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Realism in the Assessment of Nuclear Technologies

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The following papers are attached as background to Dr Rockwell's presentation.

Doc 1: "Realism in the Assessment of Nuclear Technologies",
Dr T Rockwell (extracted from "ANS White Paper on Realism").

Doc 2: Extracts from "Science" journal (Sept 2002 and Jan 2003)

REALISM IN THE ASSESSMENT OF NUCLEAR TECHNOLOGIES

ANS Position Statement 65 states: "The American Nuclear Society (ANS) urges and encourages the use of realistic models and assumptions in all studies of the risks, properties, costs, benefits and consequences related to the use of radiation and radioactive materials." This paper provides some background information for that Statement. It further defines "realism" as used herein, summarizes its current status and cost, describes needed actions, and indicates what kind of technical data and documentation are needed to accomplish the actions recommended.

Realism

"Realism" here refers to premises used to define and predict the behavior of nuclear-related systems and components, particularly in connection with hazard evaluation. This includes such items as cooling of fuel elements under defined casualty situations, release and dispersion of fission products from damaged fuel, estimation of radiation doses from dispersed fission products including presumed actions of persons to evade or mitigate radiation effects, and estimation of health effects (such as cancer or death) from received doses.

Realistic premises are defined here as those conservatively consistent with actual physical data from tests and analyses of casualty situations. Using premises more extreme than realistic ones has often been found to *impair* safety rather than enhance it.

Current Status

Current policies, practices and regulations apply unrealistic premises in each of these areas. Since hazards are characterized by multiplying many factors together, the results falsely portray the consequences of various casualties as posing catastrophic public health hazards. For example, an analysis of the releases and consequences of the TMI-2 accident would predict far greater radioactivity releases, doses and health effects than actually experienced. The physical data from tests and analyses of casualty situations show that the worst realistic casualties to a modern commercial reactor or its fuel are expected to result in few if any deaths.

This extreme approach was adopted by the nuclear community with the intent that nuclear plants be even safer than required of then-existing technologies, and to "demonstrate" that nuclear power plants could withstand even the most extreme and unnatural events and conditions. Unfortunately, the use of such unprecedented safety precautions has misled many policy-makers, media and potential investors that the potential for disaster must be similarly unprecedented. And the operational effect of such policies has been harmful rather than beneficial.

Harmful Effects of Extreme Premises

- Unrealistic mass evacuation planning falsely implies thousands of lives are at risk.
- 100,000 claims under Nuclear Workers Compensation are improperly judged under LNT premise
- Requirement to minimize collective dose constrains vital safety inspections and maintenance
- 100,000 unnecessary abortions performed after the Chernobyl accident
- Extreme radiation limits for Yucca Mtn have stymied solution of the radwaste problem
- Unnecessarily strict containment leak requirements impose costly tests and delays
- Unrealistic heat transfer premises create unwarranted concern over used fuel storage safety
- Unwarranted concern over used fuel shipment safety creates huge cost and public fear
- Extreme decontamination requirements is costing unnecessary $100s billions of dollars
- Extreme control and accountability requirements make nuclear medicine unduly costly
- Permissible limits now fall below natural radiation from uranium, radium and thorium
- Minor radiological events (e.g. a dirty bomb) are made life-threatening mob panics by radiophobia

Technical Justification for Needed Changes

Forty years of extensive testing and analysis have explored the chemistry, metallurgy, physics, thermodynamics, heat transfer, meteorology, radiobiology and other physical aspects of the potential hazards associated with the release of radioactivity from nuclear systems. These results demonstrate that no realistic casualty to a modern nuclear reactor or its fuel could create a serious public health hazard. In 1980-81, this work was documented in reports disseminated world-wide. More recently, 19 senior nuclear engineers and officials, all members of the National Academy of Engineering, co-authored a peer-reviewed Science Policy Forum (*Science,* 20 Sep 2002, p.1997, and 10 Jan 2003, p.201) that reviewed, documented and re-evaluated the data in light of their own experience, and reached the same conclusion. A White Paper was developed within ANS that provides technical backup for Position Statement 65. This is available on the Members Section of the ANS website, and to others at http://cnts.wpi.edu/RSH/realism.

But extreme premises continue to be used in setting policy and procedures. This policy was justified in the name of "prudence" or extra safety in the early days of working with nuclear materials and power reactors. But its continuation in practice has had the opposite effect. Meanwhile, research, and analysis of accidents and of fuels and test reactors deliberately driven to destruction, reduce earlier uncertainties.

It is now time to bring radiation policy and practice into line with the physical data and sound scientific and engineering practice. This will require a serious program to collect, document and evaluate the relevant information, to develop needed data and analyses not available, and to report the findings in a form from which necessary changes can be identified and justified. Some of the characteristics to be determined are:

1. Amount of fluid flow and effective cooling of fuel elements in damaged core and in storage. Conditions required for cladding ignition and effect of ignition on fission product release.
2. Composition and amount of fission product release under various temperatures and chemistries. Depletion of released fission products in reactor vessel, containment structure and in leakage path to environment.
3. Distribution of fission products outside containment as a function of meteorology, terrain, structures.
4. Expected radiation doses by organ to hypothetical populations as function of time and population distribution. (Whole populations cannot stand on plume center-lines.)
5. Estimation of individual health effects, if any, from projected radiation doses, primarily based on known medical doses and health effects.
   (Collective dose cannot be used as a valid predictor of health effects.)
6. Expected actions of personnel to evade or mitigate the effects of the casualty. These should be conservative but not ridiculous (cf. current requirement that no one moves for one year)
   Effect of these actions on the course of the casualty and on radiation dose to personnel.

As conservative but realistic parameters are established for key casualty and other abnormal conditions, the applicable regulations, design and operating procedures, and other relevant requirements will be identified, and, if necessary, actions to bring them into accord with the data will be initiated. Some of these changes may be made simply, whereas others may require petitions for rule-making and other more formal procedures, including legislation.

Will These Changes Challenge Current Science?

No. The proposed changes are intended to be in full accord with the best relevant science. For example, in the case of calculating health effects of low-dose radiation, relevant regulatory and advisory reports agree that there is no scientific evidence that low-dose radiation is harmful and that most groups exposed are benefited and not harmed. And they specifically warn against calculating health effects from collective dose. But they argue that "there is no reason not to" assume otherwise. We do not feel bound to follow this non-scientific opinion, nor has it proved to be prudent. In practice, it has been shown to work against safety.