CORE

October 1, 2007

Patrick Madden
Deputy Director, Infrastructure Policy
NRC TWFN
11555 Rockville Pike, MS O-12E13
Rockville, MD 20852

Relational Method – Proof of Concept Construction Verification Proposal

Dear Mr. Madden:

Thank you for allowing us to discuss our relational method verification proposal with you Monday. As you saw, an integrated database efficiently maintains plant design status. Currently, controlled documents (PDF/TIF & equivalents) provide source status. Software architecture capabilities today can provide complete birth-to-death design, construction, operations and decommissioning design basis controls.

The Nuclear Regulatory Commission accepted ten strategic 2008 OMB management challenges.[1] Three apply here: *Develop/implement a risk-informed performance-based regulatory approach* (Challenge 2), *Meet new reactor licensing demand* (Challenge 6), and *Modify regulatory processes to meet changing environment"* (Challenge 7). Assuring new nuclear plant construction supports safe, timely operations requires successfully addressing more than just these three challenges. Startup inspections tests analyses and acceptance criteria (ITAACs) accept the *"as-built"* physical plant to operate. Startup approval must consider design modifications, site specific design features like ultimate heat sink, new PRA analyses... indeed virtually all approved design changes from the Combined Operating License (COL) application submittal. Although standardization, completion measurement & validation, and licensing approach remain central objectives, achieving real-time *green board* requirements status assures safe, timely plant startup.

We heard you express the following concerns and/or assumptions upon meeting:

- NRC wants licensees and their agents to bear full plant construction responsibility
- New plant construction will be fast, efficient and exact based upon Part 52 COL, standard plant designs, prequalification, and construction management – unlike before.
- NSSS, AEs and/or Constructors should already use databases. Wouldn't they benefit if they don't use already relational method databases? Why haven't they adopted relational methods?
- Licensees should take more initiative, since the proposed relational method technology is better. Why haven't licensees or their agents acted to adopt relational methods?
- NRC questions supporting efforts that appear ultimately to benefit licensees, even if other relational method benefits improve design basis, quality and schedules during construction.
- Why front-end load design construction with the relational method? Under the COL, it already is heavily front-loaded. Shouldn't resource levelizing push more work towards project completion?
- Can't traditional project management tools track ITAACs and associated Action Items adequately?
- NRC plans to inspect 35% of ITAACs. If findings cause more work, shouldn't licensees or their constructors bear delay costs?
- Why shouldn't CORE pay development costs? Couldn't they eventually license their software?
- Why should NRC support proof of concept demonstration? Wouldn't CORE try to sell their software and database tools to NRC after it supported development?

[1] Ref: NUREG-1100, Vol. 23; NRC Management Challenges

- What benefits warrant NRC expenditures to address NSSS/AE/Owner issues?
- NRC lacks access to approved COL AP-1000 DCD information. NRC can't force participation in a relational method proof of concept pilot. Why would NSSS/AE's share design materials they haven't submitted under the COL? If CORE can't get their participation, who can?

Please find our responses attached. Although everyone[2] benefits, changes perceived could initially slow the existing COL licensing process. Potential AE/NSSS participants expressed concerns that change confusion would risk license delays. The first new technology license submittals are thus seen fraught with risk, creating hesitation. We believe this justifies NRC action, in the public interest, based upon identified NRC strategic objectives. Furthermore, Bush Energy Bill construction delay loan guarantees amount to as much as $2 billion. These insure against delay risks and associated plant construction costs. The Bush Energy Plan presents new NRC accountability for startup schedules. The relational method would enhance NRC startup management effectiveness. We believe that NRC strategic objectives justify developing a relational method technology.

A common relational design framework would standardize, streamline and enhance nuclear design technology. Although NRC believes it can approve and license new plants sites quickly, new application announcements project construction completion into 2014/5,[3] based upon previous ABWR experience overseas.) Other construction schedules project what loan guarantees suggest: that turnkey COL licensing is incomplete, untested and very uncertain, today.

Assuring new nuclear plants meet construction schedules, everyone needs the best tools available. We believe our approach will help the NRC and the nuclear industry find more effective ways to improve design construction consistency. Besides reducing construction delay and startup risks, benefits accrue throughout plant operating life. Safely accelerating nuclear power construction presents many new opportunities and benefits.

Sincerely,

Jim August
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c/ Michael Webb, Richard Rasmussen, David Mathews

Attachments: (Relational Method) **NRC Expressed Concerns/*CORE Responses***
Relational Method Pilot Schedule

[2] NRC, NSSS, AE, Owner, Public

[3] NRG predicts two ABWR units startup in 2014 and 2015, based on no delays

Relational Method
NRC Expressed Concerns/*CORE Responses*

- NRC wants licensees and their agents to bear full plant construction responsibility

  NRC will share the burden of any construction delays along with prospective owners. Delays could occur from construction design changes, modification requests, information requests and a host of other things beyond anyone's control, such as change orders, especially on new plants. Significant delays will increase all change orders impacts, just as they did after TMI. Just changing equipment vender catalog numbers requires change order, and these happen predictably during construction following equipment procurement. When many potential delays relate to rules that could be blamed on the NRC, responsibility for changes becomes a moot point. Change updates of any type cost time. Better controls that identify exact sources of problems and causes of delays hold AE and constructors more accountable for delays. Problem resolution improves by clearly tracing causes to their sources. Relational methods substantially improve accountability by clearly identifying problem causes, consequences in the plant design basis, dependent assumptions, and construction effects.

- New plant construction will be fast, efficient and exact based upon Part 52 COL, standard plant designs, prequalification, and construction management – unlike before.

  New construction, particularly of first-of-a-kind plants, will always be slower than optimum levels. New plant construction inevitable involves some design changes and associated delays – even for "finalized" designs. Until all SSC are procured, installed and tested, no plant design is finished. Minimizing delays requires maintaining accountably. While project management software helps, having relational methods available quickly identifies delay causes, allowing structural resolution. Correctly charging delays will speed their resolution, improve accountability and cut costs.

- NSSS, AEs and/or Constructors should already use databases. Wouldn't they benefit if they don't use already relational method databases? Why haven't they adopted relational methods?

  The AP-1000 DCD, the most advanced approved COL design, displays extensive use of internal reference tables. Their extensive cross-references, repetitive structure, and common data normally suggest database use. Indeed, an effective, well-constructed database could generate the AP-1000 DCD as a report. However assessing relational database normal (design) form, one quickly concludes that this is not the case; there are too many repeated elements. When we discussed the use of relational methods with Westinghouse, they assured us they already use databases in their design DCD. However, their top-level design is not relational. Had it been, they would have surely provided their database to NRC as a master DCD index, based on the simplification benefits to reviewers.

  Except for CAD/CAM automation, AE's today largely resumed nuclear plant design methods where they left off thirty-years ago. Better plant design basis management methods eclipsed them; they haven't constructed nuclear plants in years. Arguably, some CAD systems automate some high-level design development steps, like process and instrumentation drawings (P&ID), or master equipment lists (MEL). However, they lack methods for replicating and applying detailed equipment designs that must complete the detailed design. The prospect of designing and constructing new nuclear plants again has stimulated AE's design process development. Design basis integration has never been their engineering focus, however. The intervening absence of nuclear construction limited resources to develop new methods. Otherwise issues like those culminating in GL 96-05, Periodic Verification of Design Basis Capability, would have never

occurred. Furthermore, AE's don't want to risk anything that would further delay or in any way place their current market opportunity, building new nuclear plants, at risk.

NSSS/AE inherent conflicts of interest suggest limiting their control in a validation process to remain objective for NRC. Objective process control methods require an independent outsider's assessment perspective. At present, CORE has no conflicts of interest in the form of licensee, applicant or vender contracts that would bias our project participation.

- Licensees should take more initiative, since the proposed relational method technology is better. Why haven't licensees or their agents acted to adopt relational methods?

  Licensees have expressed concern about introducing changes that could be perceived as unnecessary, interrupting their critical path, introducing delays, questions or doubt with their current processes. Until construction reality loomed again several years ago, relational approach interest was minimal. Most commercial work stemmed from design basis reconstitution and scheduled maintenance plan basis development. Historically, AE's designed and built plants, turned design documentation over to owners and left "software" development – startup, operations and maintenance procedures, equipment lists, tag-outs, scheduled maintenance and reorder procurement specification development, for licensees. In some instances, licensees never received initial construction AE/NSSS documents like vendor technical information, or paid separately for them during the many design basis reconstitution efforts that occurred over the past twenty five years. Many licensees only acquired vender manuals and procurement specifications for original plant equipment years after startup. Some plant non-safety related equipment documentation today remains incomplete, despite broad implications of effects like PRA. Informality in program approaches cost dearly at Three Mile Island when:

  - *Scheduled maintenance omissions left equipment inoperable*
  - *Important equipment was inoperable during startup*
  - *Maintenance procedures were ineffective*
  - *Operating equipment status was clear*
  - *Operations failed to understand equipment risk contributions*
  - *Critical alarms failed*
  - *Operators failed to recognize critical failure symptoms*
  - *Training was incorrect for installed plant equipment configurations*
  - *(see NUREG-0660 and NUREG-0737, Three Mile Island Action Plans)*

  Licensees don't appreciate integrated design basis database value for improving their plant design basis management; most have never seen an integrated design basis database. Many licensees started their plants before integrated data base master equipment lists evolved in the last units started up. They have little experience with comprehensive relational databases, software or integrated use methods. At the end of the last construction wave, databases emerged, principally for equipment tag out configuration management and maintenance control. Licensees learned to live with multiple, discrete data sources, complex tracking, and manual information patching with documents or spreadsheets, based on immediate engineering or licensing needs. They had no systematic, compelling design basis information requirements other than those required by the NRC for licensing purposes (see GL-96-05, Periodic Verification of Design Basis Capability of MOV).

- NRC questions supporting efforts that appear ultimately to benefit licensees, even if other relational method benefits improve design basis, quality and schedules during construction.

  Licensees have expressed fear that submitting designs in a new format would require NRC acceptance up front. Having NRC approval requires validating experience with current practices. Efforts to gain NRC confidence and approval for an alternate method could only come from a

process like pilot validation. Without some indication of NRC support, licensees will continue to construct plants as they have before, letting designer-constructors develop high and low-level designs ("as-built's").

Fundamentally, a relational method initiative would greatly benefit the NRC. It organizes critical plant status information structurally during (and after) construction simplifying plant design basis assessment. Process owners – licensees, AEs, constructors, and NRC get better process controls, which place them in better self-control. The ability for all parties with responsibilities to identify the state of construction without locating hard copy documents offers substantial time and people savings. Without running a pilot, projecting time savings depends on estimates. The time avoided locating documents – even as electronic pdf's – is substantial. However, after the first construction design ITAACs consolidation change notices, updates, nonconformances, their resolution and a host of other materials needed to finish design comes due benefits are even greater.

- Why front-end load design construction with the relational method? Under the COL, it already is heavily front-loaded. Shouldn't resource levelizing push more work towards project completion?

  The COL front-loads design to assure smooth startup later. In principle, very little work remains in the COL license process on startup test completion, unlike design-construct methods constructing the operating nuclear fleet. The more front-loaded the design, the more complete end-of-construction, and the less work to verify. COL approved plant designs only build the high-level design framework before construction. As plant construction proceeds, SSC are acquired and high-level design fulfillment, requires developing lower level design details. Lower level design will always be inexact up to construction implementation. As a result, some lower level design back end loading is inevitable. However, the more repetitive and standard the design, the fewer low level design construction differences that occur, and the smoother construction closeout and startup.

- Can't traditional project management tools track ITAACs and associated Action Items adequately?

  The total number of items tracked ("Activities") determines the scope of the project management effort. Fewer items to track comes from efficient data structures that use all possible plant symmetries, dependencies, and other design relationships. Without an efficient underlying design basis framework, the number of items to track increases geometrically. More tracking of duplicated and less important material makes project management efforts more complex and management intensive. The relational process substantially reduces project management tracking requirements by providing a critical attribute skeleton framework. For tracking and verifying critical path concerns, the relational method provides project manager's substantial assistance automating design relationship threads. NRC's oversight role for project management gets support from intuitive linkages that organize the design as derivatives, from top level design criteria embedded in rules including 10CFR20, 10CFR34, 10CFR50, 10CFR72, and 10CFR100.

- NRC plans to inspect 35% of ITAACs. If findings cause more work, shouldn't licensees or their constructors bear delay costs?

  While validating ITAACs, discovery of problems increases inspection scope. Discovering design-related problems – a significant startup goal, requires tracing, resolving, correcting and updating design information. Independent, unrelated document design controls intrinsically take time to trace threads to causes. Fast tracking problem identification and resolution will speed construction. Quickly identifying all root cause threads – simple or complex – to correction compounds the benefits of relational data tracking.

Arbitrarily selecting 35% of ITAACs for validation assigned a target inspection number by NRC staff from experience. Alternatively, applying statistical process controls would allow the NRC to adjust ITAACs inspections dynamically based on process capabilities, allowing focus in areas that do the most good. Developing performance-based ITAACs requires the design basis to identify critical attributes. Developing a design basis assurance tool benefits everyone, but NRC more so. Assurance efforts can focus more in areas where they provide most benefits. Statistical processes can apply more resources where inspections find weaknesses.

Statistical process controls could give NRC an opportunity to improve workforce utilization. W. Edward Deming provides guidance on this and other statistical quality methods. (This was the basis for the Department of Commerce's Baldridge Award.) Direct statistical method application could risk-inform new plant startup design monitoring. Using the results inferences to improve the 10CFR52 licensing process would performance-base NRC efforts. The combination would effectively focus NRC and licensee resources where they would have most risk benefits. Such statistically-based monitoring reduces planned monitoring requirements nearly tenfold, freeing resources for more in depth review in high-risk areas, in similar manufacturing audit application.

- Why shouldn't CORE pay development costs? Couldn't they eventually license their software?

CORE is a small business, as defined by federal small business administration regulations. CORE will put over 10,000 development workhours of validated software of on the table at no cost. Post proof-of-concept license sales could help defer development costs. We feel this exceeds expected contributions from large companies in similar efforts. Expecting a small business to carry full development cost burden, instead of beneficiaries who will receive tens of years of benefits and millions returned in savings over plant lifetimes is not in anyone's long term interests. CORE's contribution exceeds its total capitalization, several times over. Furthermore, CORE's patent and other rights have limited commercial exploitation duration. Expecting CORE to forgo development cost recovery opportunity seems beyond normal duty. Would Westinghouse or General Electric provide free designs, or ask their subcontractors to work at no fee? For validated software, for small business that expectation may be unrealistic, but we will openly discuss options. Our cash flow needs must support us in any event. Were we to go it alone, our previous commercial applications would likely become our focus again.

An NRC-funded project contract would allow flexibility, best serving NRC as their understanding and development focus shifts with experience. In the absence of a CORE pilot, the AE's would likely cobble together the best parts of CORE process with their processes, with prodding from NRC. NRC would get several mutually-exclusive design basis software packages in frameworks like Westinghouse or GE's Design Control Documents – each different. It's difficult to see how multiple approaches would benefit, even assuming NSSS/AE could replicate CORE's relational method design basis software data structures and processes.

- Why should NRC support proof of concept demonstration? Wouldn't CORE try to sell their software and database tools to NRC after it supported development?

The primary safety beneficiary is the NRC, during and after design/construction. In light of the safety benefits, seeking NRC participation seems very reasonable. Assuring the accuracy of design ITAACs will improve plant completion knowledge at startup. Risks of delays from unknowns will drop. NRC will benefit from improving the quality and accuracy of design basis information at startup. Furthermore, the relational method represents evolution to the next design level. Integral design basis databases could be developed elsewhere, overseas, for example. A nuclear plant technology leadership opportunity will vanish. CORE will negotiate a fair contract that gives NRC full software rights, as a part of the project negotiations for Phase Two (see project schedule, which is Phase One).

- What benefits warrant NRC expenditures to address NSSS/AE/Owner issues?

  The plant design basis relational method will enhance NRC effectiveness regulating the NSS/AE owners, conserving a precious NRC resource – employees. Methods allow much more efficient examination of licensee materials for precursors that measure license completeness design basis health (or lack thereof). Rule compliance validation efforts require thread tracing to sources for root cause or other problem resolution makes the relational method a powerful tool. In essence, every time the NRC performs a safety system functional inspection (SSFI) or augmented inspection, they manually repeat steps similar to relational methods. Manually implemented, labor effort and cost precludes performing more frequent audits. Thus, comprehensive analytical verification of today's fleet occurs very infrequently, often in response to problems, rather than as a routine matter. Checking new nuclear plant SSC functional performance requires a relational process to efficiently verify all oversight threads. These same checks can be repeated with automation over the life of the plant.

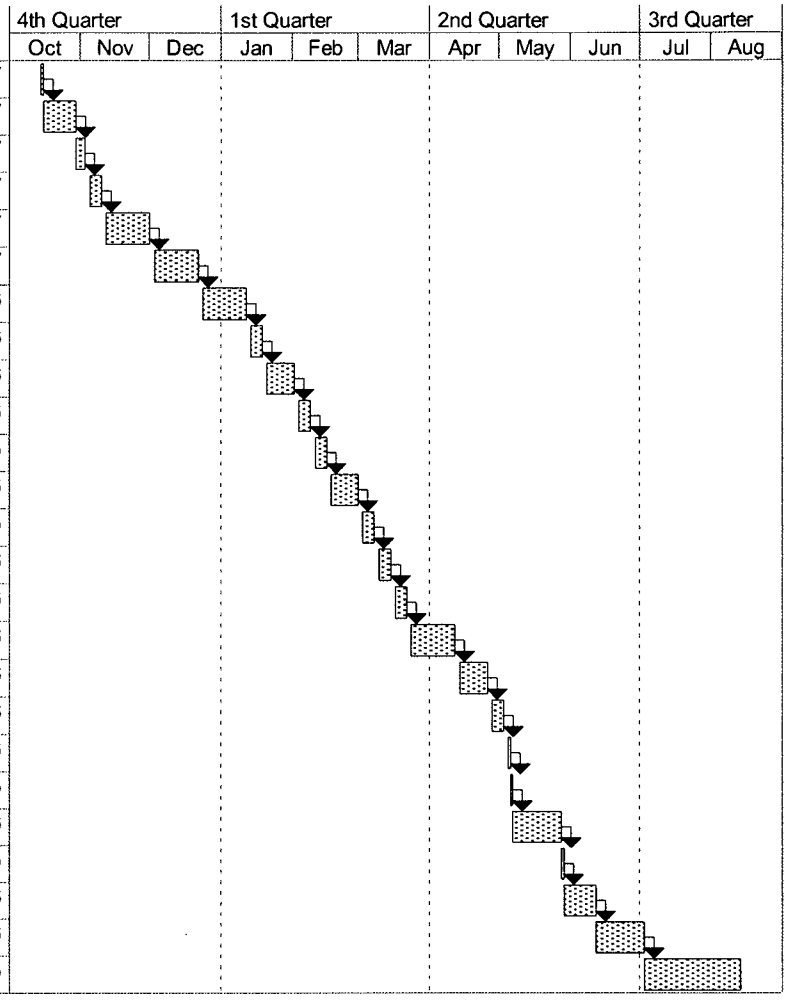
  Avoiding federal loan guarantee payouts benefits taxpayers, if not the NRC directly. Other benefits, like avoiding alternative fuels expense like gas, are also indirect. In 2006 the average cost of nuclear-produced electricity was 1.72 cents per kilowatt hour, compared with 2.37 cents for coal-fired and 6.75 cents for natural gas plants (WSJ Sept 2007). Given new commitments to build nuclear plants, financing costs avoided by meeting schedules to start date projections on-time reduce finance costs. We believe these methods can play a significant role improving nuclear plant design and construction up front, and operations later. Energy users will benefit, if indirectly.

- NRC lacks access to approved COL AP-1000 DCD information. NRC can't force participation in a relational method proof of concept pilot. Why would NSSS/AE's share design materials they haven't submitted under the COL? If CORE can't get their participation, who can?

  Operating entities seeking to build new plants will accommodate NRC wishes. Where national or safety interests require, NRC promotes consistency and voluntary compliance. Current rules do not require standard plant designs, but those who seek to procure and build standard designs receive priority scheduling resources. Policy sets standardization guidance. NRC methods support voluntary compliance. Prospective owner/agent concerns for this initiative center around NRC acceptance and support. With NRC support, plants would participate and cooperate. These same methods could solicit participation in similar follow-on initiatives. CORE believes NRC interest and support will provide the activation energy that sustains proof-of-concept interest and pilot project execution.

  This pilot offer could go to any voluntary group with a Part 52 licensed design. Westinghouse, Toshiba (ABWR), General Electric, Areva (EPR), or Mitsubishi could be solicited to participate. If prospective support proving a new low cost method was clear, we believe other NSSS/AE's would follow.

ID		Task Name	Duration	Start	Finish
1		Perform NRC Conceptual Training	1 day	Mon 10/15/07	Mon 10/15/07
2		Define "Tracking" Requirements	10 days	Tue 10/16/07	Mon 10/29/07
3		Negotiate NRC RFP Equivalent	4 days	Tue 10/30/07	Fri 11/2/07
4		Map Architecture to Regulations (RCT-NRC)	5 days	Mon 11/5/07	Fri 11/9/07
5		Negotiate Relational Tracking Objectives	15 days	Mon 11/12/07	Fri 11/30/07
6		Model AP-1000 Design Control Document	15 days	Mon 12/3/07	Fri 12/21/07
7		Analyze AP-1000 -- Four Systems	15 days	Mon 12/24/07	Fri 1/11/08
8		ID Systems (1-4)	5 days	Mon 1/14/08	Fri 1/18/08
9		ID SSC's Systems (1-4)	10 days	Mon 1/21/08	Fri 2/1/08
10		Develop New Tracking Reports	5 days	Mon 2/4/08	Fri 2/8/08
11		Develop Statusing Method	5 days	Mon 2/11/08	Fri 2/15/08
12		Validate AP-1000 Framework	10 days	Mon 2/18/08	Fri 2/29/08
13		Create Draft for NUREG:step 1	5 days	Mon 3/3/08	Fri 3/7/08
14		Plan Soft Platform Migration for Large Groups	5 days	Mon 3/10/08	Fri 3/14/08
15		Negotiate RFP for Large Group	5 days	Mon 3/17/08	Fri 3/21/08
16		Negotiate Objectives for Large Group	15 days	Mon 3/24/08	Fri 4/11/08
17		Create Structure for Large Group	10 days	Mon 4/14/08	Fri 4/25/08
18		Create Schedule for Large Group	5 days	Mon 4/28/08	Fri 5/2/08
19		Demonstrate Multi-user use	1 day	Mon 5/5/08	Mon 5/5/08
20		Demonstrate Web-user use	1 day	Tue 5/6/08	Tue 5/6/08
21		Migrate from Access to SQL or Oracle	15 days	Wed 5/7/08	Tue 5/27/08
22		Demonstrate Access Migration	1 day	Wed 5/28/08	Wed 5/28/08
23		Create Operating Plant Demo	10 days	Thu 5/29/08	Wed 6/11/08
24		Demonstrate Relational Method	15 days	Thu 6/12/08	Wed 7/2/08
25		Document Relational Method NUREG	30 days	Thu 7/3/08	Wed 8/13/08



Task

Split