaluate current ongoing uses of QRA methodologies to determine if interim guidance was needed, and perform a gap analysis to identify additional research needed to reduce uncertainty in the use of QRA.

It is my belief that there is much to be gained by a deliberative process to study, define, and implement risk-informed methodologies at defense nuclear facilities.

We should not forget that the first such attempt by NRC, the Reactor Safety Study, also known as the Rasmussen Report, was much criticized at the time. However, four years after the report the Three Mile Island incident validated the concerns about small loss of coolant accidents that the report had, with very high confidence, assigned unexpectedly large probabilities. That fact – alone – should cause us all to renew our interest in this subject. The section of the HPAV Report, mentioned earlier, on phenomenological uncertainties says "It is questioned whether there are additional sources of uncertainty embedded within the deterministically treated rules and equations, and whether the applied conservatisms are sufficient to bound the effects of those uncertainties."

We should keep in mind the strengths of the risk informed approach that have been identified by other agencies. Not the least of which are its strengths in prioritizing accident scenarios and improving communication with the public and within the regulatory process. PRA could also help prioritize training, be an effective training tool, and contribute to the core objective of continuous improvement. And in a resource constrained environment, it can inform decisions necessary to protect the worker, the public, and the environment. Considering the hazards of these activities, every predictive tool must be considered in our efforts to ensure safety.

There are however, significant weaknesses in this methodology as applied to defense nuclear facilities that must be avoided. As DOE experienced with the reactor safety studies in the early nineties, there is a paucity of relevant data upon which to build a credible quantitative analysis. If quantitative or probabilistic methodologies are in the future, then DOE and NNSA must begin to identify the necessary parameters and populate related databases for defense nuclear facilities. Incomplete data can result in a flawed analysis and a false sense of safety. And if the NRC experience is the model to be followed, then DOE must mount a significant effort to develop regulatory guides similar to the NRC's on in-service inspections, quality assurance, technical specifications and in-service testing, among others.

Before I close, I want to ensure that I have not left you with the impression that I am completely satisfied with deterministic methodologies currently being used for accident analysis at defense nuclear facilities. There remains, in my view, significant uncertainty which is routinely papered over with potentially unnecessary and costly conservatism. For example, there are five factors considered in calculating plume dispersion following an accident: material at risk, damage ratio, airborne release fraction, respirable fraction, and leak path factor. Each element of the five factor formula could benefit from further research and additional data collection. However, little recent effort has been made towards improving our knowledge and understanding of this methodology, increasing confidence, and reducing unnecessary conservatism.

In accident analysis we are attempting to determine what might happen. Niels Bohr once said "prediction is very difficult, particularly if it is about the future." Without a well documented, independently peer reviewed process and analysis, built upon credible data, the result may do little more than justify the initial assumptions and expectations. I look forward to hearing your views on safety decision making and learning what remains to be done to reduce uncertainty and increase confidence.