

*An Evaluation of the NRC
Response to the Fukushima
Nuclear Accident*

August 7, 2012

Christopher Paine
Nuclear Program Director
Natural Resources Defense Council
(NRDC)

Charge from the Commission

- Provide “public interest perspective on NRC Actions and stakeholder involvement in response to Fukushima accident”
- Full 56 slide presentation reviews NRC’s modification/disposition of all 12 of the Near-Term Task Force (NTTF) overarching recommendations
- In the allotted 10 minutes I cannot possibly cover every point in the presentation, but will try to convey our top-line concerns.

Table of Acronyms

ACRS	Advisory Committee on Reactor Safeguards
AEA	Atomic Energy Act
ANPR	Advance Notice of Proposed Rulemaking
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
EP	Emergency Plan
EPZ	Emergency Planning Zone
EU	European Union
FLEX	Diverse and Flexible Coping Strategies (for “beyond-design-basis” external events)
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NPP	Nuclear Power Plant
NTTF	Near -Term Task Force (produced July 12, 2011 NRC review of Fukushima accident)
PRA	Probabilistic Risk Analysis
RCS	Reactor Cooling System
RHV	Reliable Hardened Vent (of reactor primary containment)
ROP	Reactor Oversight Process
SAMG	Severe Accident Management Guidelines
SBO	Station Black Out (loss of offsite and fixed onsite AC electrical power sources)
SFP	Spent Fuel Pool
TMI-2	Three Mile Island Unit 2 (site of 1979 nuclear reactor accident near Harrisburg, PA)

NRC has strayed from the intent of its statutory framework

- Under the Atomic Energy Act (AEA), primary vehicle for “Stakeholder Involvement” in nuclear safety is supposed to be the licensing process
- In compensation for a Federal monopoly on regulating nuclear power, AEA granted states/citizens the right to challenge each and every licensing decision

Citizen Safety Concerns Should Be Adjudicated in Licensing Proceedings

- By steady accretion of exclusionary rules, NRC has insulated the licensing process from citizen nuclear safety concerns, including *post-Fukushima safety concerns*
- Structured “discussion” and “information” sessions like the present one are now NRC’s preferred mode for dealing with the public

Large Gap Between Internal vs. External Views of NRC Efficacy

- Internal NRC view is typically “We’re rated the Number One place to work in the federal government!”
- NRC Senior Staff briefings rarely fail to convey aura of confidence that its efforts represent the best achievable “within currently available resources.”
- What public sees, however, is an ostensibly “impartial” NRC Staff that is almost always *perfectly aligned* with industry’s opposition to 100% of contentions in citizen petitions to intervene in licensing proceedings.

Do state/public interveners really offer nothing of value?

- Do they offer literally NO concerns/insights worthy of adjudication?
- Public/press perception of the NRC as a “captive agency” is cemented by high “moat” of industry-protective rules, including:
 - Prejudicial and technically demanding “contention “admissibility” standards that public must meet within 60 days of a license application being filed;
 - Wide latitude for licensing boards to interpret these pleading standards and subjectively determine when they have been met.

More sources of public disregard for NRC

- Agency NEPA procedures violate due process and place gratuitous burdens and costs on ordinary citizens.
- Over-reliance on simplistic, technically erroneous, and quickly outdated “Generic” NEPA determinations -- which may then endure for 15-20 years -- to preclude site specific consideration of troublesome issues
- Unbalanced legal resources: Large teams of aligned NRC-industry attorneys typically face off against a single attorney representing interveners, if they can afford an attorney at all.

Industry can literally buy the licensing results it wants

- Just getting to starting line -- e.g. "party status" with one "admitted" contention -- can cost citizen intervener in excess of \$100,000
- Path forward through adjudication in the hearing process, Commission appeals, and ultimately appellate court review, is very long and very costly
- Industry has \$400/hr attorneys on retainer, written off as a business expense, to help them navigate and manipulate the process.
- Two-against-one: NRC attorneys frequently pile-on and echo industry arguments, but seldom side with petitioners or remain neutral.

Paralyzing Penchant for Paper

- Vast impenetrable interlocking maze of NRC Rules, "SECY Papers", Requirements Memoranda, RAI's, Orders, Staff Guidance, Guidelines, Policy Statements, etc.
- Indecipherable by concerned ordinary citizens, ordinary lawyers, and the even the industry itself (hence its ubiquitous reliance on specialty practice law firms)
- Fukushima response to date is consistent with this NRC penchant for churning paper, with a notable dearth of on-the-ground ACTIONS to increase the safety margin against severe accidents.

Compelling Example of Why the NRC Engenders Public Distrust

- Commission's first official act (10 days) after inception of the Fukushima Nuclear Accident, was to:
- Renew operating license of Vermont Yankee, an old (1972) GE BWR Mark I unit of the same type and vintage as the exploding Fukushima units.

This tone-deaf action did not meet AEA “reasonable assurance” standard

- On March 21, while accident was still ongoing, Commission could not possibly have known:
 - the role, if any, inherent BWR Mark 1 design flaws may have played in the accident;
 - the role, if any, unregulated hardened vents or other Mark 1 equipment failures may have played in the accident.

Vermont Yankee Relicensing, cont.

- Moreover, the Commission took this action AFTER:
 - Plant operators had been caught lying to Vermont state officials regarding groundwater contamination from buried pipes
 - State Senate had voted 26-4 in opposition to license renewal
 - A plant cooling tower had collapsed in 2007

Post-Fukushima NRC Stakeholder Involvement

- Offers little to date other than opportunity to comment and convey concerns
- No meaningful opportunities to adjudicate important issues
- As George Orwell might observe: Some “Stakeholders” are More Equal than Others
 - Exhibit A is March 2012 NRC “Mitigation Strategies” Order (EA-12-049) and Staff Guidance, which is completely wrapped around December 2011 NEI “Flex” Proposal

Top Line Findings

- Seventeen months after the accident, only 3 of 12 NNTF-recommended “near-term” orders have been issued, and only one (Reliable Hardened Vents) is in the form originally intended.
- Only 2 of 7 recommended rulemakings have been (barely) initiated, by vague ANPR’s rather than proposed draft rules.
- Planned timetables for actual implementation of upgrades range from leisurely (e.g. Dec. 31 2016 for RHVs) to “indeterminate” for all issues.

Top Line Findings - 2

- Fuzzy, uncertain interface of post-Fukushima upgrades with ongoing reactor licensing/relicensing/power uprate processes, which remain unperturbed by accident
- Current NRC relicensing rules foster conservation of obsolete reactor technologies with inherent design flaws, at sites with ever larger populations and economic value at risk.

Top line findings -3

- NRC response to Fukushima is diffuse and excessively segmented, lacks urgency and focus.
- Interlocking architecture of original NNTF recommendations has been lost
- Implementation schedules are receding, paper studies are proliferating

Top line findings - 4

- NRC has some 4200 employees, an average of about 66 staff per regulated nuclear plant site.
- Surely, Commission has nominal capacity to do more than simply incorporate wholesale in its Orders plans for industry self-regulation written for it by NEI.
- NEI "Flex" Plan compounds current unwieldy "patchwork" of voluntary and partial regulatory initiatives that guide mitigation of severe accidents.

Top-line Recommendations:

- Create “Extended Design Basis” Regulatory Framework NOW for SBO/Severe Accident Mitigation, and make it part of the Reactor Oversight Process to guide subsequent efforts
- Require high capacity filters for Reliable Hardened Vents
- Reinstate NTTF emphasis on early implementation of extended minimum initial coping time for SBO events, and include self-powering options to maintain control of steam-turbine-driven emergency cooling pumps and valves.

Top-Line Rec's - 2

- Reinstate original NTTF proposal on spent fuel instrumentation and pool makeup capability
- Satisfy ACRS concerns with draft staff guidance on this issue
- Pursue swift implementation of ACRS proposal to ensure current reactor and containment instrumentation remains functional under severe accident conditions
- Augment this capability via addition of in-core thermocouples to monitor fuel cladding temperature.

Consider Risk Factors Beyond Achievable Dose Savings

- Reform licensing process to require consideration of risk factors beyond achievable dose savings via evacuation—e.g.:
 - total population at risk
 - land and water contamination
 - property losses
 - reduction in economic activitywhen assessing severe accident risks arising from reactor siting and licensing actions

Evaluation of NRC Actions on Each Major Fukushima Near Term Task Force (NTTF) Recommendation

NTTF Rec. 1: Create an Extended Design Basis

- Establish “logical, systematic and coherent regulatory framework” for ensuring adequate protection against severe events now seen as “beyond-design-basis.”
- “Extended Design Basis” regulation would lend coherence and enforceability to NRC’s post-Fukushima actions.

Extending Design Basis, cont.

- Commission failing to implement this critically important recommendation.
- In fact, Commission policy is heading in the opposite direction.
- Acceptance of industry-devised FLEX approach to mitigate effects of prolonged SBO just thickens informal “patchwork” of unenforceable protections.

NTTF Rec. 2: Seismic and Flood Protection

- “Require licensees to reevaluate and upgrade...design basis seismic and flooding protection”
- Relaxed timetables, with paper study due dates of 3-5 years after the accident, suggest NRC does not take these threats seriously.
- Flooding hazard revaluations (i.e. paper studies) to be completed by March 2015 (4 years after accident)

Reevaluating Seismic and Flooding Hazards

- Seismic hazard reevaluation deadline is May 30, 2014 for Eastern US plants, and November 2015 for Western US plants.
- These dates, and any regulatory actions taken in response to these reevaluations, are too late to meaningfully inform the baseline data for FLEX contingency planning and procurement.

NTTF Rec. 3: Enhance Mitigation of Seismically Induced Fires & Floods

- In October 2011 NRDC recommended folding review of this hazard into the seismic/flood walk-downs and reevaluations, rather than postponing consideration.
- Obvious seismic weaknesses in plant electrical and fire protection systems, including potential for cascading negative interactions – should be addressed now, without waiting 7-8 years (!) for detailed PRA analyses.

NTTF 4: Require Licensees to strengthen SBO mitigation

- This was a two-part recommendation
- Short term order (4.2) to provide:
 - “reasonable protection” for 10 CFR 50.54 (hh) (2) emergency equipment;
 - additional equipment to address “multi-unit events;”
 - conforming changes to rule.
- Initiate rulemaking (4.1) to revise 10 CFR 50.63 to establish:

NTTF's SBO Mitigation, cont.

- (1) minimum coping time of 8 hours for loss of all ac power;
- (2) equipment, procedures and training necessary to implement extended coping time of 72 hours for core and spent fuel cooling and assurance of RCS/primary containment integrity, and
- (3) Offsite resources to support these functions deliverable to site in the time period for extended coping under degraded transport conditions

NRC “Mitigation Strategies” Order (EA-12-049) abandons coherent regulatory approach

- NTTF emphasis on early improvement of initial coping time has been lost
- Scope of industry-devised and mostly unaccountable “FLEX Program” infringes on, and may be intended to supplant or predetermine outcome of NTTF’s recommended rulemaking

FLEX Approach Devoid of Firm Binding Requirements

- Minimum required initial and extended coping times (8- and 72-hours) have been jettisoned
- No minimum standards required for equipment, procedures and training necessary to achieve extended coping times, whatever these may turn out to be at any given site.

More FLEX Concerns

- FLEX purports to be severe event/prolonged SBO mitigation strategy, but planning baseline assumes no damage to core safety system functions other than extended loss of AC onsite and offsite power
- (e.g. all critical pumps, valves, and control circuits are assumed to remain operable during and after “severe event”).
- How realistic is this assumption, given known daily impairments to safety systems at operating US reactors (e.g. leaky RCS valves and tanks, short-circuits, electrical bus failures, stuck valves, unreliable ECCS turbine speed controls, etc.)

More FLEX Concerns

- How will FLEX credibly incorporate “extended design basis” revisions if these are unlikely to be established in regulation for many years, if ever?
- Without common performance, standards and inspection criteria, how will the NRC credibly evaluate and enforce the efficacy of some 64 discrete and unique FLEX SBO response plans?
- Is EA-12-049 erecting a “Potemkin Village” approach to mitigating “beyond design basis” external events?

NTTF #5: Reliable Hardened Vents (RHVs)

- NRDC supports prompt installation of High-Capacity Filtered RHVs in all US PWR's, starting with GE BWR Mark I and II units.
 - Sweden installed high capacity filtered vents in all NPPs by the end of 1988
 - All French PWRs were similarly equipped in mid 1990s.

High-Capacity Filtered RHVs afford maximum flexibility

- All German BWR's have high capacity filtered vents
- Why has the NRC lagged behind?
- 8-inch diameter "Reliable Hardened Vents," intended solely to protect primary containment prior to onset of core damage, offer insufficient protection under the plausible range of conditions likely to be found in a severe accident.

Why High Capacity Filtered Vents?

- Not all severe accident scenarios are slow-moving, SBO-based events
- Potential need in fast-moving, large-break accident for early venting (within minutes) of possibly damaged core BEFORE at-risk population can be evacuated
- Uncertain fission product scrubbing in Mark I “wetwell” – noble gases and potentially explosive hydrogen not condensed

Case for Filtered Vents, cont.

- In 1988 ORNL suggested high-capacity filtered vent systems for BWR-Mark II's because operation of simple hard vents in these units would more likely result in discharge of radioactive aerosols directly into the environment.
- Long Island Lighting Co. planned hardened high-capacity filtered vent similar to Swedish FILTRA, for the Shoreham Plant, a BWR Mark II.

Transition from Preventing Core Damage to Severe Accident Mitigation is Inherently Uncertain

- NEI position (April 12, 2012) – “there are (other) modifications... more beneficial than filtration” is predicated on three dubious assumptions:
 - (1) Current computer modeling can accurately predict progression of core damage under different accident scenarios;

NEI's Flawed Premises

Regarding High-Capacity Filtration

- (2) plant operators can ascertain real-time condition of the core throughout stages of a severe accident
 - (3) operator errors would not make a severe accident far worse
- These assumptions are neither realistic nor appropriately conservative:
 - (1) Current computer models under-predict the rates of hydrogen production empirically demonstrated in European severe accident experiments

Filtered Vents are a Prudent Real-World Tool

- (2) As shown at TMI-2 and Fukushima, plant operators not likely to understand condition of core during progression of a severe accident;
- (3) As shown in these and other nuclear accidents large and small, operator errors can suddenly make matters worse:
- In a severe accident, avoiding uncontrolled loss of containment and restoring cooling to damaged core(s) could require swift high-capacity venting of contaminated gases and aerosols to the local environment.

A Prudent Hedge Against Possible/Probable Failures

- High Capacity Filtered RHVs are also a Prudent Hedge Against:
 - Delayed/Botched Evacuations in Densely Populated Areas
 - Failure of Other Systems for Managing Damaged Core
 - Failure of Timely External SBO Mitigation Measures

NTTF #6: Hydrogen Control and Mitigation Inside Containment

- NRDC supports heightened NRC attention and regulatory action on this issue:
- Need to better understand safe performance envelopes and inadvertent risks of various hydrogen igniter and passive recombiner systems;
- Need to reconcile technical bases for conflicting EU/NRC requirements for hydrogen mitigation.

Hydrogen Monitoring

- In 2003 NRC reclassified oxygen and hydrogen monitors as “non-safety related” equipment: i.e. no seismic and other endurance qualification, no redundancy, and no on-site backup power required.
- In light of Fukushima hydrogen detonations, this error should be corrected.

NRC Relaxed Hydrogen Monitoring Interval

- In 1983, NRC issued an order requiring that hydrogen concentrations in containment be monitored within 30 minutes of emergency cooling injection
- In 1998, NRC extended this timeframe to 90 minutes after coolant injection - too late to be of use in a large break loss of coolant accident.

NRDC Supports UCS Hydrogen Monitoring Proposal

- Safety-qualified monitoring instrumentation with prompt availability should be installed in:
 - BWR Mark I and II secondary containments
 - Fuel handling buildings of PWRs and BWR Mark IIIs
 - Any other NPP structure where it would be possible for hydrogen to migrate

NTTF #7: Require enhanced spent fuel pool makeup capability and instrumentation

- Commission unwisely narrowed scope of NTTF instrumentation recommendation to gross measurement of water level only
- EA-12-051 omits monitoring for SFP temperature and radiation levels
- ACRS guidance review calls for greater resolution in SFP water level measurements, and would restore temperature monitoring.

Spent Fuel Instrumentation

- NTFF recommended an Order providing for “safety-related” instrumentation (i.e. subject to the quality-assurance requirements of Appendix B to 10 CFR Part 50.)
- Staff guidance appears to make quality assurance a site-by-site self-determination by industry.

Spent Fuel Pool Makeup

- Commission has unwisely deferred NCTF-recommended orders that would have ensured:
 - Safety-related ac electrical power for the SFP makeup system (7.2)
 - A train of onsite emergency power – not currently required -- for SFP makeup and instruments when reactor is not operating and irradiated fuel is present (7.3)

Ensuring SFP Monitoring and Makeup Capability, cont.

- A seismically qualified means to spray water into the SFP, including an easily accessible connection to supply the water
- Possible future rulemakings on these three issues demoted to “Tier 2” priority
- Recent NRC actions reference less stringent industry plans via NRC Staff “guidance:”
- These incorporate NEI “guidance” on Flex (NEI 12-06) and SFP instrumentation (NEI 12-02), both of which now serve as proxies for the NRC’s own regulatory work product.

NTTF #8: Strengthen and Integrate On-Site Emergency Response Guidelines and Training

- Clear operator understanding of emergency guidance regimes -- their essential tasks, qualifications, training and decision-makers -- is a crucial facet of defense-in-depth strategy
- To date, only Commission action has been, not prompt "Orders," but issuance of a dilatory ANPR on April 18, 2012, more than a year after the accident
- Delay in implementing this recommendation undermines reasonable assurance protection against the threat of severe accidents

NTTF #9: Emergency Plan Revisions for Prolonged SBO/ Multi-Unit Events

- NTTF flagged issue for both near-term orders (9.3) and rulemaking (9.2)
- Commission initially demoted recommended 9.3 orders to future Tier 2 “regulatory actions”
- All that now means is eventual issuance of a “Tier 3” ANPR, beginning some time in 2014, and completing a final rule “4.25 years later.”

NTTF #10-11: Additional EP Topics:

- Protective Equipment for Emergency Responders in light of Fukushima
- Command and Control Structure for Long-Term SBO/Multi-unit Events
- Enhancements to EP decision-making framework based on Fukushima experience
- Real-time radiation monitoring on-site and within EPZs, training on appropriate KI use

NTTF #10-11, cont.

- These issues designated Tier 3, put in same 2014 “do nothing now” ANPR bin as NNTF #9.
- No resources allocated to Tier 3 issues in FY 12 or proposed FY 13 NRC budgets
- Might be addressed in “FY 14 and beyond” (if resources are made available)

NTTF #12: Modify ROP to Encompass "Defense-in-Depth" Measures

- This important recommendation consigned to "Tier 3."
- Includes enhanced training for NRC staff and resident inspectors on managing severe accidents
- Current "risk-informed" Reactor Oversight Process (ROP) does not inspect for compliance with voluntary SAMG's, or consider possible challenges to a facility's licensing basis.

Additional Staff/ACRS Recommendations (Tier 3)

- *Emergency Planning Zone Size* -- NRDC supports proposed review of the basis for EPZ size, in light of:
 - Fukushima real world contamination and evacuation experience
 - massive growth in population, property values, and economic activity at risk in a severe nuclear accident.

Staff Recommendations, cont.,

- Review pre-staging of Potassium Iodide (KI) Beyond 10 miles
 - NRDC supports NRC review of this issue.
- Review of Expedited Transfer of Spent Fuel to Dry Cask Storage:
 - While disagreeing with Staff's current views on SFP safety, we support NRC review of this issue -- appears legally required in any event in light of the D.C. Appeals Court "Waste Confidence" NEPA compliance ruling.

ACRS Proposal to Enhance Reactor and Containment Instrumentation

- Current reactor and containment instrumentation is not required to remain functional under severe accident conditions
- NRDC supports the ACRS proposal to add this capability
 - We recommend inclusion of in-core thermocouples to monitor fuel cladding temperature at various elevations and radial positions.
 - Key to detecting, forecasting hydrogen formation, transitioning to SAMGs.
- This effort needs higher prioritization and implementation schedule.

END

Acknowledgement

The author of this presentation would like to thank NRDC Science Fellow Dr. Jordan Weaver, and NRDC Nuclear Program Consultant Mark Leyse, for their assistance in the preparation of this presentation