Nuclear Power 2010 Program
Dominion Virginia Power
Cooperative Project

U.S. Department of Energy
Cooperative Agreement DE-FC07-05ID14635

Construction and Operating License
Demonstration Project
Final Report

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List of Abbreviations and Acronyms

ACRS	Advisory Committee on Reactor Safeguards
ASLB	Atomic Safety and Licensing Board
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
CDI	Conceptual Design Information
CMS	Content Management System
COL	Combined License
COLA	Combined License Application
CY	Calendar Year
DCD	Design Control Document
DCWG	Design-Centered Working Group
DEIS	Draft Environmental Impact Statement
DHS	(U.S.) Department of Homeland Security
DNNA	Dominion Nuclear North Anna, LLC
DOE	(U.S.) Department of Energy
DOR	Division of Responsibility
EIS	Environmental Impact Statement
EP	Emergency Plan
EPA	(U.S.) Environmental Protection Agency
EPC	Engineer, Procure, Construct
EPRI	Electric Power Research Institute
ER	Environmental Report
ESP	Early Site Permit
EVMS	Earned Value Management System
ESBWR	Economic Simplified Boiling Water Reactor
FAA	(U.S.) Federal Aviation Administration
FEMA	(U.S.) Federal Emergency Management Agency
FOIA	Freedom of Information Act
FSAR	Final Safety Analysis Report
GE	General Electric
GEH	General Electric-Hitachi
GIS	Geographic Information System
IFIM	Instream Flow Incremental Methodology
ISG	Interim Staff Guidance
NAPS	North Anna Power Station
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NOAA	(U.S.) National Oceanic and Atmospheric Administration
NP 2010	Nuclear Power 2010
NRC	(U.S.) Nuclear Regulatory Commission
PMF	Probable Maximum Flood

PMP	Probable Maximum Precipitation
PPE	Plant Parameters Envelope
QA	Quality Assurance
PSWS	Plant Service Water System
RAI	Request for Additional Information
R-COLA	Reference COLA
RFI	Request for Information
RTNSS	Regulatory Treatment of Non-Safety Systems
S-COLA	Subsequent COLA
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SME	Subject Matter Expert
SSAR	Site Safety Analysis Report
STP	Sewage Treatment Plant
UFSAR	Updated Final Safety Analysis Report
US-APWR	US-Advanced Pressurized Water Reactor
VDEQ	Virginia Department of Environmental Quality
VDHR	Virginia Department of Historic Resources
VPDES	Virginia Pollutant Discharge Elimination System

1. Executive Summary

The United States Department of Energy (DOE) and Dominion Virginia Power (formerly Dominion Nuclear North Anna, LLC; hereafter referred to as Dominion) entered into Cooperative Agreement Number DE-FC07-05ID14635 in April 2005. The Cooperative Agreement, established under the auspices of DOE "Nuclear Power 2010 (NP 2010)" program, created the management framework for the North Anna Construction and Operating License (commonly referred to as the "Combined License" or "COL") project. The purpose of the project was to promote the economic, technological, and engineering evaluations necessary to determine the feasibility of establishing a new nuclear plant at the North Anna Power Station and to support the creation of a COL application (COLA) for the proposed new plant.

The Cooperative Agreement ended in the spring of 2010 with total project costs of approximately $150 million. At the conclusion of the 5-year North Anna COL project, significant progress had been made towards the goals set forth in the Cooperative Agreement. Multiple revisions of the ESBWR design certification application had been submitted for NRC review, a Combined License application for the ESBWR at the North Anna site had been submitted to the NRC, ESBWR and site-specific engineering for a new nuclear power plant was advanced, and a business case was developed to support a decision to build a new nuclear power plant at the North Anna site.

In April 2007, ESBWR design and NRC design certification activities were removed from the Cooperative Agreement and assigned to a separate Cooperative Agreement between DOE and GE-Hitachi (GEH). Delays associated with the detailed design of the ESBWR, in part related to the need to reply promptly to a multitude of NRC Requests for Additional Information (RAIs) on the design control document (DCD), slowed the plant design engineering effort for site-specific facilities. Increased NRC requirements for detailed information, limits on GE funding and resources, and GE submission of incomplete versions of the DCD contributed to delays in obtaining NRC Design Certification and approval of the North Anna Unit 3 Combined License Application. Dominion was unable to enter into a satisfactory engineering, procurement and construction (EPC) agreement with GEH. In late 2008, Dominion announced a competitive process to select a nuclear technology supplier. In May 2010, Dominion announced that, as a result of the competitive process, it had selected Mitsubishi Heavy Industries' US-Advanced Pressurized Water Reactor (US-APWR) as the technology for North Anna Unit 3.

The North Anna COL project Cooperative Agreement was successful in advancing the site-specific plant design for North Anna Unit 3, furthering the development of the licensing process for COLAs that reference an early site permit (ESP), producing license application documents supporting the likely approval for the construction and operation of a new nuclear unit at the North Anna site, and establishing the business case supporting the development of a new nuclear facility. The ultimate goal of the DOE Nuclear Power 2010 program is to reduce technical, regulatory, and institutional barriers to the construction and operation of new nuclear power generating units. Given the current advanced state of the North Anna COL effort, the Cooperative Agreement between DOE and Dominion was a success because it served as a demonstration of much of the COL process for a proposed new plant at a location with an existing Early Site Permit. The Cooperative Agreement also helped to stimulate the entry of multiple vendors into the U.S. commercial market for new nuclear power plants.

2. Introduction

The Nuclear Power 2010 (NP 2010) program was initiated by the United States Department of Energy (DOE), Office of Nuclear Energy, in 2002. The goals of the program are to reduce the technical, regulatory, and institutional barriers to building new nuclear power plants in the United States as well as to secure industry decisions to construct and operate the new plants. The NP 2010 program is structured to promote a partnership between government and industry to reach these goals, with DOE and industry sharing the costs of program activities.

The NP 2010 program promotes the development of new nuclear power plants in the United States, in part through the support of reactor design activities, development of licensing processes to meet United States Nuclear Regulatory Commission (NRC) requirements for the siting, construction, and operation of new plants, and cooperative projects with industry for intensive study of certain technologies at specific prospective locations. One of the cooperative projects undertaken by the NP 2010 program was a task to develop NRC COL documentation and determine the feasibility of the GE ESBWR nuclear power plant technology as a new nuclear power unit at the Dominion North Anna Power Station (NAPS) located near Mineral, Virginia. Two years into the five year project, the technology-specific engineering tasks were removed from the Cooperative Agreement and placed in a different one created between GE-Hitachi and DOE. COL development and site-specific engineering activities continued under this Cooperative Agreement into 2010. This document provides an overview of the North Anna COL Cooperative Agreement project (DOE Cooperative Agreement DE-FC07-05ID14635).

Dominion is one of the nation's largest producers and transporters of energy, with a portfolio of more than 27,500 megawatts of generation and 6,000 miles of electric transmission lines. Headquartered in Richmond, Virginia, Dominion serves retail energy customers in 12 states. Under Dominion management and leadership, primary members of the project team included General Electric-Hitachi (GEH) and Bechtel. Specialty contractors supporting Dominion included Tetra Tech NUS, Inc. (environmental data collection and analysis, environmental impact assessments), Mactec Engineering and Consulting, Inc. (site subsurface investigation and laboratory testing), and Risk Engineering, Inc. (probabilistic seismic hazard analyses). Entergy, a member of the ESBWR Design-Centered Working Group (DCWG) preparing a subsequent COLA (S-COLA) for an ESBWR at the Grand Gulf site, and Enercon, a contractor to Entergy, also actively supported development of the R-COLA.

This report serves to summarize the major activities completed as part of Dominion's Cooperative Agreement with DOE, based on periodic status reports and briefings generated during the course of the project (e.g., quarterly reports submitted to DOE by Dominion). Project successes, lessons learned, and suggestions for improvement are also discussed herein, based on a review of project deliverables and input from interviews of Dominion management personnel.

The objectives of the North Anna COL project included:

- Prepare and submit the General Electric (GE) Economic Simplified Boiling Water Reactor (ESBWR) design certification application
- Obtain United States Nuclear Regulatory Commission (NRC) design certification for the ESBWR
- Prepare and submit a COLA for the ESBWR at the North Anna site
- Obtain NRC approval of the COL
- Complete the ESBWR design and site-specific engineering

- Develop a business case necessary to support a decision on building a new nuclear power plant

Dominion completed five submissions of the Reference COLA (R-COLA) for the ESBWR technology and reached the Phase 3 milestone for the NRC Staff's Safety Evaluation Report (SER) by completing the NRC's Advisory Committee on Reactor Safeguards (ACRS) review of the SER with open items. There were only seven open items remaining before Dominion completed a competitive procurement process which resulted in changing the reactor technology. Had Dominion not changed technology to the US Advanced Pressurized Water Reactor (US-APWR) in May of 2010, a Final SER was targeted for February 2011. Because of DOE's NP-2010 program, the COLA process was able to make great strides to facilitate the restart of the industry by creating clear and consistent frameworks for both industry and regulators to follow. The success of North Anna's COLA helped advance the following goals of NP-2010:

- Work with the NRC to resolve technical and regulatory issues associated with the COL process
- Clearly define the form and content of a COLA
- Demonstrate the new COL process

Section 3 of this report provides a brief project summary, Section 4 identifies lessons learned from the project, and Section 5 is a narrative detailing insights and recommendations based on the experience and outcome of the Cooperative Agreement project.

3. COL Demonstration Project

3.1 NP 2010 COL Demonstration Project Purpose and Achievements

The North Anna COL Project was performed by Dominion with the following objectives:

- Prepare and submit a COLA to the U.S. Nuclear Regulatory Commission (NRC) incorporating Economic Simplified Boiling Water Reactor (ESBWR) technology for a third unit at Dominion's North Anna Power Station (NAPS) site located near Mineral, Virginia
- Support the NRC review process and mandatory hearing
- Obtain NRC approval of the COLA and issuance of a COL
- Develop a business case necessary to support a decision on building a new nuclear power plant at the NAPS site

Major milestones of the project included:

- The project began on April 4, 2005.
- Submission 1 of the COLA with Revision 0 of all parts of the COLA was provided to the NRC on November 27, 2007.
- The Early Site Permit (ESP) was issued on November 27, 2007.
- NRC Docketing Decision Letter was issued and the acceptance review completed on January 28, 2008.
- Submission 2 (Non-Public Version) of the COLA and Submission 3 (Public Version) with Revision 1 of most parts of the COLA were provided to the NRC on December 20, 2008.
- Submission 4 (Public Version) of the COLA with Revision 2 of the FSAR and Departures Report was provided to the NRC on May 29, 2009.
- Submission 5 (Public Version) of the COLA with Revision 2 of the Environmental Report (ER) was provided to the NRC on July 29, 2009.
- The Advisory Committee on Reactor Safeguards (ACRS) review of the SER with Open Items was completed on November 4, 2009.
- The Final Supplemental Environmental Impact Statement (SEIS) was issued to U.S. Environmental Protection Agency (EPA) on March 19, 2010.

Appendix 1 identifies schedule milestones for the project.

Applying for a COL is a federal licensing action before the NRC as well as an action that is conducted by the applicant and regulator in the public eye. Given this circumstance, several deliberate opportunities are afforded by the NRC during their review for the public to provide input and comment. There are NRC regulations and guidance that apply directly to the COL process, while other federal, state, and local regulatory authorities interact with the NRC or Dominion during the licensing effort. Such interactions may be as simple as consultation or solicitation of comments, or may be as involved as obtaining certifications and permits for actions to be conducted at the site in coordination with NRC approvals. The National Environmental Policy Act (NEPA) is an example of a federal statute requiring an environmental review by the NRC, in parallel with the NRC's technical review under 10 CFR 52, which necessitates interactions with multiple federal and state agencies. Examples of agencies and organizations with which Dominion interacted during the ESP and COL projects included the U.S. Fish & Wildlife Service, U.S. Army Corps of Engineers, Federal Aviation Administration (FAA), U.S. Department of Energy (DOE), Department of Homeland Security

(DHS), U.S. Environmental Protection Agency (EPA), Virginia Department of Environmental Quality (VDEQ), Virginia Department of Historic Resources (VDHR), National Guard and other emergency responders, Federal Emergency Management Agency (FEMA), Electric Power Research Institute (EPRI), local counties' Boards of Supervisors, and local community, business, and citizen action groups. Considerable information on these interactions during the North Anna COL Project is provided in the COLA and NRC review documents.

3.2 Project Execution

3.2.1 Significant Activities — Calendar Year (CY) 2005

On March 31, 2005, DOE awarded Dominion a financial assistance award in the form of Cooperative Agreement DE-FC07-05ID14635 under the NP 2010 program. The work to be completed under the Cooperative Agreement was to be performed in two phases. The first phase, Phase 1, was the project planning phase. Phase 1 activities included the assembly of the project team and infrastructure, development of a detailed work scope and schedule, establishment of DOE interface and oversight of the project, preparation and submission of the ESBWR Design Certification application, and commencement of COLA preparation. In addition, Phase 1 of the Cooperative Agreement included the economic, financial, risk, and other evaluations and analyses necessary to support a decision whether to proceed with the COL project.

The second phase of the Cooperative Agreement, Phase 2, was the project implementation phase. Phase 2 activities were to include the engineering and licensing actions needed to receive the ESBWR design certification, preparation and submission of the COLA for the ESBWR at North Anna, follow-on activities needed to obtain NRC approval of the COL, and completion of the ESBWR plant design and site engineering.

NOTE: On April 1, 2007, tasks related to the development of the ESBWR design and preparation of the ESBWR Design Certification to the NRC were removed from the scope of this Cooperative Agreement and placed in a separate agreement between DOE and GEH. As a result, this summary does not include details associated with those tasks after that date.

A selection of accomplishments, issues, and activities are detailed below to illustrate the progression of the Cooperative Agreement.

3.2.1.1 2Q05

In April, biweekly project status phone calls were initiated, with DOE, Dominion, GE, and others as participants. On June 30, the final schedule for Phase 1 activities was submitted to DOE.

The DOE Interface and Oversight Agreement was submitted to DOE on June 24, and approved by DOE on June 28.

Work proceeded on establishing quality assurance plans and confidentiality agreements between the entities associated with the Cooperative Project.

Work was undertaken to develop an outline for the COLA and associated regulatory documents. GE initiated development of design certification documentation.

3.2.1.2 3Q05

On August 24, GE submitted the DCD to the NRC. On September 23, the NRC responded to GE that NRC's acceptance review had concluded that portions of the DCD required additional detail, but that those sections containing adequate information would be reviewed while the gaps in other areas of the document were addressed.

On September 12, Dominion notified DOE of the intent to proceed with Phase 2 of the Cooperative Agreement. The preliminary cost and schedule base-

lines for the entire project were submitted to DOE on September 29.

The COLA outline and list of required environmental permits, consultations, and authorizations were completed.

The GE ESBWR team conducted a training session and information exchange with the NRC on September 27–29.

Site engineering activities during 3Q05 included Dominion and Bechtel inspections of the abandoned North Anna Unit 3 & 4 outfall structure and electrical duct banks on August 23. An inspection report summarizing the findings was prepared.

Dominion met with General Dynamics/Electric Boat to understand how Electric Boat capabilities and approach to modularization could be applied to ESBWR.

The DOE Interface and Oversight Agreement was implemented, effective September 30.

3.2.1.3 4Q05

A meeting to discuss the path forward to obtain the COL was held on October 7 among Dominion, GE, and NuStart. COLA development was discussed at a meeting held on December 1 among Dominion, Entergy, NuStart, GE, Enercon, and Bechtel.

A Special Status Report was submitted to DOE on October 18 in response to a DOE request for information concerning the results of the page-turn and red team reviews of the DCD.

In November, DOE conducted a program management preliminary audit of GE. On November 15–17, the NRC Quality and Vendor Branch A conducted an inspection of GE's implementation of its QA program on the ESBWR project.

On December 22, revised cost, schedule, and technical baselines were submitted to DOE.

The ESBWR DCD was docketed by the NRC on December 1. A tentative schedule for review was established by the NRC, including a projected date of October 11, 2007, for the publication of the Safety Evaluation Report (SER) with Open Items and January 2009 for the final design approval.

During 4Q05, GE selected a steam turbine generator to be designed and manufactured by GE as the basis for the ESBWR standard plant.

3.2.2 Significant Activities — CY 2006

3.2.2.1 1Q06

In the first quarter of 2006, activities associated with both phases of the Cooperative Agreement project were ongoing. Among the project management and administration activities, Six Sigma evaluations of the COLA preparation process were initiated by Six Sigma black belts from Dominion, GE, and Bechtel. Subcontracts were signed by Dominion to undertake an aerial survey and archaeological walkdowns of the North Anna site. In addition, bids were received and were under review for the completion of the site subsurface investigation and testing program.

Schedule and resource estimates for the COL development were established. The schedule reflected a division of responsibility for COLA sections with the NuStart Grand Gulf team. Weekly conference calls to discuss the COLA schedule and action item status were also initiated.

Progress towards NRC approval of the ESBWR design certification application was made with the submission of Revision 1 of ESBWR DCD Tier 2. This revision incorporated resolution to NRC RAIs and other clarifications/enhancements.

ESBWR and site engineering tasks during 1Q06 included a variety of ongoing work, including the initiation of the defense in depth and diversity assessment, review of feedwater heater sizes and heights, and issuance of the site layout drawing.

To support the modular construction approach planned for the ESBWR at North Anna, several site walkdowns were conducted by the GE ESBWR team and an initial modularization assessment was undertaken.

3.2.2.2 2Q06

GE selected Washington Group International as the nuclear island EPC supplier and Worley Parsons to support the development of processes and procedures for the ESBWR generic deployment strategy. A partnering agreement with Hitachi was finalized by GE also, resulting in the formation of GEH.

Dominion awarded Mactec the subcontract for the site subsurface investigation and testing program.

GEH completed the ESBWR cost estimate and schedule approach report and initiated the North Anna Unit 3 price estimate process.

Dominion advised DOE of a change to the COLA submittal date from September 2007 to November 2007.

Preparation and review of draft COLA sections continued. Dominion, NuStart, and Entergy formed a combined team to coordinate the preparation of COLAs for North Anna, Grand Gulf, and River Bend.

GEH continued to respond to RAIs from NRC and submitted Revision 1 of DCD Tier 1.

ESBWR engineering activities completed by GEH during 2Q06 included the issuance of (1) the Service Building General Arrangements for review, (2) the report on ESBWR recommended waterproofing methods, and (3) the ESBWR drywell space study.

Site engineering activities included the completion of aerial surveys of the site and initiation of design of the intake structure.

On May 12, Dominion completed a report defining the assumptions and methodology for the ESBWR construction cost estimate and schedule approach.

3.2.2.3 3Q06

Phase 1 activities were completed during the third quarter of 2006. A summary report was provided to DOE by Dominion on September 26.

The NRC continued work on the draft COLA Regulatory Guide (DG-1145). A final version for comment of DG-1145 was issued by the NRC in September. The North Anna COL demonstration project team participated in the industry review effort.

Dominion, NuStart, and Entergy formed the ESBWR Design-Centered Working Group (DCWG), as described in a July 17, 2006, letter to the NRC. The intent of the group is to develop a standardized approach to facilitate consistency to the extent possible among the various anticipated ESBWR COLAs.

The ESBWR DCWG met with the NRC on September 20. A communication protocol among the DCWG members and the NRC was being prepared during this time period.

By the end of 3Q06, the preparation of first draft COLA sections was noted to be over 80 percent complete, with joint reviews being conducted by the DCWG members. In addition, preparation of second draft COLA sections was noted to be just beginning.

Dominion initiated detailed planning efforts for state, local, and other federal permits, consultations, and authorizations. EA Engineering, Science, and Technology, Inc. was contracted to assist in the permitting effort.

ESBWR and site engineering activities continued. Tasks underway included the development of the electrical building cable tray layout and raceway system design, development of the site layout drawing, and design for switchyard expansion.

GEH continued work on the selection of a heavy haul supplier. In addition, preliminary modularization evaluations continued.

The number of RAIs issued by the NRC on the DCD was noted to have an adverse effect on GEH resources, resulting in delays in maintaining the schedule for multiple tasks (e.g., COLA preparation, ESBWR engineering). GEH indicated that they added additional resources to the project in an attempt to reduce the impacts to the project schedule.

The subsurface investigation task began in August.

3.2.2.4 4Q06

In November, an effort to "re-baseline" the project schedule was initiated, with particular focus on the activities necessary to submit the COLA. Also in November, GEH issued the Project Design Manual for use.

The ESBWR DCWG conducted meetings with the NRC on October 24 and December 7.

The preparation and review of draft COLA sections continued, with preparation of first draft sections more than 90 percent complete. Joint reviews of these sections were being undertaken by DCWG members.

Pilot efforts on the "New and Significant" process for developing the COLA Environmental Report progressed. However, communications with NRC staff during this time period resulted in inconsistent direction on expectations for the New and Significant review process.

Dominion continued detailed planning efforts to understand local, state, and federal permitting and consultation requirements.

Phases 1 and 2 of revision 2 of the DCD were submitted to the NRC in October and November, respectively.

GEH continued to respond to RAIs from the NRC. By mid-December, approximately 2,700 RAI questions had been received by GEH, with replies provided to about 1,900 of them.

ESBWR engineering activities continued. Among the many ongoing tasks was a study of maintenance of the main steam tunnel, detailed piping stress analysis of the Class 1 portion of the main steam system, and development of the initial core design.

The field work associated with the subsurface investigation task was completed in November. Other site engineering tasks included the development of the excavation plan drawings and specifications for the intake structure, intake pump house, and discharge structure.

The number of RAIs issued by the NRC regarding the DCD continued to be a significant burden on the resources of GEH, resulting in a decreased ability to maintain the schedules established for COLA preparation and the ESBWR engineering effort. GEH was dedicating additional resources to the project to reduce the schedule impacts of the RAI volume.

3.2.3 Significant Activities — CY 2007

3.2.3.1 1Q07

In February, a decision was made to prepare and submit DCD Revision 4 in 2007, before the COLA submittal. This decision impacted the previous re-baseline efforts. Further adjustment to the project schedule was needed to reflect activities associated with DCD Revision 4 and the resulting impacts on COLA preparation efforts.

GEH issued an assessment of the Electric Power Research Institute (EPRI) Utility Requirements document.

The COLA preparation team began to issue second draft COLA sections for review. The level of effort on COLA preparation was expected to increase significantly in the coming months. Dominion was

working with NuStart/Entergy to establish a division of responsibility to improve the efficiency and effectiveness of the second draft review process.

Work on the Content Management System (CMS) continued during 1Q07. The North Anna ESP Application was loaded into the system at the end of March. DCD Revision 3 (approximately 7,500 pages) was converted for upload into the CMS. A training session on the CMS was held on January 17-18, with attendees from Dominion, GEH, Bechtel, and NuStart present.

The ESBWR DCWG met with the NRC on February 1. The meeting included a joint session with the AP1000 DCWG and an Environmental Report pre-application discussion.

The NRC held a workshop on February 2 to discuss the format and content of the COLA. GEH trained their authors on preparation of COLA sections on February 26–27; Dominion and NuStart representatives attended to answer questions.

Revision 3 of the DCD was submitted to the NRC on February 22.

On March 7, Dominion, NuStart, and GEH met to discuss the parallel processes of DCD revision and COLA preparation. A DCD/COLA integration team was formed to further study the impacts of DCD Revision 4 on the COLA.

On March 9, NRC staff met with Dominion, Bechtel and NuStart personnel to discuss North Anna environmental issues. The NRC agreed that the process proposed by the project to identify new and significant information was acceptable.

On March 19, Dominion, NuStart and GEH determined that DCD Revision 4 would be submitted before the promised delivery date of the COLA to the NRC (November 2007). The DCD/COLA integration team was to determine the content of DCD Revision 4 with a mandate to minimize impact on COLA preparation.

On March 22–23, the ESBWR DCWG met with NRC staff. The meeting was held jointly with the AP1000 DCWG. Key topics included operational programs, the DCD/COLA parallel process, and Severe Accident Mitigation Alternatives /Severe Accident Mitigation Design Alternatives.

GEH continued to respond to NRC RAIs. As of the end of 1Q07, 3,261 RAI questions had been received, with 2,540 responses submitted and 1,109 resolved.

Work continued on ESBWR and site engineering tasks. Examples of the many accomplishments in the first quarter of 2007 included the completion of the initial core design, work on three licensing topical reports for human factors engineering, and the final circulating water system optimization study. In addition, analysis of data from the subsurface investigation completed in November 2006 continued, with testing for soil adsorption scheduled to begin at the Savannah River laboratory in May 2007.

GEH established six task teams to create procedures and processes to govern construction deployment activities. The topics to be addressed were:

- Construction plan (e.g., heavy haul review, labor analysis, crane plan)
- Modularization plan
- Quality assurance plan
- Procurement policy/plan
- Administrative coordination and control plan
- Site engineering plan

The six task teams were to meet monthly and provide progress briefings quarterly.

As in 3Q06 and 4Q06, the number of RAIs issued by the NRC regarding the DCD was noted to be a significant burden on the resources of GEH, resulting in a decreased ability to maintain the schedules estab-

lished for COLA preparation and the ESBWR engineering effort. GEH was dedicating additional resources to the project to reduce the schedule impacts of the RAI volume.

3.2.3.2 2Q07

On April 1, the Dominion Cooperative Agreement was restructured. ESBWR design certification and engineering tasks were moved to a newly created and separate GEH Cooperative Agreement.

In June, DOE completed an external independent review of the cost and schedule performance baselines. Final DOE acceptance of the cost and schedule performance baselines took place in September 2007.

Also in June, Dominion obtained concurrence from the Commonwealth of Virginia resource agencies on an in-stream flow incremental methodology study and completed a Pennsylvania-Jersey-Maryland interconnection impact study.

The preparation and review of second draft COLA sections continued. Concerns were noted regarding the ability of the team to meet the scheduled delivery date for the COLA. To address the problem, more frequent meetings began to be conducted to resolve issues that, if left unresolved, would delay the completion.

On April 3, the project team began to fully implement the New and Significant process for determining content and scope of the Environmental Report supplement.

On April 30, GEH conducted two training sessions on Revision 2 of the GEH COL Writers Guide.

The ESBWR DCWG, along with the AP1000 DCWG, met with the NRC on May 2–3. Positive feedback was received from the NRC on the following approach to DCD and COLA preparation:

- A limited scope DCD Revision 4 will be submitted to the NRC in advance of submitting COLA Revision 0
- COLA Revision 0 will be submitted to the NRC based on DCD Revision 4
- DCD Revision 5 will be submitted to the NRC following NRC acceptance of the COLA
- COLA Revision 1 will be submitted to the NRC based on DCD Revision 5
- DCD and COLA sections will be prepared in parallel

On May 31, Dominion responded to the NRC regarding the NRC Regulatory Issue Summary 2007-08. In the response, Dominion identified a COLA submittal date of November 2007. GEH also issued a letter to the NRC on June 1 that stated its intention to submit DCD Revision 4 on or before September 28, 2007, and DCD Revision 5 on or before March 31, 2008.

The ESBWR DCWG, along with the AP1000 working group, met with the NRC on June 13–14. Topics discussed included operational programs, COL holder items, and pre-application quality assurance audits.

Site engineering activities during this period included the issuance of the final circulating water system optimization study, as well as preparation of the calculations for dynamic slope stability and earth pressure, static and dynamic properties.

Dominion, GEH, and Bechtel conducted a site walkdown of the North Anna facility on April 13. Site construction logistical plans were noted to be under development. The layout of the site suggests that a multi-phase plan will be needed to construct the new unit.

3.2.3.3 3Q07

In September, biweekly conference calls with DOE to discuss the project status were temporarily sus-

pended pending completion of the COLA in the fourth quarter of 2007. The biweekly calls were expected to resume in 2008. Concerns continued regarding the schedule for the preparation of several COLA sections.

In September Dominion completed the subsurface investigation data report.

Site engineering accomplishments during 3Q07 included the completion of an analysis of cooling tower noise, the site excavation plans and foundation profiles, the design descriptions and COLA calculations for the plant cooling tower makeup system, and storm water management analysis and design.

3.2.3.4 4Q07

The North Anna ESBWR R-COLA was submitted to the NRC on November 27. Two days later, Dominion met with the NRC to provide "orientation training" on the document. On December 13–14, Dominion met with the NRC to discuss the technical content of the COLA.

Further progress was made in resolving site engineering issues. Among the accomplishments during 4Q07 was the completion of an analysis of lake water chemical constituents, completion of the calculation for dynamic slope stability, completion of a calculation demonstrating that the new condenser heat duty had an insignificant impact on previous ESP analysis results, and completion of an accidental liquid release analysis.

3.2.4 Significant Activities — CY 2008

3.2.4.1 1Q08

During this quarter, GEH provided an updated cost estimate for the generic ESBWR power block.

By letter dated January 28, 2008, the NRC notified Dominion that the COLA was accepted for docketing. A subsequent letter from the NRC dated February 27, 2008, provided the COL environmental and safety review schedules to Dominion.

Dominion and Bechtel prepared a number of COLA change packages for upcoming revisions of the COLA, prepared for the planned NRC environmental audit at North Anna (scheduled for April 2008), and continued to review responses by GEH to RAIs on the DCD and draft sections of DCD Revision 5.

On March 20 and 28, respectively, the NRC issued the first two formal questions on the COLA.

Site engineering activities continued during the first quarter of 2008. Activities included the preparation of specifications for yard equipment, design tasks in support of the site separation scope, and the start of "90 percent" design packages. ("Site separation" involves the relocation and replacement of existing site utilities and structures needed to accommodate the siting of the new proposed Unit 3.)

In the 1Q08 quarterly report, it was also noted that the GEH focus on DCD RAIs and DCD Revision 5 had delayed ESBWR engineering and the development of construction costs and schedule. These delays were observed to impact the ability of Dominion to make a decision to build. It was suggested that increased focus and funding by GEH on ESBWR engineering and development of construction costs and schedule should be undertaken.

3.2.4.2 2Q08

Dominion, GEH, and Bechtel participated in a joint workshop on April 15–16 to review revisions to the work breakdown structure and schedule coding structures. Subsequent progress review meetings were held among Dominion, GEH, and Bechtel on April 30 and June 9.

During 2Q08, GEH provided another revised cost estimate for the generic ESBWR power block.

The NRC conducted an environmental audit at North Anna from April 14–18.

Dominion and Bechtel continued the preparation of COLA change packages and review of GEH responses to RAIs on the DCD. In addition, an evaluation was undertaken to determine the impacts to the COLA from changes made in Revision 5 of the DCD.

Site engineering activities continued to progress, with a number of tasks completed. Examples include:

- Architectural concept for administration building, including renderings, plans, and elevations
- Evaluation of the impacts of a new Virginia nutrient general permit on cooling system chemical treatment and sewage treatment plant design
- Case study report for using foundation field bus technology
- Calculations for modifications to domestic water and main fire loop for site separation

In the 2Q08 quarterly report, it was repeated (from the 1Q08 report) that the GEH focus on DCD RAIs and DCD Revision 5 has delayed ESBWR engineering and the development of construction costs and schedule. These delays were observed to impact the ability of Dominion to make a decision to build. It was suggested that increased focus and funding by GEH on ESBWR engineering and development of construction costs and schedule should be undertaken.

3.2.4.3 3Q08

In August, the NRC issued RAIs for all SER chapters, and Dominion completed the draft specification for the hybrid cooling tower.

During 3Q08, Dominion, GEH, and Bechtel continued to review the impact to the COLA from changes made in Revision 5 of the DCD and prepared responses to NRC RAIs.

Schedules for the ESBWR engineering (GEH) and site engineering (Dominion/Bechtel) tasks were under review to develop a plan to better integrate activities by prioritizing the development of information necessary to advance other engineering tasks. It was noted that the tasks were sufficiently "out of step" that site engineering work was sometimes delayed while waiting on needed inputs from ESBWR engineering.

Site engineering accomplishments during this time period included the issuance of (1) rough grading drawings, (2) circulating water system general arrangement, (3) specifications for variable frequency drives and power centers, and (4) the new fuel haul route drawings. In addition, material lists for fire protection, domestic water, sanitary sewage, and construction air system modifications were completed.

3.2.4.4 4Q08

In December, discussions on an EPC contract between Dominion and GEH were suspended and Dominion initiated a competitive process to select a nuclear technology vendor.

Dominion, GEH, and Bechtel continued to respond to NRC RAIs and evaluate impacts to the COLA from changes associated with Revision 5 of the DCD. The first revision to the COLA (COLA submission 2 and 3) was submitted to the NRC in December.

The NRC completed the Draft Environmental Impact Statement (DEIS) in December. The 6-month comment period was scheduled to end in June 2009, with issuance of the Final EIS expected from the NRC in December 2009.

Efforts continued to integrate the ESBWR engineering and site engineering schedules. Delays associated with the ESBWR engineering were noted to have a negative impact on site engineering progress. Examples of site engineering accomplishments during this period included completion of preliminary detail design for the fuel oil storage tank foundations and station water intake structure, issuance of specifications for intake building heating, ventilation, and air condi-

tioning (HVAC) and the makeup demineralizer plant, and participation in a state agency in-stream flow incremental methodology meeting held at North Anna.

A number of "90 percent commercial packages" were completed by Bechtel and provided to Dominion for review, including those for fire protection and domestic water system modifications, new buildings, sanitary sewage, and construction air system modifications.

3.2.5 Significant Activities — CY 2009

3.2.5.1 1Q09

Dominion, GEH, and Bechtel ceased efforts to integrate the ESBWR engineering and site engineering tasks.

Efforts to respond to NRC RAIs and prepare changes to various COLA packages continued. The impacts to the COLA from the changes associated with planned DCD Revision 6 were also evaluated.

Site engineering activities were "re-baselined" during this period to be consistent with Dominion's EPC competitive bid process. As a result, activities shifted from site-specific ESBWR engineering to support of environmental permits. Site engineering activities completed during this period included the preparation of the embassy gate specification for the new security building, issuance of the "90 percent design package" for storm water alterations, and submission of preliminary input to the Joint Permit Application alternatives analysis.

3.2.5.2 2Q09

During the second quarter of 2009, Dominion performed a QA audit of Bechtel. In addition, revisions were completed to the Quality Assurance Program Plan to implement NQA-1-1994.

Dominion, GEH, and Bechtel participated in the first Advisory Committee on Reactor Safeguards (ACRS) subcommittee meeting for the North Anna Unit 3 COLA.

Preparation of responses to NRC RAIs and development of COLA change packages continued during this period. Site engineering activities included the issuance of specifications for storm water alterations pump and controls, the communication tower, and a diesel generator.

3.2.5.3 3Q09

Revision 6 of the ESBWR DCD was submitted by GEH to the NRC on August 31. The SER with open items for all chapters was issued on August 7.

Dominion, GEH, and Bechtel participated in additional ACRS subcommittee meetings for the North Anna Unit 3 COLA. In addition, work continued to address NRC RAIs and prepare COLA change packages.

Among the site engineering highlights was the development of draft design calculations for numerous features, including the oil/water separator modification, manhole designs for reserve station service transformer routing, and the thrust block design for fire water piping.

3.2.5.4 4Q09

During this reporting period, Dominion and Bechtel began preparation of standard R-COLA change packages necessary as a result of the issuance of Revision 6 to the DCD. Work also continued to address NRC RAIs.

Dominion and Bechtel provided support to help resolve NRC concerns regarding the planned use of fiberglass reinforced piping for the underground plant service water system.

The ACRS review of the SER with Open Items was completed on November 4, with no significant concerns noted.

Site engineering tasks continued, with completed actions including the issuance of specifications for steel frame buildings and the motor fuel storage and dispensing facility.

3.2.6 Significant Activities — CY 2010

Preparation of standard R-COLA change packages and responses to NRC RAIs continued during the first quarter of 2010. Dominion and Bechtel also participated in a meeting with current and new NRC project managers to facilitate smooth transition of ongoing NRC review activities.

Site engineering activities included further progress on developing the earthwork commercial package and safety-related specification for trenching and backfill in the flood protection dike.

In February 2010, NRC issued its Supplemental Final Environmental Impact Statement for the North Anna Unit 3 COLA that incorporated ESBWR technology.

On May 7, 2010, Dominion announced the selection of the Mitsubishi US-APWR for the proposed Unit 3 at North Anna.

3.3 Project Management Approach and Controls

Based on experience from the Cooperative Agreement, this section describes the activities necessary to prepare a COLA and support the NRC review and hearing.

3.3.1 Project Formation Activities

Project formation activities to begin a COL project include:

- **Make decision to pursue new nuclear generation as an option**. This is a business decision that would generally occur in advance of the decision to form a COL project- or in North Anna's case, prior to the decision to form the ESP project.

- **Perform site selection study**. The site selection study must satisfy the requirements of 10 CFR 51, 10 CFR 52, and NUREG-1555 (Section 9.3). Use of the "Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application (Siting Guide)," published by the Electric Power Research Institute in March 2002, is recommended. Dominion's site selection study can be found on the DOE website at: http://www.nuclear.energy.gov/np2010/espStudy/espStudyDominion.pdf.

- **Obtain project funding.** Project funding would be obtained by the entity forming the COL project in accordance with its normal business practices.

- **Select the project team**. This includes in-house personnel, consultants, and contractors. Particular attention should be paid to the selection of the specialty consultants and contractors for activities that may be needed to prepare the COLA, including subsurface investigation, geologic field investigations, geotechnical engineering, probabilistic seismic hazards analysis, hydrological evaluations, environmental investigation, legal, and document editing and publication.

- **Select the reactor design that will be used in the COLA**. Depending on which reactor design is chosen, information and support from the reactor vendor will be needed to support preparation and review of the COLA.

- **Prepare project procedures and programs**. These will include the quality assurance program, project execution plan, engineering procedures, licensing and document control procedures, etc.

- **Develop the work breakdown structure, detailed project schedule, and cost estimate**. A project work breakdown structure should be established that is consistent with the various parts, chapters, and sections of the COLA.

  Next, a detailed, resource-loaded project schedule should be created. The activities, durations, and resource estimates should be prepared with direct input from project personnel and should consider lessons learned, RAIs, and experience from previous COL projects. The schedule should be prepared at the section level of the COLA. The activities necessary to prepare each "X.Y" section of the COLA should be identified and resource-loaded in the project schedule. For some sections (particularly SSAR Sections 2.4 and 2.5), the schedule should be further broken down to the "X.Y.Z" level. Typical schedule activities to prepare a COLA section include:

  — **Collect data.** Gather information through internet searches, contacts with agencies and organizations, and requests issued to the reactor vendor or other team member companies.

  — **Conduct pre-job briefings**. Appendix 2 provides a suggested outline for a pre-job briefing which has been adapted from the Author Presentation approach used for the North Anna COL Project. Pre-job briefings should be held early in the effort to prepare the section and can be conducted via meeting, conference call, video conference, webcast, etc. If significant questions and/or data gaps are noted during the pre-job brief, consideration should be given to conducting a follow-up briefing to ensure concurrence with the path forward once the information needs are resolved.

  — **Perform detailed calculations, analyses, and engineering design activities**. Developing the various sections of the COLA will involve a significant amount of supporting engineering and analysis work. Appendix 3 lists many of the types of activities which can vary from project to project. The schedule should show the origination, independent review, and approval activities for each product.

  — **Prepare draft section**. Draft sections should include not only the text, tables, and figures that will be placed in the COLA, but also the supporting regulatory conformance tables and validation package. Any open items should be clearly identified for later resolution.

  — **Perform licensing, legal, management, and coordination reviews**. It is important to perform a full review as draft sections are issued in order to avoid editorial delays as deadlines approach.

  — **Resolve review comments**. Comments should be addressed and their resolution reviewed with the commenter to confirm that the comment was correctly understood and dispositioned appropriately. Depending on the project's quality assurance requirements, these comments and their resolution may need to be fully documented and archived.

  — **Issue final section**. Issuance of the final section should be in the form of a publication-ready document and supporting materials, including conformance tables, validation package, and identification of any open items. This final document package will most likely be a project quality assurance record.

  The schedule should also identify the following activities:

  — **Team reviews of compiled chapters**. After the final versions of all sections of a

chapter are completed, a team review of the compiled chapter should be performed.

— **Page-turn reviews**. Once all chapters and parts have been completed, "page-turn" reviews of the complete, compiled COLA should be performed.

— **Pre-application interactions with NRC and state and local agencies**. The NRC affords potential applicants the opportunity for interaction prior to assuming the more formal status of "applicant" and the constraints that are imposed by the governing regulations. Potential applicants should take full advantage of the opportunity. Similarly, the pre-application period offers the opportunity for early interaction with state and local agencies in an informal manner that will serve the applicant well during the more formal licensing process. In particular, early consultation with state agencies concerning the proposed cooling water systems, aquatic impacts, and process for obtaining related certifications under the Clean Water Act and Coastal Zone Management Act should be pursued.

— **Schedule Critical Path**. Particular attention should be paid to the critical path and near-critical paths to ensure the activities, durations, and logic ties are well understood and accurately reflected in the project schedule. Depending on the project, critical and near-critical paths could include:

  — FSAR Section 2.5, including the subsurface investigation, laboratory analyses, and the numerous geotechnical and seismic analyses.

  — FSAR Section 2.4, including the subsurface investigation, collection of groundwater data, and the hydrological evaluations.

  — FSAR Section 2.3 (and the corresponding ER section) regarding the atmospheric dispersion analyses, including the collection and verification of onsite meteorological data and the dispersion analyses.

  — Cooling water sections for the environmental report, including the evaluation of alternatives, conceptual design and analysis, and evaluation of impacts.

  — Development of the plot plan.

3.3.2 Application Preparation

All work to prepare the COLA should follow the detailed project schedule. Good practices are identified below.

- **Regulatory Conformance**. The COLA should be prepared to conform to applicable NRC regulations and guidance. Any deviations from these guidance documents should be identified and fully justified. Lessons learned and RAIs from previous ESP and COL projects should also be specifically considered during section preparation. NRC guidance documents applicable to parts of the COLA include:

  — Part 1* – General and Administrative Information; Regulatory Guide 1.206.

  — Part 2 – Final Safety Analysis Report (FSAR); Regulatory Guide 1.206, NUREG-0800, and other Regulatory Guides.

  — Part 3 – Environmental Report; NUREG-1555, Regulatory Guide 1.206, and other Regulatory Guides.

  — Part 4 – Technical Specifications; Regulatory Guide 1.206, NUREG-0800, NUREG-1555, and other Regulatory Guides.

— Part 5 – Emergency Plan; Regulatory Guide 1.206 and other Regulatory Guides.

— Part 7 – Departures Report; Regulatory Guide 1.206 and other Regulatory Guides

— Part 8 – Security Plan; Regulatory Guide 1.206 and other Regulatory Guides.

— Part 10 – Tier 1/ITAAC; Regulatory Guide 1.206 and other Regulatory Guides.

*NOTE: Early COLA formats developed by industry envisioned different numbers of COLA parts with most technologies settling on 10 or 11 parts. In an effort to maintain consistency between technologies, the industry elected to maintain a consistent numbering scheme for each part. However, in some COLAs, like North Anna's, not all parts were used. For example, Part 6 was reserved for Limited Work Authorizations (LWAs) which was not included in the North Anna COLA. The complete list of COL parts is shown in Appendix 4.

- **Pre-Application Interactions**. The project team should expect and fully support pre-application interactions with the NRC Staff and their contractors. For the North Anna COL project, Dominion had multiple contacts with the NRC Staff prior to submitting the COLA. Beginning with direct conference calls and meetings at NRC headquarters for process inquiry and notification of the proposed action and intended efforts, Dominion also met with other interested industry representatives at forums and meetings. Of utmost importance was the ever-open offer by Dominion to invite and host NRC visitors to the North Anna site and/or local support offices. Face-to-face interactions went a long way to support communications and understanding of meeting regulatory needs. The NRC also visited the North Anna region to meet with other state agencies, local government representatives, and local community associations. This facilitated the open-to-the-public process, was effective in delivering information about the NRC licensing process, and left no surprises as to Dominion's intentions and analyses.

- **Weekly status conference calls**. Weekly conference calls should be conducted with key members of the project team, subcontractors, and consultants to review critical issues, schedule progress, action items, interface issues, upcoming activities, etc. Separate weekly review meetings on specific application sections (e.g., FSAR Section 2.5) are also recommended to allow for further detailed discussions outside the weekly project status meeting.

- **Pre-job briefings**. Pre-job briefings should be held for each COLA section. Efforts should be made to ensure that the section preparation effort directly follows the pre-job briefing. This will maximize the benefits of the discussions and the exchange of ideas and approaches from the pre-job briefing. Additionally, briefings should be used for complicated work activities.

- **Document publication**. Several activities should be completed early in the effort, including selection of the software that will be used to publish the COLA, creation of the Writer's Guide and author training, and creation of the electronic template(s) for the application. The document publication function should also serve as the single source for authors to acquire COLA content.

3.3.3 Support of NRC Review and Hearing

Following acceptance of the application for review, the NRC will publish a schedule outlining the major milestones for the safety and environmental reviews. Good practices to support the NRC review effort and hearing include:

- **Frequent and routine communication**. Conference calls and meetings should be used to ensure good communication with the NRC Staff. A significant amount of coordination with state and local agencies will also be needed, particularly if

these agencies are reviewing related permit applications (e.g., water permits, Coastal Zone consistency certification).

- **Responding to RAIs and submitting application revisions**. Procedures and processes for efficiently preparing responses to NRC RAIs and application revisions should be developed and implemented before the application is submitted. The NRC typically expects that responses to RAIs will be submitted within 30 days in order to maintain their published review schedule. RAI responses should include an identification of any corresponding application changes that will be incorporated into the COLA in a later revision.

- **Atomic Safety and Licensing Board (ASLB) Questions**. Beyond the RAIs issued by NRC Staff to support their safety and environmental reviews, the ASLB will also issue questions requesting coordinated responses from the applicant and NRC Staff. The effort to respond to ASLB questions should not be underestimated and will likely require access to numerous technical experts, including experts that may have completed their work several years earlier and are no longer actively supporting the project.

3.3.4 Expected Schedule

Expected schedule durations for a COL project are as follows:

- 6 to 9 months for prerequisite activities (decision to proceed, siting study, project funding).

- 15 to 24 months for project formation and preparation of the COLA. This will vary, depending on site- and project-specific issues.

- 42 to 48 months for the NRC review and approval, including 12 months for hearings.

3.3.5 Cost Summary

Dominion consistently managed project costs within the bounds of the budget established by DOE. Beginning with the first quarter of 2006, each quarterly report provided to DOE included a task-by-task summary status of the total project earned value performance. In addition, each quarterly report contains a table summarizing the status of the approved spending plan for the Cooperative Agreement along with the costs incurred to date. As an example, the last quarterly report details an approved total (i.e., DOE funds combined with Dominion cost share) spending plan amount of $176,169,956, with an actual spent to date (based on invoices) of $149,312,835. Additional financial performance information can be found in the Cooperative Agreement Quarterly Progress Reports provided by Dominion to DOE.

Compliance with the requirements of DOE Order G 413.3-10, Earned Value Management System (EVMS), was accomplished early in the project, with Dominion, GE, and Bechtel providing data by January 2006. Beginning with the first quarter of 2006, each Cooperative Agreement Quarterly Progress report contained an updated table detailing, on a task-by-task basis across seven tasks, the following information:

- Original and current budget hours

- To-date scheduled, actual, and earned hours

- To-date percent complete

- Schedule and job hour performance

- Original and current budget cost

- To-date actual and earned cost

- Estimate at completion- Gold Card and Work Breakdown Structure

- Cost performance- budgeted cost for work performed/actual cost of work performed

- Schedule and cost variance
- Variance at completion- Gold Card and Work Breakdown Structure

Project performance based on EVMS summary data is provided in the quarterly progress reports provided to DOE.

4. Overall Lessons Learned and Experience

The Cooperative Agreement scope included the development of a COLA and site engineering at a site with an approved ESP. This post-ESP approach to obtaining an NRC license to build and operate a nuclear plant is a new method meant to streamline the review and approval process. In addition, few applications for new nuclear plants have been filed in the United States over the past 20 years. As a result, the effort to obtain a license to build/operate North Anna Unit 3 presented a number of learning experiences that may facilitate future nuclear plant licensing efforts. These observations and recommendations are characterized in the tables that comprise Section 4 as "Opportunities to Enhance the Regulatory Process" (Table 1), "Lessons Learned" (Table 2), and "Benefits of the North Anna ESP in Developing the COLA" (Table 3).

Part 1 of Table 2 lists lessons learned that may be important to future COL project management personnel. Several lessons learned are considered to be best practices for future ESP and COL projects. These best practices fall into the general category of up-front planning. Author presentations (also referred to as pre-job briefings for section development) to the project's leadership team were found to be an excellent method for establishing section strategies before significant efforts were expended resulting in redirection and/or rework. Pre-job briefings on individual work activities (e.g., prior to the start of a complicated analysis) were used to discuss the effort and resolve issues before work began. NOTE: Although the North Anna project originally distinguished between Author Presentations completed for the development of each section and pre-job briefings for individual work activities, the pre-job briefing (PJB) terminology is currently being used by Dominion.

Another key lesson learned pointed to the importance of holding frequent coordination meetings to ensure good communication among all project participants, particularly when multiple COL sections addressed common issues.

Of note is a lesson learned that highlights the need to provide extensive training to the team to emphasize the quality of the work. Development of the COLA is a complex and rigorous effort so the quality of work must be continually emphasized to all project participants regardless of their prior experience.

Another dominant theme in several of the lessons learned centered on the need to schedule the project activities and make systematic progress to avoid the "bow wave" of section preparation and review at the end of the effort. Also, author presentations or pre-job briefings should be shown as a scheduled project milestone for each section of the application.

Part 2 of Table 2 lists lessons learned that may be important to future COLA author and licensing personnel.

Preparation of the North Anna COLA began over 2 years before Regulatory Guide 1.206 was issued in June 2007. Draft Guide DG-1145, Proposed Revision 0 was published in September 2006 and was used until Regulatory Guide 1.206 was issued. Thus, the project encountered numerous issues regarding basic licensing principles (e.g., what information must be submitted to satisfy the regulations and the NRC Staff's review) starting in April 2005 and continuing through September 2006 when DG-1145 was issued.

Certain important lessons learned were identified. For example, licensing personnel should plan to have "page turn" reviews of the entire document prior to

submittal. These reviews were found to be most effective in ensuring consistency among related sections, consistency of terminology, etc. A minimum of 2 to 3 weeks' duration should be allowed for the "page turn" reviews.

Part 3 of Table 2 lists lessons learned that were captured over the course of the work that may be important to future COLA document production personnel. Lessons learned in this area included technical editing considerations, preparation of a Writer's Guide, and electronic formatting.

Part 4 of Table 2 lists lessons learned that were unique to developing a COLA for a site with an ESP. Lessons learned in this area included regulatory guidance, the plant parameter envelope (PPE) approach, new and significant information, and the need for guidance on the format for a COLA Final Safety Analysis Report (FSAR) that needs to incorporate the content of an ESP application Site Safety Analysis Report (SSAR) by reference.

Table 1. Opportunities to Enhance the Regulatory Process Based on Lessons Learned

No.	Background/Description	Lessons Learned and Enhancement Opportunities
1	During the COLA review process, it was evident that state and local regulatory agencies were becoming more familiar with the COL process than they had previously been with the ESP process. Although these agencies are becoming more attuned to the NRC Part 52 process, some of the environmental permitting processes can still take longer than expected and impact the project schedule. Decisions have to be made by the project regarding when to initiate communication on permitting actions.	ESP and COL applicants should assume that state and local regulatory agencies continue to need to become more familiar with the NRC nuclear licensing processes. **T**herefore, the project should be prepared to provide significant background education and support to the agencies. As the NRC has gained experience, it, too, has developed a more robust process of informing potential stakeholders when potential applicants identify their interest in a particular site. The DOE should continue to support and expand its public information initiatives related to new nuclear generation.
2	As part of an ESP application, the applicant has the option of including a "major features" emergency plan or a full and integrated emergency plan. Dominion included the "major features" option in its ESP application. The benefit of the major features approach has not been readily discernable. The option has been viewed by some as having no benefit, although it may have benefits for ESP applicants who select a greenfield site. The primary concern is that the same major features approved during the ESP stage are revisited in substantially more detail during the COL process. The resulting impression is that work is being done twice with little or no benefit.	Of the four ESPs issued to date, only two (North Anna Unit 3 [NA3] and Vogtle) have progressed significantly enough through the COLA process to evaluate the "major features" approach vs. the "full features" approach. NA3 selected the "major features" approach to addressing the Emergency Plan (EP), while Vogtle selected the "full features" approach. Based on the information from the RAIs issued by the NRC, there is little benefit to including a "major features" EP in the ESP application for applicants who do not select greenfield sites given that: (1) The number of EP-related RAIs issued to Dominion for NA3 at the time of the COLA was four times the number issued to Vogtle. This indicates that a much greater degree of finality was achieved with the "full features" EP. (2) The number of EP-related RAI questions issued to Dominion for NA3 at the time of the COLA (64) was greater than the average of the applicants through the summer of 2010 (~57), not including the applicants with ESPs for greenfield sites. This indicates that the inclusion of the "major features" EP did not significantly affect "finality" with respect to the EP. However, based on the larger number of RAIs for Lee (greenfield site), it appears that, if the applicant has used the ESP approach and included a "major features" EP, the number of RAIs at the time of the COLA may have been reduced, supporting the supposition that the "major features" EP would be beneficial to a greenfield site.
3	The NRC has no guidance regarding the use of data acquired from the internet.	Dominion chose to attempt to verify internet data sources that were used in the SSAR (ESP application) for those sections that are quality-related. This turned out to be only four sets of data. Weather data obtained from the National

Table 1. Opportunities to Enhance the Regulatory Process Based on Lessons Learned

No.	Background/Description	Lessons Learned and Enhancement Opportunities
		Climatic Data Center was validated. One set of internet data from the Coastal Services Center department of NOAA could not be validated. This same lesson-learned was identified by the NRC's Advisory Committee on Reactor Safeguards (ACRS). No action by the NRC to address this topic has been identified. DOE support to encourage NRC to develop such guidance would be appropriate.
4	At the time of the ESP application, the "Interim Staff Guidance (ISG) on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures" was not available. DC/COL-ISG-7 was issued final on June 23, 2009.	With the issuance of DC/COL-ISG-7, the NRC has made it clear what information is needed in ESP or COLA. The NRC position is that the snow loads for safety-related structures should be based on the 100-year snowpack or snowfall, whichever is greater, recorded at ground level, plus the weight of the 48-hour winter probable maximum precipitation (PMP) at ground level for the month corresponding to the selected snowpack. A COL applicant may choose and justify an alternative method for defining the extreme load combination of maximum snow load and winter precipitation load by demonstrating that the 48-hour winter PMP could neither fall nor remain on the top of the snowpack and/or building roofs because of the specified design of the roof.
5	Extensive back-and-forth correspondence was required to resolve the single bounding roof load (maximum roof load) defined in the Design Certification Document (DCD) with the site-specific winter precipitation characteristics that are inputs to the actual roof loads (i.e., 100-year snow pack, maximum winter precipitation, etc.).	Require a DCD to provide a composite breakdown of the assumed winter precipitation load components, i.e., assumed site parameters (consistent with the ISG-7 requirements) that are used as inputs for the maximum roof loads in design.
6	Review the development and study of long-term weather cycles for periods of up to 100 years. The NRC's ACRS has commented that "The staff has made appropriate modifications to the Standard Review Plan to recognize that there are cycles in the weather. Such cycles are especially well known for the east coast of the United States. The staff has made contact with knowledgeable technical societies, will be attending pertinent scientific conferences, and is proposing research studies of trends in the frequencies and intensities of hurricanes."	In brief, the ACRS is concerned about the potential impact on global warming as it relates to nuclear safety and the environment and is encouraging the staff to develop a regulatory position. Future COL applicants should address climate issues based on site-specific climatology. The DOE should support the NRC's efforts to develop a position on this subject so that it can be appropriately and consistently addressed in future permit and license applications. Since this time, the NRC has issued NUREG/CR-7004, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane- Borne Missile Speeds for Nuclear Power Plants," Draft, December 2009, and Draft Regulatory Guide DG-1247, "Design-

Table 1. Opportunities to Enhance the Regulatory Process Based on Lessons Learned

No.	Background/Description	Lessons Learned and Enhancement Opportunities
		Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," August 2010.
7	NRC requirements in the Code of Federal Regulations are written in a concise manner. The NRC expands on those requirements by providing guidance illustrating acceptable ways to meet the requirements. It is not unusual for permit and license applicants to be similarly concise in their submittals. However, in such instances, the NRC may issue a request for additional information (RAI) soliciting the details and descriptions that "tell the story."	COL applicants should be proactive in providing information at the outset sufficient for the NRC to make its required findings. In addition, applicants need to be mindful that the NRC feels a strong obligation to communicate openly with the public regarding its activities. The additional effort by applicants to "tell the story" in COLAs as they are prepared will serve to preclude a substantial number of RAIs. As the NRC continues to update regulations and guidance, additional information may be necessary to complete the story. Although the North Anna COLA received a small number of ER RAIs, Turkey Point's ER was more detailed because they learned by reviewing all previous RAIs what level of detail is currently expected by the NRC.
8	Although the NRC is the primary licensing authority for a COL, it works in coordination with other federal, state, and local government agencies to discharge its responsibilities.	COL applicants must be mindful that regulatory agencies other than the NRC will have an impact on the review and approval of the application. Applicants should be proactive in identifying and interacting with those agencies early in the licensing process. The interactions should address both the applicant's business goals, a description of the NRC regulatory process, and specific areas where state and/or local agency consultation, certification, or approval will be required.
9	The NRC held a pre-application public outreach meeting on October 24, 2007, in Louisa County to inform the public of the expected submittal by Dominion of a COLA later that year and to provide the public with information on the NRC licensing process. The NRC also conducted pre-application site visits to assess Dominion's data collection techniques and quality processes. Other NRC public meetings in Louisa County included an Environmental Scoping meeting on April 16, 2008, and a Draft Supplemental Environmental Impact Statement (SEIS) public meeting on February 3, 2009.	Pre-application visits by the NRC were beneficial to the NRC, Dominion, other affected agencies, and the public. The NRC continues to develop alternative approaches to enhance and refine its pre-application interactions based on schedule and other considerations. These efforts should include pre-application interactions on environmental and safety review topics. The DOE should continue to encourage and support NRC efforts in this area. The comprehensive Instream Flow Incremental Methodology (IFIM) study was of great interest because the study scope included the river recreational impact and the Lake Anna water level impacts on shoreline and wetlands.
10	The NRC's technical review of the COLA was divided into safety and environmental reviews. The NRC organization was structured similarly,	In Dominion's experience, the RAI process implemented by the NRC on safety issues was efficient and effective. It provided early opportunity to discuss the

Table 1. Opportunities to Enhance the Regulatory Process Based on Lessons Learned

No.	Background/Description	Lessons Learned and Enhancement Opportunities
	with lead safety and environmental project managers. This resulted in different processes to request additional information. On the safety side, the NRC first provided RAIs to Dominion in draft form and afforded Dominion the opportunity to discuss the draft RAIs, including an assessment of the time required to respond. On the environmental side, the NRC process was essentially the opposite: NRC first issued the formal RAI and then afforded Dominion the opportunity to discuss and clarify the RAIs.	NRC's concerns when the questions were in a formative stage. As a result, when the NRC sharpened its focus in the final version of the RAI, Dominion was generally able to provide a timely response because it better understood the issue and the NRC better understood what the applicant was capable of providing. On several occasions, the need for the NRC to actually issue the RAI was eliminated. This approach proved superior to the process used for environmental RAIs. Environmental RAIs were issued without notice in final form, the NRC was less willing to revise the RAI once issued, and any dialogue regarding the question took place "on the clock," i.e., within the time period established by the NRC in the transmittal letter to respond. Near the end of the technical review, NRC management acknowledged the difference in the processes and designated one project manager as overall lead to standardize the process. Since then, the NRC has continued the policy of an overall project lead, but because of the continuing organizational alignment within the NRC and subject matter differences, the tendency for the safety and environmental RAI process to diverge remains. ESP and COL applicants should be mindful of this tendency and take appropriate actions, when necessary.
11	If a COLA references an ESP, 10 CFR 51.50(c)(1) requires that the COLA ER include "any new and significant information for issues related to the impacts of construction and operation of the facility that were resolved in the early site permit proceeding."	Specific regulatory guidance to implement the "new and significant" requirements of 10 CFR 51.50(c)(1) has not yet been issued by the NRC. As part of Dominion's efforts to prepare the North Anna COLA, a rigorous, multi-step process was implemented to identify new and significant information for inclusion in the COLA ER. Dominion's "new and significant" process met the NRC's expectations for the information that must be included in the COLA ER. In fact, the NRC accepted, and complimented, Dominion on its thorough and rigorous approach. The NRC issued the Final SEIS to Dominion on March 19, 2010. Specific and clear guidance, especially for addressing time sensitive information, needs to be issued by the NRC for this challenging process.
12	NRC guidance is now more robust and reflects the Part 52 ESP and COL licensing process. The ESP process has been demonstrated, and the NRC	Some efficiencies are being realized as a result of the first three ESP applications piloted under DOE's NP 2010 Program with the review times decreasing from 50

Table 1. Opportunities to Enhance the Regulatory Process Based on Lessons Learned

No.	Background/Description	Lessons Learned and Enhancement Opportunities
	has worked to improve the efficiency of its review process. Now that the COL process has also been demonstrated, further efficiencies will continue to take place. Reduced review times should start to be realized now that COL applicants can incorporate site-specific and design information by reference under the Part 52 guidance.	months to 37 months. The DOE should continue to encourage and support the NRC's efforts to further improve the efficiency of its safety and environmental reviews and, thus, reduce the resources and time required to review ESP and COLAs.
13	Although Dominion changed reactor technologies before progressing to the hearing stage, the question of whether efficiencies could be gained in the mandatory hearing process is still an issue. A mandatory hearing is required under current NRC regulations. During the North Anna ESP application process, the hearing was uncontested, all contentions having been previously dismissed by the hearing board. The final safety and environmental documents were issued by the NRC Staff at the end of 2006; the ESP was issued in November 2007. No changes to 10 CFR 2.104 have been made as of September 2010.	In April 2007, the NRC COL Review Task Force, headed by then Commissioner Merrifield, presented several recommendations to the Commission to improve the licensing process, including recommendations specifically targeting the mandatory hearing (Reference: COMDEK-2007-001/COMJSM-2007-001). The task force recommended that the Commission revise 10CFR 2.104 to reflect a policy that a contested hearing for a COLA fulfills the requirement in Section 189a.(1)(A) of the Atomic Energy Act that "the Commission shall hold a hearing ... on each application for a construction permit ...." Under the recommended policy, there would be a hearing on uncontested issues only if there were no hearing on contested issues; and any hearing on uncontested issues would be conducted by the Commission itself. The task force also recommended that the Commission request legislative authority from Congress to eliminate the statutory requirement for a mandatory hearing (i.e., a hearing on uncontested issues). On June 22, 2007, the Commission approved the task force proposal that the Commission itself conduct the mandatory hearing (in the absence of legislation eliminating the requirement for a hearing even if a request for hearing is not made). The Commission continues to have the authority and discretion to request that the Atomic Safety and Licensing Board Panel (ASLBP) conduct a hearing in a particular case. The NRC's Office of General Counsel was directed to prepare a plan for the conduct of these hearings by the Commission modeled after the Browns Ferry restart meeting and the Calvert Cliffs and Oconee license renewal meetings. The Commission also approved obtaining legislative authority from Congress to

Table 1. Opportunities to Enhance the Regulatory Process Based on Lessons Learned

No.	Background/Description	Lessons Learned and Enhancement Opportunities
		eliminate, from Section 189a of the Atomic Energy Act, the statutory requirement to conduct a hearing if no one has asked for a hearing. A significant schedule reduction could be realized by eliminating the mandatory hearing, when appropriate, or conducting the mandatory hearing in the manner recommended by the task force. The DOE should work with the NRC and Congress to support these proposed enhancements to the NRC regulatory framework.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
PART 1 – LESSONS LEARNED FOR PROJECT MANAGEMENT		
1-1	Strong Project Management leadership is essential throughout the COLA project and especially during the planning stages and initial startup.	Project Management must take the lead from the beginning and all personnel must buy into the plan, including schedule, licensing approach, document control, information exchange, division of responsibilities, etc. Although some changes in leadership and personnel are inevitable, continuity and consistency should be maintained to the greatest extent possible.
1-2	Much of the float on some front-end activities of COLA development was lost because of lack of discipline in maintaining the project schedule plan, which contributed to the bow wave of activities in the latter half.	Each organization must adhere to the schedule more rigorously from the very beginning of the project. All personnel must understand that "schedules are real." Any float used on the front end of the schedule will cause problems later due to the bow wave effect.
1-3	The process to develop a COLA was effective but overly complex, leading to multiple meetings on the same subject, discussions off topic, and COLA package documentation that was difficult to follow.	COLA development is a complex process with each step in the process requiring guidance in the form of work instructions, automated document file control systems with supporting training, orderly meetings, and conference calls. Project management also plays a key role in limiting off-topic discussions that otherwise impact meeting efficiencies.
1-4	Development of design documentation and environmental input was sometimes not adequately coordinated.	The information put in the environmental report was sometimes not adequately coordinated with design and analysis. Appropriate schedule links must be identified to ensure that inputs needed for environmental assessments are conducted in the appropriate sequence. Internal reviews should be conducted of all work that involves engineering and environmental assessments such that environmental considerations are appropriately addressed in the design documents (e.g., site layout plans and power line routing).

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
1-5	Two schedules were maintained—one for design/engineering work and one for licensing activities. With use of separate schedules, it was unclear why activities were needed at specific times and how change in finish date on one schedule affected completion of activity on the other schedule, even though links identified and used in the P3 schedule indicated that delay in finish was reducing float.	Using an integrated schedule provides better project control and understanding of interfaces required in COLA development by all parties. The detailed project schedule should specifically include each calculation/analysis that must be performed to support the application, including the origination, checking, and approval steps.
1-6	Durations of schedule activities provided/ allowed were sometimes too long to judge the probability of meeting the Early Finish date. Some activities had descriptions such as “Review and Issue” or “Prep and Issue” that included a number of steps.	Experience has shown that durations longer than 3 weeks do not provide a sense of certainty in meeting the expected finish date. Activities with long durations should be split into steps/tasks with smaller, more measurable durations. Preparation of a section could be split into subsections, drawings into sheets, etc. To aid in forecasting/ tracking an activity, each step/ reviewer should have a separate activity, including internal reviews prior to external reviews. The easier it is to identify the person/ group tasked with an action, the easier it is to status a schedule.
1-7	The schedule for COL sections did not always define activities for the section in a chronological manner.	All Requests for Information (RFIs) and engineering/calculations supporting a section’s development should be grouped at the beginning of a section schedule to lend focus to those items needed prior to section development. If the RFIs and engineering activities are scattered among the section activities or placed after section development activities, the ability to focus on these predecessor activities is lost.
1-8	The project schedule was created based on detailed discussions with authors/supervisors and attempted to show logic ties from one section to another. Despite this effort, some inputs/output relationships on the schedule were not properly captured.	Additional emphasis should be placed on front-end scheduling to capture all section schedule logic ties. This is a significant effort.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
1-9	Two utilities, Dominion and Entergy, planned to write COLA based on using the ESBWR technology. These organizations started meeting to discuss issues and share resources and experience. Both the technology vendor and the utilities benefited from this informal working group.	The working meetings were started by the utilities and GE Hitachi Nuclear Energy (GEH) because it made sense for everyone to benefit from years of operational program experience. These eventually evolved into the current Design-Centered Working Groups (DCWGs). In conjunction with the Nuclear Energy Institute (NEI) COL Task Force recommendations and the NRC's Regulatory Issue Summary 2006-06 on May 31, 2006, the design-centered review approach (DCRA) and the DCWGs were formalized.
1-10	Coordination, primarily on environmental issues, between the NRC, state agencies, and other environmental permitting agencies is critical. Skilled and dedicated resources in the applicant/applicant contractor organization facilitate this process because each regulatory body is the centered around its own processes and regulations. During meetings between the NRC and state regulating agencies on environmental quality issues, the NRC needs to have a better understanding of the state's role.	Knowledgeable individuals should be sought and empowered to work with the NRC as well other federal, state, and local regulators on environmental issues. These same individuals are critical when interfacing with the public, which more readily relates to environmental issues than to more esoteric nuclear safety issues. Future projects should plan on a very proactive, early engagement with state and local agencies and concerned citizens. The NRC should consider initiating pre-job briefings with state agencies so that meetings held later between the NRC and these agencies can be conducted more efficiently.
1-11	Close coordination with the NRC project manager facilitated the ACRS meetings. Both parties─Dominion and the NRC Staff─were aware of the information being provided by the other.	All COL applicants should maintain close coordination with the NRC Staff.
1-12	A licensing "core team" evolved and became a critical element in ensuring understanding and consistency within the COLA.	Establishing a licensing core team that includes highly capable licensing experts from both the applicant and applicant's contractor organizations is critical to development of a complete and quality COLA. This was identified as a **Best Practice**.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
1-13	A formal process (e.g., using RFIs) was needed between organizations to acquire information for COLA development. The process is necessary to ensure that accurate and complete information is being used to develop COLA content. Typically, formal processes for transmitting quality technical information can be slow, especially when handling a large volume of information in a limited time.	The process for transmittal of information needed for COLA development should be reviewed prior to use both to familiarize the project team with the process and to ensure that information can be transmitted expeditiously to support the COLA preparation schedule.
1-14	Changes in site layout, relocation of structures, etc., can have significant and cascading effects on development of COLA sections. The final configuration of the site layout is a critical component of the ESP/COLA. This design product serves as the basic input to multiple analyses performed in support of the license application. Such analyses include dose calculations, storm water drainage plans, flooding analyses, and cooling tower drift analyses. Thus, the site layout must be frozen at the earliest possible date within the project execution schedule. For the Dominion COL project, the site layout was not frozen until late in the project schedule because the reactor technology plot plan was in flux due to lack of design progress.	It is critical to come to early agreement on the site plan, including location of nuclear/turbine island complex and all yard structures. Site topography should be understood by all stakeholders. All stakeholders should be involved in this review. Emphasis must be placed on the importance of freezing the site layout early in the final project planning and schedule. All parties must establish and work to a clear milestone date for freezing the site layout.
1-15	The ER portion of the COLA must evaluate the impacts of construction on the site. The impacts include land use, water use, noise, air emissions, haul routes, barge locations, etc. The applicant and subcontractors are reliant on the reactor technology supplier (and their constructor) to provide construction facilities planning information to support the ER impact analyses. Experience on several COLA projects has shown that the reactor technology suppliers are not equipped to provide this information efficiently or on a timely basis to support the schedule. Preparing the ER suffers from receipt of late information from the reactor technology supplier or information that changes at a later time.	The project schedule should reflect receipt of the needed information from the plant constructor (or reactor technology supplier) at a very early stage. The applicant is advised of the importance of early receipt of this information, and should make every effort to expedite the information from the plant constructor on a timely basis.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
1-16	Relative location of cooling towers to plant facilities relies on many factors that should be considered early in the planning process.	An understanding of site wind and meteorological conditions (including prevailing wind; distance from electrical equipment and heating, ventilating, and air-conditioning (HVAC) intakes; and surrounding topography) is needed to properly site the plant cooling towers relative to the plant.
1-17	Author Presentations (or Pre-Job Briefings) were considered to be beneficial by most project participants.	Author Presentations should be continued and initiated as early as possible in the project's schedule. These presentations were felt to be one of the strengths of the entire program to produce the application. Author Presentations or a similar approach should be used to develop sound technical approaches for resolving all regulatory issues, site limitations, and engineering concerns early in the project. Including Author Presentations or pre-job briefings as milestones on the master project schedule was identified as a **Best Practice**. The Author Presentation process (using a "Basis Document" format) was employed for the North Anna COLA to confirm author buy-in, ensure that the review team agrees with the author's approach, and agree on section strategy prior to a large-scale investment in time.
1-18	Detailed planning and scheduling, action item lists, and weekly schedule meetings greatly aided in identifying problem areas and schedule impacts.	These activities should be continued and were identified as a **Best Practice.**
1-19	Throughout the document preparation, several project activities required pre-job briefings. These activities included complicated analyses such as the cooling water analysis, offsite dose analysis, and some of the geotechnical/seismic analyses.	The "pre-job briefing" process was identified as a **Best Practice**. See Table 6 for an example of subjects and discussion topics used in Author Presentations and pre-job briefings.
1-20	Most RAIs issued by the NRC were on a 30-day clock. A schedule template was used and enforced. Early discussions with NRC prior to issuance of RAIs was helpful. Also, strategy calls with Licensing and Engineering Subject Matter Experts (SMEs) held immediately upon receipt of RAIs to determine appropriate response strategy proved extremely beneficial.	A rigorous RAI process and schedule should be maintained.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
1-21	The resurgence of the nuclear industry and the ESP/COL permitting activities involves the use of engineers and scientists who may not have an in-depth exposure to the demands of creating a complex application with zero defects. Personnel resources for the work come from a variety of backgrounds and experience.	Significant training should be mandated for authors, checkers, licensing reviewers, etc., focusing on the need to prepare permit applications with zero defects. Project managers must fully recognize that not all project participants have the same level of experience, and many project participants may be working on their first NRC submittal of any magnitude.
1-22	Some section authors failed to identify all existing information, applicable regulatory requirements and guidelines, and their interface.	Institutionalize front-end planning requirements. The use of Author Presentations and pre-job briefings is very useful in identifying existing information and applicable regulatory requirements and guidelines.
1-23	Many issues need to be addressed in more than one section of the COLA, either the FSAR and/or the ER. Several team members felt that this could have been handled more efficiently. The way in which transmission systems was handled was cited as an example.	The approach (strategy) to be employed for these issues needs to be communicated clearly to each affected author. These common issues could have been the subject of additional Author Presentations to stress the themes or strategies to be employed in multiple affected sections.
1-24	Based on many different factors (including size of the engineering or licensing group, background, and experience) some of the sections in the COLA were assigned to off-project personnel.	At project inception, and periodically throughout the project, the team should re-evaluate the responsibility for application sections based on the experience of the individuals, workload, and other factors. The team should be ready to adjust. Formalized training should be developed for off-project personnel. The need for additional indoctrination and training should be continuously evaluated throughout the project.
1-25	A Level 3 schedule was created that identified dates by when first draft (Revision A) sections should be issued for review.	For a document of the size and complexity of a COLA, it is critical that the intermediate scheduled dates are met for each issue of the document's revisions. Delays in the preparation of the initial submittals serve to aggravate the "bow-wave" when too many sections must be reviewed and approved at the end of the schedule.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
1-26	Schedule activities for review and comment of Revision A sections should be tailored to the section content.	The project schedule should recognize that some sections require more extensive, longer reviews than other sections. All groups must exhibit higher discipline at the front end of the schedule so the "bow wave" effect can be avoided.
1-27	The time and resources necessary to support the NRC's pre-application audit were much greater than originally estimated. These efforts included advance communication and arrangements, site and area tours, travel by technical experts to the site to support the audit, etc.	Additional emphasis, planning, and resources should be implemented to support pre-application interactions with the NRC Staff.
1-28	The division of responsibility (DOR) between the reactor supplier (and its subcontractors) and the utility (and its site characteristics information support contractors) needs to be established early and clearly for each calculation that is a shared responsibility. Some calculations (e.g., offsite doses) need inputs from both sides (source terms from the reactor vendor and meteorological data from the utility), and either side can perform the calculation.	A clear DOR for each calculation is needed to establish the schedules for obtaining needed inputs and performing the calculations.
PART 2 – LESSONS LEARNED FOR AUTHOR AND LICENSING PERSONNEL		
2-1	Although there was an NEI COL Task Force, no NRC or NEI guidance was provided on the format for a COLA FSAR that needs to incorporate a DCD by reference. NuStart guidance on COLA FSAR format was not consistent with Dominion's format guidance.	Variations in FSAR format cause confusion for the NRC during reviews. The NEI should take the lead in reviewing the various R-COLA formats and S-COLA formats to standardize the best approach.
2-2	The approach to identifying conceptual design information (CDI) in each DCD is not standardized. A COLA FSAR needs to address CDI, but there should not be uncertainty in CDI in the DCD.	Uncertainties in the need for FSAR content due to the extent of CDI in a DCD cause confusion for the NRC during reviews. The NEI should take the lead in reviewing the various DCD formats for identifying CDI to standardize the best approach.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-3	On an existing plant site, the reference elevation and plan coordinate datum are established in the design bases documents and UFSAR. New construction is typically developed in the latest datum. Interfaces become an issue and can result in confusion and potential calculation errors and design inadequacies. Further, such issues could lead to use of more than one datum in the COLA and potential errors if a difference in elevations is not appropriately documented and reconciled.	Early identification of vertical and horizontal datum should be established for consistent use throughout the ESP/COLA development. The appropriate vertical datum should be identified for each elevation identified or the consistent use of a single datum ensured, making reference to alternate datum when referring to existing unit elevations as appropriate.
2-4	NRC requests for additional information (RAIs) on COLAs have generated the next level of detail required in a COLA.	An NEI process should be in place to review RAIs against the COLA content requirements in NRC Regulatory Guide 1.206 and identify the next level of detail being required by NRC reviewers for COLAs.
2-5	The ACRS presentation for the R-COLA was supported by subject-matter experts (SMEs) remotely using a conference call setup. Due to technical difficulties, the SMEs were muted and could not be heard when questions were directed to them.	The NRC should allow use of SMEs at remote locations to support the ACRS meetings due to the expense in traveling and the generally short amount of time that their area of expertise is needed at the meeting. Improved controls for audio equipment or upgrading to use of videoconferencing equipment would help to obtain the answers needed from the SMEs in real time and minimize expenses.
2-6	Little guidance was provided on which systems needed P&ID figures or the detail level required for P&ID figures for the systems.	Guidance is needed on which systems (or system classifications) require P&IDs in the FSAR and the level of detail required by system or system classification. This is an issue to be addressed for both DCDs and COLAs.
2-7	Preparation of the North Anna COLA began over 2 years before Regulatory Guide 1.206 was issued in June 2007. Draft Guide DG-1145, Proposed Revision 0 was published in September 2006 and was used until Regulatory Guide 1.206 was issued. Thus, the project encountered numerous issues regarding basic licensing principles, e.g., what information must be submitted to satisfy the regulations and the NRC Staff's review, during the time period from April 2005 through September 2006 when the DG was issued.	This was the result of the project being an industry first-of-a-kind effort in developing a COLA that references an ESP. Future COLA preparation efforts should take into account the schedule impact of changing regulations, standards, and guidance.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-8	A common issue found in early section drafts was that descriptions of the same information presented in multiple sections were not consistent—even when originated by the same author. Additionally, there were inconsistencies in descriptions between the FSAR and ER.	Training must be conducted for the author, checker, and licensing review responsibilities at the beginning of the project. The Style Guide must be published prior to any sections being written. Consistency issues and adherence to the Style Guide must be addressed during Author Presentations and pre-job briefings. One of the objectives of the final page-turn review is to check the entire application for consistency.
2-9	COLA changes were submitted to the client for Revision 1. The COLA changes were based on FSAR RAI responses and ESBWR DCD Rev. 5. In some cases, particularly for COLA changes associated with COLA FSAR RAI responses, the COLA FSAR change package mark-ups did not include a corresponding mark-up for the ER. A change package for the ER was submitted at a later time. The adverse impact was COLA changes that resulted in inconsistencies in the application that were not consistently tracked. A re-review of RAI responses and revisions had to be performed to verify consistency in the COLA.	To maintain consistency and accuracy in the COLA, a consistency check between the different parts of the COLA should be performed prior to submitting a revision or RAI response. This would improve the quality of the deliverable as well as decrease hours spent on re-review of similar or related COLA changes.
2-10	No guidance is provided on which structures require fire zone details or FHAs to be presented in the FSAR.	The NRC should provide direction on which site structures (or structure classifications) require fire zone drawings and FHA tables should be included in the COLA FSAR.
2-11	The FSAR indicated that the seismic category I structural fill would be obtained from the hard rock excavated from below the reactor and other deeply buried structures, and then crushed to gravel-sized particles.	Since the fill material would not be available until plant construction, parameters such as shear wave velocity and the relationship of shear modulus degradation and damping with strain had to be estimated, leading to multiple RAIs. Eventually, Dominion committed to obtaining samples of similar rock from a local quarry that would be crushed to a specified gradation (VDOT 21A) and then tested to obtain the required parameters. In a future situation where the fill beneath the site is not available, such testing should be performed on similar materials at the time of the site investigation.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-12	Concrete fill will be placed beneath the reactor building to replace weathered rock in situations where weathered rock is encountered at the foundation elevation.	No details of the concrete fill were originally provided in the FSAR, leading to a series of RAIs. In the future, where concrete fill will be placed beneath seismic category I structures, concrete parameters such as strength, shear wave velocity, unit weight, and Poisson's ratio need to be included, as well as a description of the measures to be taken to eliminate cracking due to thermal effects during curing.
2-13	The FSAR stated that structural fill would be tested at least once every 10,000 ft^2 placed.	The NRC Staff prefers that a commonly used standard be the basis for the testing frequency. The 10,000 ft^2 value was later replaced by 250 yd^3 as indicated in Table 5.6 of ASME NQA-1-1994.
2-14	For central and eastern U.S. (CEUS) hard rock sites, the evaluation methodology of Regulatory Guide 1.165 or Regulatory Guide 1.208 leads to high-frequency safe shutdown earthquake (SSE) amplitudes. These high frequency amplitudes are relatively high compared to: (1) lower frequency amplitudes for standard design response spectrum of existing nuclear power plants, and (2) in an absolute sense, the amplitudes predicted by design response spectra of standard shape and anchored to industry-accepted values for a PGA of 0.3g, thought to envelope SSE spectra for most CEUS sites.	The evaluation of high frequency SSE spectra and comparison to standard plant design spectra remains an unresolved industry/NRC issue. The DOE and the Electric Power Research Institute have begun working on a new characterization of the CEUS with guidance planned for issue in late 2013.
2-15	NUREG/CR-6728 guidance was implemented for an ESP application for the first time.	Although NUREG/CR-6728 provided recent advances in methods to select time histories, incorporate site-specific soil/rock column amplification factors, and compute ratios of vertical to horizontal motions at a site, NRC acceptance of the NUREG's methods was not assured when the COLA was prepared. ISG-01 on Seismic Issues Associated with High Frequency Ground Motion, issued on May 19, 2008, which references NUREG/CR-6728, provided additional guidance.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-16	Several pre-job briefs for calculations were conducted well in advance of the actual start of the calculation. This was a result of building the schedule to meet the specified end date and then having to make multiple revisions to the schedule to incorporate changing requirements. In a few instances, this resulted in pre-job briefs being scheduled and conducted several weeks before the actual start of the calculation and before the receipt of input data as requested in RFIs. This situation was further exacerbated by the fact that many RFI responses were received late, resulting in an even longer time between when the pre-job brief was conducted and when the calculation actually began. With the creation of an excessive time gap between the pre-job brief and the start of the calculation, some of the benefits of conducting a pre-job brief were lost.	It is recommended that the pre-job briefs for calculations be held as close to the start of the calculation as possible. If there is a planned or unplanned time gap between the pre-job brief and the start of the calculation, then the project should consider holding a second pre-job brief or an informal pre-job brief update near the start of the calculation. Ideally, the pre-job brief should be held after all input data has been received and reviewed. For complex calculations with a large amount of input data and requiring sophisticated modeling, it is recommended that the project consider holding additional interim pre-job briefs as the preliminary modeling tasks are completed. Interim pre-job briefs will provide an opportunity for the team to reevaluate assumptions based on preliminary output. Also, if input data is revised during the origination of the calculation, an interim pre-job brief will provide an opportunity to communicate and discuss any technical issues associated with the calculation.
2-17	ESP and COL projects require extensive subsurface investigations to support the permit applications to the NRC. If the ESP or COL permit application is for a new unit at an existing site, then the Owner will have in-house capability to know and communicate the environmental issues associated with the subsurface work. However, if the subsurface work is for a greenfield site, then the Owner will most likely not have in-house information available that addresses the environmental issues for the work. For example, the Owner would not have readily available information for endangered species, archeological, cultural resource concerns, etc. Applicants for COL projects with a greenfield site should be aware of situations where the environmental conditions at the site need to be investigated before drilling can begin.	The subcontract for the environmental subcontractor's support for a greenfield project (or existing site where the location of the proposed unit[s] has not been previously investigated) should include the scope of work to support the subsurface investigation. The environmental subcontract for ER work should be issued early in the project and should include an investigation for items that may impact the subsurface investigation subcontractor.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-18	ESP and COLA require water quality data to develop various sections of the ER and FSAR. Uses of the water quality data include but are not limited to identifying water treatment chemicals, determining cooling tower cycles of concentration limits, and determining discharge stream chemistry. Certain sites may not have meaningful water quality data, including seasonal changes readily available either because they are a greenfield site or because the cooling systems and discharge streams at an existing site are of a design and permitted such that the data is not collected to the level necessary to support evaluations of new units.	Project scoping should appropriately account for the effort and responsibility for providing the information, especially if the effort could result in significant expenditure of hours and cost to the project. Dialogue and interfaces between various stakeholders (e.g., water treatment, mechanical, environmental engineering; utility) need to be initiated during early project planning and reflected in detail in schedule logic.
2-19	The analyses in support of ESP or COLA should consider all federal requirements that could lead to a limitation on liquid discharges from the plant. This includes not only NRC CFRs and Regulatory Guides but also EPA regulations. The North Anna ESP project did not evaluate the release of tritium in liquid discharges for compliance with EPA drinking water standards. Although this compliance is not part of the NRC's review responsibility, the NRC pointed out to Dominion how the North Anna application could be questioned regarding its ability to meet EPA drinking water standard regulations.	Analysis of liquid discharges to meet NRC criteria should include analysis of conformance to EPA drinking water standards. The latter may not need to be reported in the ESP or COLA, but will need to be considered within the project's overall regulatory framework.
2-20	For some subsections of FSAR Section 2.4, Hydrology, where the flooding hazards were identified as low or not contributing to the design basis flood level, the NRC Staff requested additional data on sources of information and how conclusions were reached. This included requests for information on stage storage data for Lake Anna, database searches for seismic seiches and landslides, records of ice jams on upstream rivers, and documentation on the volumes of upstream reservoirs.	Even when it is obvious that a particular flood hazard will not be a factor, information and data sources need to be included in the application to substantiate the conclusions reached. If searches are made that yield no results, the sources searched should be identified with the indication that no information was found (e.g., no seiches were found in the state of Virginia after searching xyz database).

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-21	All meteorological data reported in the ER and FSAR was based on data observed at Richmond, Virginia, located southeast of the site. This approach was consistent with the existing North Anna UFSAR. Consequently, the potential ice thickness on Lake Anna and any open water body was calculated using Richmond temperature data. However, an NRC review indicated that using data from another nearby weather station northwest of the site produced a larger potential ice thickness.	Consideration should be given to looking at weather data from other nearby stations when calculating ice thickness (or other weather-based characteristics) and selecting that data which produces the maximum potential ice thickness (more conservative result). Any questions on data sources should be resolved with the NRC during pre-application interactions.
2-22	Conflicting requirements for Regulatory Treatment of Non-Safety Systems (RTNSS), e.g., the ESBWR Plant Service Water System (PSWS) design, resulted in delays in the preparation and completion of R-COLA FSAR sections.	Requirements should be defined and conflicting requirements resolved upfront to ensure that proper SSC design is incorporated in the COLA.
2-23	Bechtel utilized the HEC-RAS computer model to perform the probable maximum precipitation (PMP) runoff analysis for North Anna Unit 3 COLA FSAR Section 2.4.2 to evaluate the potential impacts of flooding at the site. The results of the analysis as well as the conservative assumptions used as input to the model are described in the FSAR. NRC issued an RAI requesting the applicant to provide the HEC-RAS input files and updated HEC-RAS input files used to conduct the FSAR Revision 1 analysis.	COL applicants should provide the NRC with the HEC-RAS input files and updated files used in subsequent COLA FSAR revisions at the time of submittal of the COLA or a revision of same.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-24	The Commonwealth of Virginia has issued General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Regulation (9VAC 25-280-10) that severely restricts nitrogen and phosphorous discharges to tributaries that ultimately feed into the Chesapeake Bay. Standard Sewage Treatment Plant (STP) discharge treatment technologies that are routinely employed do not assure compliance with these limits. In addition, these limits essentially rule out phosphate-based corrosion- inhibiting technologies for cooling water systems that ultimately discharge into such tributaries. Compliance with these limits requires the use of low or no phosphate based corrosion inhibiting technologies, use of materials suitable for the cooling water chemistry, and/or mitigating measures being taken to reduce the nutrient impact. Initial design of STP and cooling water/chemical treatment systems for North Anna Unit 3 did not consider the subject regulation requiring reevaluation of the subject systems' design. The new unit designs were based on the existing Units 1 and 2 discharge permit.	Several regions have recently imposed more stringent limits on nitrogen and phosphorous (among others). The design engineer is responsible for proposing a design that meets the discharge permits along with any updated regulations in any location. In many cases, discharges for an existing facility may be acceptable (grandfathered), but the addition of a new facility on the site causes the more restrictive regulation to be invoked. The evaluator of systems and system chemical treatment plans should check current discharge permits as well as updated regulations for the state in which the facility is to be located to ensure that appropriate options are selected for the site.
2-25	Responses to some RFIs underwent revisions numerous times, causing delays to R-COLA section and supporting analysis preparation.	Prior discussions with the responding organizations to clarify intent of requested information and review of draft responses can avoid and save the time needed for revisions to responses.
2-26	The NRC asked for justification for assuming that subsurface conditions within an area of the technology footprint where there were no borings were the same as subsurface conditions in adjacent areas where borings had been made.	Unless good quality borings already exist from prior subsurface investigations, sufficient borings should be performed throughout the technology footprint to ensure that there are no significant unexplored areas.
2-27	Since North Anna was considered a "rock site," the original work plan did not call for running SHAKE analyses in the soil at the site during the ESP stage. This approach was modified during the COL analysis, but the SHAKE analysis used only "best estimate" values of shear wave velocity of the soil and did not provide variation (e.g., 0.67 and 1.5 times the best-fit value). This variation was provided in response to an NRC RAI.	Even for "rock sites," high quality shear (and compression) wave velocity measurements should be performed in both the rock and the soil above the rock. A randomization analysis should be performed to provide sufficient soil and rock parameter values to envelope possible parameter variations.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
2-28	When reporting the values for extreme meteorological conditions, care should be taken that the basis for the number is clearly explained.	The NRC questioned the maximum wind speed information provided because (a) an outdated calculation method was cited, and (b) the greatest of several maximum wind speed data included for comparison was not used. It is important to ensure that the maximum wind speed be reported as the "100-year return value 3-second gust" or the historical maximum, whichever is higher. The "fastest mile wind speed" should no longer be referenced.
2-29	The application review process included a "team review" or "page turn" of the compiled document. In preparing the COLA (either for initial submittal or for subsequent revisions), a final activity in the process is typically a "page-turn" review. During this review, the key stakeholders (from Dominion as well as supporting organizations) closely review the document to make sure it is in its final form, that all comments and questions have been addressed or resolved, and to ensure consistency within the overall document. Attendees at this page-turn meeting are to be intimately familiar with the document being reviewed and are to be prepared to discuss the document and to efficiently perform confirmatory reviews on-the-spot.	This was identified as a **Best Practice** for the project and served to improve the consistency of language and approaches to multiple sections. The page-turn review should not be conducted before open items have been closed or before the document is ready to be considered final. In the page-turn review meeting, it is most helpful to have ready access (preferably electronic) to the other section of the COLA that may be related to the section/chapter being reviewed, and to other COLAs, especially in the same technology.
PART 3 – LESSONS LEARNED FOR DOCUMENT PRODUCTION PERSONNEL		
3-1	Following submittal of more recent COLAs, the NRC has requested electronic versions of certain figures from the Environmental Report in a native file format (e.g., pgn files with associated GIS and metadata) for their use in development of the Environmental Impact Statement (EIS).	The final licensing packages for a section should also include electronic copies of all figures in the native file format. If a section is developed by a subcontractor, electronic copies of all figures should be provided as part of the supplier document submittals.
3-2	COLA content requires that there be multiple authors from multiple organizations. Poor administrative controls can quickly result in loss of COLA content configuration and adversely affect the ability to deliver a quality COLA on schedule.	Lessons learned include rigorous administrative control of the document during COLA development use of a post Rev. 0 issuance process that employs a "living COLA" from a single source.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
3-3	The Writer's Guide and Work Instructions were constantly being updated and new revisions issued. Numerous format and consistency issues arose that caused rework and lost time during the production of the document.	The Writer's Guide and Work Instructions evolved as problems were identified. Future projects should have a Writer's Guide and Work Instructions prepared and authors trained before any sections are written if at all possible. The importance and time required to prepare and issue an effective Writer's Guide and Work Instructions were underestimated. Although easy to say in theory, in practice it is difficult to produce a completely workable Writer's Guide and Work Instructions before starting the project, since the need for changes is identified once the authors start to use the guides. Applicants should review internal lessons learned to develop the most complete instructions possible prior to the start of author section preparation.
3-4	Control of figure content and revisions must be consistent and uniform by all parties to ensure proper document incorporation and consistent use of terminology.	A process should be established for figure management (i.e., revision control and author access) and a mandatory set of typical terminology provided for use in both text and figure content (e.g., Plant North, True North, Grid North, facility names and abbreviations, etc.).
3-5	The convention and mechanics for Reference and Figure call-outs must be clearly established before sections are written.	Considerable time and effort were expended to ensure that text reference and figure call-outs were correct. A fool-proof manual or automatic method should be established before any sections are put into production. Lessons learned during the ESP application were put into practice during the COLA, resulting in much greater efficiency.
3-6	The final electronic format of the application is professional and easy to use.	The practice of preparing ESP and COLAs using Adobe® FrameMaker® (or equivalent) software specifically designed for large document production should be continued. Typical word-processing applications are not up to the task. The project team should include someone who is knowledgeable in the creation of large electronic documents. This was identified as a **Best Practice**.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
3-7	Teleconferencing was used as the primary method for holding Author Presentations and pre-job briefings.	This technique was found to be very effective and resulted in avoiding time-consuming and costly travel for face-to-face meetings. This practice or Web conferencing should be used for future COLAs.
3-8	An eRoom or ftp site was used to exchange and store large electronic files.	The use of an eRoom to exchange and store large electronic files was identified as a **Best Practice**.
3-9	When the COL project started, paperwork was completed in duplicate and sometimes triplicate.	Up-front planning and automation are essential to the efficiency and overall success of the project. A good document control system, as well as a transmittal tool, needs to be implemented at the start of the project.
PART 4 – LESSONS LEARNED DURING COLA DEVELOPMENT WITH AN ESP		
4-1	The key to **"**COLA Development from an ESP**"** is not doing the COLA based on an ESP, but doing an ESP in the first place.	Dominion has long extolled the virtue of doing an ESP first from the perspective of early identification of potential impediments. A more mundane but equally worthwhile benefit is that ESP preparation is an excellent dry run for COLA preparation. It allows the applicant to acquire resources, establish processes and organizations, and develop the skill set necessary to implement the new NRC licensing process effectively.
4-2	The transition process from ESP to COLA is still evolving**.** Understanding the relationship of the ESP to the COLA is one key to deriving benefit. The COLA preparation team must understand what is in the ESP. An individual knowledgeable in the scope of ESP content is valuable in assembling the comparison tables required in the COLA to demonstrate that the technology selected in the COLA "falls within" the limits of the ESP. In addition, the transition from ESP to COLA is also made easier if an Appendix B quality program is used for ESP development.	Dominion included Appendix B, 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" in its ESP application, although some ESP applicants did not include Appendix B. By including the Appendix B quality program, the transition from ESP to COLA avoided additional challenges and backfitting. Future ESP/COL applicants should include Appendix B in the ESP work plan.
4-3	Although the NRC's evaluation of once-through cooling identified small to moderate environmental impacts during the Staff's review of the ESP application, interactions with state agencies brought to light concerns with the initial planned approach of once-through cooling for Unit 3. (Note: Unit	Significant benefits of the ESP process include confirming the original determination regarding the potential suitability of the site, early resolution of siting issues, deferring a technology decision until supported by the business case, and keeping the nuclear option open while monitoring market

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
	4 had always been envisioned to use closed-cycle cooling.) As a result of numerous discussions and consultations, Dominion elected to change the cooling water approach for Unit 3 from a once-through cooling system to a closed-cycle cooling system. The change was implemented through a revision to the ESP application. Although challenging at the time, the ESP process served the beneficial purpose of identifying and resolving a significant concern at an early stage of Dominion's planning for Unit 3. Taken in perspective, the effect on Dominion's cost and schedule would have been significantly more severe had this conceptual design change been made during the COLA process. Because a COLA involves the development of more robust design information compared to an ESP and the commitment of substantially more resources to support, Dominion would have suffered a significantly greater adverse impact to its overall plans for North Anna Unit 3 had this change only been identified and addressed as part of the North Anna 3 COLA.	conditions. The environmental impact reviews performed by the NRC and the state agencies must be closely monitored as there is no assurance that similar conclusions will be reached. Because this issue was identified during the ESP project, the results were used during the R-COLA with no delay to schedule.
4-4	The ESP application process, in conjunction with the PPE approach, allowed Dominion to defer a technology decision until justified by the business case. Dominion did in fact change its original reactor technology selection for the North Anna 3 COLA while the ESP phase was still in process, with a relatively small impact on the Unit 3 program's time line. Dominion subsequently changed its reactor technology selection again in the spring of 2010 prior to submitting Revision 3 of the COLA with relatively small impact expected on the Unit 3 time line.	Significant benefits of the ESP process include confirming the original determination regarding the potential suitability of the site, resolving siting issues early, deferring a technology decision until supported by the business case, and keeping the nuclear option open while monitoring market conditions.
4-5	There is no NRC or NEI guidance on how to identify new and significant information for a COLA ER that is based on an ESP. The process used to identify new and significant information did not account for the short amount of time that had elapsed between approval of the ESP and writing of the COLA ER.	There should be a reasonable amount of time after an ESP is issued before a search for "new" information for time-sensitive key inputs must be conducted. The NEI should take the lead in developing guidance for performing the new and significant information searches.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
4-6	In many cases, the "new and significant process" evaluated the FEIS and ESP application on a statement-by-statement basis. This resulted in piecemeal evaluation of some concepts and evaluation of statements regardless of their ability to be "new and significant," such as those pointing to figures, tables, sections, etc.	Not every statement in the FEIS and/or ESP application needs to be evaluated against "new and significant." "Key inputs" would be better identified on the multi-sentence or paragraph basis so that a complete concept can be evaluated instead of a sentence taken out of context.
4-7	An ESP application can be for a specific reactor design or for a range of designs, i.e., a PPE. The PPE approach can be for few or many designs, and can comprise current and/or future generation designs. The more complex the PPE, the more challenging and potentially less definitive the NRC review.	The PPE concept should be retained and supported. The NRC should continue to provide guidance to applicants who wish to prepare and submit ESP applications based on a PPE approach. The DOE should continue to support such an approach as a critical component of the licensing framework for new nuclear plants. During preparation of the COLA (both the R-COLA and now the S-COLA), Dominion learned that not enough conservatism in envelope values was allowed to provide more flexibility in accommodating changes in the cooling tower design. Consideration needs to be given to adding reasonable operating margins to PPE values at the ESP stage by future ESP/COL applicants.
4-8	There is no NRC or NEI guidance on the format for a COLA FSAR that needs to incorporate the content of an ESP application SSAR by reference. COLA FSAR format (principally for Chapter 2) was not consistent between Dominion's R-COLA and the Grand Gulf S-COLA, both of which were based on ESPs.	Variations in FSAR format cause confusion for the NRC during reviews. The NEI should take the lead in reviewing the various COLA formats for FSAR Chapter 2 to standardize the best approach.

Table 2. Lessons Learned

No.	Background/Description	Lessons Learned
4-9	There was insufficient direction available regarding development of COLA ER Chapter 3, Plant Description, for a site that has an ESP based on the PPE process. By necessity, for a site using the PPE process, limited detail can be provided for site design in Chapter 3. Given the finality of the ESP, questions arose as to how much technology detail was necessary in the COLA ER and whether specific technology parameters needed to be defined.	The NRC needs to clearly define the level of detail required to be addressed in Chapter 3 for technology specific design when an ESP using PPE exists. Because there was no clear definition, and therefore impossible for the authors to determine which information should be included versus which was not necessary, Dominion's section authors laboriously wrote the sections for ER Chapter 3 including all information with specific technology detail and then deleted information repeated from the ESP. Detailed guidance from the NRC will eliminate this duplication of effort.
4-10	The site suitability evaluation with respect to radionuclide transport characteristic as defined by 10 CFR Part 100.20(c)(3) requires the use of observed site specific parameters important to hydrological radionuclide transport (such as soil, sediment, and rock characteristics, adsorption and retention coefficients, ground water velocity, and distances to the nearest surface body of water) obtained from on-site measurements. Onsite measured values of adsorption and retention coefficients for radioactive materials were not provided in the ESP application, because the assessment of accidental releases of liquid effluents to groundwater was deferred to the COL stage when radionuclide inventories would be known. The NRC identified this issue as an SER Open Item.	For the North Anna ESP, resolution of the SER Open Item could have required Dominion to send soil samples to a laboratory to measure adsorption coefficients. This testing would have been unplanned and would have delayed the NRC review. This issue was ultimately resolved by the NRC identifying a Permit Condition that mandates no accidental radwaste releases to the environment. In preparing the R-COLA, site-specific Kd values were obtained and used. For future ESP applications, to address potential accidental releases of radionuclides into any potential liquid groundwater pathway, site-specific distribution coefficients (Kds) should be determined using representative soil samples for the radionuclides expected to be present in liquid effluents. For COLAs without an ESP, site-specific Kd values need to be obtained with this testing planned for in the schedule.

Table 3. Benefits of the North Anna ESP in Developing the COL Application

Benefit of an ESP	Dominion Experience
Determine potential suitability of the site.	The general suitability of the North Anna site was determined during the site evaluation phase of the project which preceded the ESP work. The ESP preparation process determined that no site characteristics were "show stoppers" for site development before considerable resources were expended to develop a technology-specific design during the COLA development.
Early resolution of siting issues. Defer technology decision until justified by the business case.	The ESP review phase and consultations with state agencies brought to light concerns with the initial planned approach of once-through cooling for Unit 3. Thus, the ESP process served the purpose of identifying and resolving a significant concern at an early stage of Dominion's planning for Unit 3. The effect on Dominion's cost and schedule could have been more severe had this conceptual design change been made during the COL process. Because this issue was identified during the ESP project, the results were used during the R-COLA with no delay to schedule. The North Anna ESP application was prepared and approved using a PPE approach which allowed Dominion to select a reactor technology later.
Keep nuclear option open while monitoring and evaluating market conditions.	Although this is a benefit of the ESP process, Dominion moved directly from the ESP phase into the COL phase after having selected the ESBWR reactor technology. Market conditions and other factors led Dominion to not "bank" the ESP, but rather move directly to the COL stage.

5. Insights/Recommendations

5.1 Accomplishments

The purpose of the Cooperative Agreement was to advance the design of a new nuclear power plant technology as well as develop the business case and licensing approach for Dominion to decide to build a plant and obtain NRC approval to construct. Although some of the goals detailed in the Cooperative Agreement were not met, the project as a whole was very successful in advancing the potential for a new nuclear unit to be constructed and operated at North Anna. The Cooperative Agreement also helped to stimulate the entry of multiple vendors into the U.S. commercial market for new nuclear plants.

5.1.1 Meeting of Cooperative Agreement Objectives

Prepare and submit the ESBWR Design Certification application

The ESBWR design activities were removed from this Cooperative Agreement on April 1, 2007, and transferred to a separate Cooperative Agreement between GEH and DOE.

Obtain NRC Design Certification for the ESBWR

The ESBWR design activities were removed from this Cooperative Agreement on April 1, 2007, and transferred to a separate Cooperative Agreement between GEH and DOE.

Prepare and submit a Combined License application for the ESBWR at the North Anna site

In November 2007, Dominion submitted the initial version of the COLA for the ESBWR at the North Anna site. The last revision of the COLA FSAR and Environmental Report based on the ESBWR technology was submitted to the NRC in May and July 2009, respectively.

Obtain NRC approval of the Combined License Application

Approval of the COLA was not accomplished, but the process was "on schedule" at the conclusion of the Cooperative Agreement. The further development of the ESBWR R-COLA is now being led by the Detroit Edison Company for the Enrico Fermi Nuclear Generating Station.

Complete the ESBWR Standardized and Site-Specific Design and other Site-Specific Engineering

ESBWR standardized and site-specific design activities for the GEH scope of work were removed from this Cooperative Agreement on April 1, 2007, and transferred to a separate Cooperative Agreement between GEH and DOE. Site-specific engineering for Unit 3 yard facilities was progressed until Dominion's decision to enter the EPC competitive process. Site separation engineering activities were largely complete at the conclusion of the Cooperative Agreement.

Develop the Business Case Necessary to Support a Decision on Building a New Nuclear Power Plant

Dominion developed the business case for the construction and operation of a new nuclear power plant at North Anna. Although a decision was made to pursue a different technology than the one addressed in this Cooperative Agreement, the business case developed as part of the project facilitated the Dominion decision to remain interested in the development of a new nuclear power unit at North Anna.

5.1.2 Meeting of Cooperative Agreement Terms and Conditions

The Cooperative Agreement included several requirements to facilitate DOE oversight of activities,

including quarterly progress reports, quarterly financial status reports, a yearly independent financial audit of Dominion, and special status reports (upon request). Each of these required documents was provided on time and in sufficient detail to meet DOE expectations. Only one special status report was requested by DOE during the Cooperative Agreement. This request was related to concerns raised during review of the initial version of the ESBWR DCD. The special status report was submitted in October 2005.

In addition to required periodic deliverables, DOE and Dominion participated in numerous conference calls (typically biweekly) and in-person meetings to update the status of the project.

5.2 Discussion and Recommendations

To promote a thorough and accurate overview of the work performed, and outcomes achieved by the project, a "compliance scorecard" (see Appendix 5) was developed from requirements detailed in the Cooperative Agreement. The scorecard was completed by several members of the Dominion project management team. Based on the information contained in the completed scorecards, as well as information obtained from project documentation (e.g., quarterly reports to DOE), follow-up discussions were held with Dominion management personnel. This section summarizes opinions regarding the performance of the project and provides recommendations for improvement for similar government-industry efforts that may be undertaken in the future.

Although the Cooperative Agreement did not meet all of the established objectives, it was a success in that it facilitated the likely construction of a new nuclear facility at North Anna within the next decade and stimulated interest by multiple competitive vendors in the U.S. commercial nuclear power market. In particular, the Cooperative Agreement funding advanced the development of the COLA (as an earlier Cooperative Agreement had spurred the ESP process to completion) and development of the business case supporting the decision to construct the new unit. The ESP-COLA framework, coupled with the business case findings, provided Dominion with flexibility to continue forward by switching plans to use the US-APWR technology as it became clear that successfully negotiating an EPC contract with GEH was unlikely until a competition for the plant was conducted. As summarized by the DOE director for light water reactor technologies, Ms. Rebecca Smith-Kevern, in the July 2010 Nuclear Energy Institute newsletter, Insight: "Dominion has an ESP that it got under our program and because of that, Dominion believes the licensing of the new Mitsubishi design is going to be very straightforward and rapid. They don't have to go back and completely redo the environmental report because it was bounded by the ESP. They [NRC] just have to add a supplement to the environmental impact statement." The NP 2010 program was a major contributor to jump start utility interest in new nuclear unit development in the United States. The progress made in development of licensing approaches, reactor designs, and business cases for new nuclear development would likely remain far less advanced without the NP 2010 program. The innovative approach employed by DOE in extending partnership opportunities to utilities for the development of new nuclear units serves as a model for future government-industry cooperative efforts.

The COLA development effort was undertaken after an ESP was obtained from the NRC. It should be noted that the ESP was developed using a "Plant Parameters Envelope (PPE)" approach that defined the physical and technological bounds of the proposed new unit several years before a specific nuclear power plant technology was selected. This approach was useful in allowing generic (i.e., not technology-specific) regulatory and licensing activities to progress concurrent with the utility's evaluation of bids from technology vendors.

The establishment of the ESBWR DCWG by several utilities and GEH in 2006 was reported to be very useful to all parties and consistent with NRC's expec-

tation for licensing new plants under Part 52 of a design-centered review approach. Utilities and technology vendors shared resources, with subject matter experts from different organizations providing input to design and licensing concerns that were expected to be common to all future ESBWR plant operators. A subset of this group, the technical oversight group, which was composed of utilities and GEH, was also developed. The technical oversight group provided a collaborative means of developing and reviewing ESBWR design, where shared plant design and operating plant expertise was drawn upon to improve the overall plant design. A partnership in which utility operating experience is combined with technology vendor engineering expertise is likely to yield more thorough licensing documents, and the DCWG concept promotes this approach. The NRC also benefited from the DCWG organization because it promoted consistency in issue resolution and pending license applications, thereby helping to streamline the future review and approval process.

The Cooperative Agreement concept would likely be improved in future endeavors if a well-established chain of command is detailed among the parties on the industry side of this type of government-industry partnership. From inception of the Cooperative Agreement through March 31, 2007, the engineering design for the ESBWR technology was conducted by GEH through the integrated agreement. From April 1, 2007, ESBWR engineering design activities were conducted under a different DOE Cooperative Agreement established directly with GEH. From the onset of the project, differences in understanding regarding the extent of ESBWR design engineering to be accomplished became evident between Dominion and GEH. Dominion viewed the completion of the ESBWR design to a "ready for construction" level of detail to be a goal of the project. GEH reportedly expressed an understanding that the mandate of the Cooperative Agreement was simply to complete the ESBWR design to a level sufficient for DCD approval. When an unexpectedly large number of RAIs regarding the DCD were issued to GEH from the NRC, it became increasingly challenging for GEH to meet the schedule established for ESBWR design engineering. When the ESBWR design certification tasks were eliminated from the Cooperative Agreement and placed in a newly formed agreement between GEH and DOE in April 2007, additional challenges in coordinating schedules, priorities, and overall project progress developed. Delays associated with ESBWR design engineering negatively impacted progress for site engineering and the development of licensing documents. A well-defined chain of command among the industry participants would likely have resulted in a more unified approach to the project, and additional progress may have been achieved.

If a project similar to this Cooperative Agreement is undertaken in the future, it is recommended that an integrated schedule including direct associations between engineering and licensing tasks be used, as this will help highlight "critical path" items with the greatest potential to cause delays to the project as a whole if not completed on time.

The most significant obstacle to progress noted during the project was the need by GEH to allocate resources away from ESBWR design engineering to address the tremendous number of RAIs from the NRC resulting from staff review of several revisions of the DCD. If a project similar to this Cooperative Agreement is undertaken in the future, increased emphasis should be placed on ensuring the quality and thoroughness of the DCD before submission to the NRC to minimize delays and unanticipated impacts on the schedule. In addition, to avoid overall project delays, contingency plans to add qualified staff to meet both the NRC RAI response time requirements and project schedule requirements should be developed and implemented if conditions warrant.

6. References

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A P P E N D I X 1

Schedule Milestones

Date	Description
April 4, 2005	Project start
October 24, 2007	NRC Public Outreach Meeting, Louisa County
November 27, 2007	North Anna ESP issued by NRC
November 27, 2007	Submission 1 of the COLA with Revision 0 of all parts of the COLA was provided to the NRC
November 29, 2007	North Anna Unit 3 (NA3) COLA Orientation presentation to NRC
December 20, 2008	Submission 2 (Non-Public Version) of the COLA and Submission 3 (Public Version) with Revision 1 of most parts of the COLA were provided to the NRC
May 29, 2009	Submission 4 (Public Version) of the COLA with Revision 2 of FSAR and Departure Report was provided to the NRC
July 29, 2009	Submission 5 (Public Version) of the COLA with Revision 2 of the ER was provided to the NRC
	Acceptance Review
December 3, 2007	Acceptance Review Start
January 28, 2008	NRC Docketing Decision Letter was issued and the acceptance review completed
February 27, 2008	Review Schedule Established/Schedule Letter Issued to Applicant
	Safety Review
August 29, 2008	Phase 1 – Requests for Additional Information (RAIs) Issued to Applicant
August 7, 2009	Phase 2- SER with Open Items (incorporating COLA Rev 1) issued
November 4, 2009	Phase 3 – ACRS Review of SER with Open Items Complete
(September 2010)-T*	Phase 4 – Advanced SER with no Open Items Issued
(December 2010)-T*	Phase 5 – ACRS Review of SER with no Open Items Complete
(February 2011)-T*	Phase 6 – Final SER Issued
	Environmental Review
April 16, 2008	Environmental Scoping Public Meeting, Louisa County
September 5, 2008	Phase 1 – Scoping Summary Report Issued
December 19, 2008	Phase 2 – Draft Supplemental Environmental Impact Statement (SEIS) issued to Environmental Protection Agency (EPA)

T* = Target. This table includes milestones that had been targeted prior to the time Dominion announced the change in technology for the North Anna COLA.

A P P E N D I X 1

Schedule Milestones

Date	Description
February 3, 2009	Public Meeting, Louisa County, to discuss Draft SEIS
March 20, 2009	Phase 3 – End of the Draft SEIS comment period
March 19, 2010	Phase 4 – Final SEIS issued to EPA
	Hearing
	Commission or ASLB hold mandatory hearing
	License
	Commission decision on issuance of COLA
	COL issued by NRC
	Technology Change
May 18, 2010	North Anna COL Technology Change Letter to NRC
June 28, 2010	Submission 6 and Submission 7 of the COLA submitted to NRC
	NP2010 Project Close-out
November 2010	Project summary report issued

A P P E N D I X 2

Pre-Job Briefings For COL Section Development

Subject	Discussion Topics
1. Approach to Section Preparation	Describe the overall approach to section preparation.
2. Conformance With NRC Regulations and Guidance	Describe conformance with applicable NRC regulations and guidance documents (10 CFR 52, Regulatory Guide 1.206, NUREG-0800, NUREG-1555, other Regulatory Guides, other NUREGs, other documents).
3. Changes/Deviations from R-COLA or DCD	Identify any potential changes/deviations from the R-COLA or DCD content.
4. COL Items and ESP Permit Conditions	Describe the approach, necessary actions, etc., to address each COL item and ESP Permit Condition (if applicable).
5. Links to Other Sections	Identify links to other application sections.
6. Basis/Input Documents To Be Used	Identify documents that are planned to be used as input to the section or supporting analyses and their validity.
7. Lessons Learned from Other ESP Applications and COLAs	Identify pertinent lessons learned from other ESP applications and COLAs and how addressed.
8. NRC RAIs and Questions Pertinent to the Section(s)	Describe pertinent NRC RAIs and questions from other ESP applications and COLAs and how addressed.
9. Data Collection	Describe plans for data collection and identify planned Requests for Information (RFIs). Identify to whom the request will be made.
10. Analyses and Validation Package	Describe planned analyses; describe approach to validation package.
11. Special Challenges/Other Issues	Identify any special challenges or other issues.

A P P E N D I X 3

Supporting Engineering and Analyses for COL Applications[1]

Mechanical
Siting Study/Report Water Balance Calculation
Chemical Feed for Raw Water and Cooling Towers
Raw Water/Station Water Pump Calculation Waste Water Characterization Calculation Circulating Water System Process Flow Calculation
Circulating Water Cooling Tower Sizing Calculation
Service Water Pump Calculation Plant Service Water System Cooling Tower Sizing Plant Service Water Basin Volume Calculation
Plant Service Water System Pump and Pipe Design Calculation
Station Water Storage Tank Sizing Water Use Diagram
Raw Water/Station Water P&ID
Circulating Water System P&ID
Plant Service Water P&ID
Potable Water System & Sanitary Waste System P&ID
Fire Protection Yard Loop P&ID
Electrical and Switchyard
Switchyard Single Line Diagram(s)
Switchyard General Arrangement Drawing(s)
Transmission Line Map(s)
Civil/Plant Design
Plot Plan
Boring Plan(s)
Site Plan
Construction Facilities/Site Utilization Plan Site Topography – Pre-Development

[1] *Identified activities are for a COLA based on ESBWR technology. Required analysis and diagrams for a COLA will vary depending on technology, especially in regard to whether the technology is passive or active design.*

A P P E N D I X 3

Supporting Engineering and Analyses for COL Applications[1]

Preliminary Site Grades to Support Probable Maximum Precipitation (PMP) Calculations
Nuclear Island Excavation Plan and Profiles
Cut/Fill Estimates
Plant Renderings – Visual Study Support
Various Figures to Support COLA Chapters
Nuclear Analysis
Design Basis Accident Dose Analysis
Liquid and Gaseous Effluent Dose Analysis
Construction Worker Dose Analysis
Liquid Tank Rupture Activity Release Analysis
Radiological Impacts of Normal Operation
Environmental
Entrainment/Impingement Calculation
Population Distribution Projection Analysis
On-site Chemical Hazard Calculation - Explosion, Flammable Vapor Cloud, Toxic Chemicals
Nearby (Offsite) Chemical Hazard Calculation - Explosion, Flammable Vapor Cloud, Toxic Chemicals
Road Hazard Calculation - Explosion, Flammable Vapor Cloud, Toxic Chemicals
Railway Hazard Calculation - Explosion, Flammable Vapor Cloud, Toxic Chemicals
Waterway Hazard Calculation - Explosion, Flammable Vapor Cloud, Toxic Chemicals
Pipeline Hazard Calculation - Explosion, Flammable Vapor Cloud, Toxic Chemicals
Aircraft Accident Analysis
Baseline Weather Calculation
Monthly, Seasonal, Annual Mixing Heights, Wind Speed, & Ventilation Indices Analysis
Tornado Frequency Analysis
Severe Weather Calculation
Wind Rose Tabulations
Accident (Short Term) χ/Q Analysis
Normal Release (Long Term) χ/Q & D/Q Analysis
Control Room χ/Q Analysis
Technical Support Center χ/Q Analysis
Validation of Meteorological Data from Onsite Meteorological Tower
Compilation of Hourly Meteorological Data for Submittal to NRC

Supporting Engineering and Analyses for COL Applications[1]

Evaluation of Long-Term Climatic Trends
Seasonal and Annual Cooling Tower Impact Evaluation of Fogging, Icing, Salt Deposition, and Visible Plume
Wildfire Heat Flux Analysis
Design Basis Temperature Parameters
Design Basis Snow Load Parameters
Geotechnical & Hydrological Engineering
Hydrograph Validation
PMP Analysis
Probable Maximum Flood (PMF) Analysis
GIS Data Analysis in Support of Hydrologic Calculations
Dam Break Flooding Analysis
Wave Height and Run-up Analysis
Low Water Temperatures, Ice Thickness, and Ice Effects Analysis
Low Water Analysis
Site Drainage Analysis
Circulating Water Intake Temperature Percentiles
Circulating Water Discharge Outfall Sizing
Circulating Water Intake Structure Hydraulic Design
Circulating Water Blowdown Discharge Structure Hydraulic Design
Circulating Water Makeup Water Pipeline Hydraulic Analysis
Circulating Water Pump Intake Sizing/Hydraulic Design
Circulating Water System Steady-State Analysis
Circulating Water System Transient Analysis
Subsurface Hydrostatic Loading
Contaminant Transport
Update EPRI (1988) Seismicity Catalog
Develop Procedure for Converting Between Moment Magnitude and Wave Magnitude
Shear Wave Velocity of Soil and Bedrock
Develop Rock Response Spectra
Develop Frequency Rock Spectrum Compatible Time Histories
Develop Hi and Low Frequency Target Spectra for Spectral Matching
Select Seed Input Time Histories for Spectral Matching
Develop Spectrum-Compatible Time Histories for Rock Sensitivity Analysis

A P P E N D I X 3

Supporting Engineering and Analyses for COL Applications[1]

Develop Spectrum-Compatible Time Histories for Site Response Analysis
Rock Column Sensitivity Analysis
Develop Amplification Factors and Sigmas as a Function of Rock Input Motion Develop Method 2A ASCE FOSID Response Spectra Develop Vertical SSE from Horizontal SSE
Site Response Analyses of Randomized Rock Profiles
Develop SSE Spectrum Tabulation of Seismic Source Data Surface Faulting Field Reconnaissance Report
Source Logic for EPRI-SOG Sources
Develop Updated Rock Seismic Hazard
Replication of 1989 EPRI-SOG Hazard
Develop Geotechnical Engineering Properties and Subsurface Materials
Liquefaction Analysis
Bearing Capacity and Settlement Analyses
Lateral Earth Pressures on Building Structures Analysis
Emergency Planning
Evacuation Time Estimate Analysis

A P P E N D I X 4

Table of Contents for a COL Application

Section	Title
—	**TRANSMITTAL LETTER**
PART 1	**GENERAL AND ADMINISTRATIVE INFORMATION**
PART 2	**FINAL SAFETY ANALYSIS REPORT (FSAR)**
Chapter 1	Introduction and General Description of Plant
Chapter 2	Site Characteristics
2.1	Geography and Demography
2.2	Nearby Industrial, Transportation, and Military Facilities
2.3	Meteorology
2.4	Hydrology
2.5	Geology, Seismology, and Geotechnical Engineering
Chapter 3	Design of Structures, Systems, Components, and Equipment
Chapter 4	Reactor
Chapter 5	Reactor Coolant and Connecting Systems
Chapter 6	Engineered Safety Features
Chapter 7	Instrumentation and Controls
Chapter 8	Electric Power
Chapter 9	Auxiliary Systems
Chapter 10	Steam and Power Conversion System
Chapter 11	Radioactive Waste Management System
Chapter 12	Radiation Protection
Chapter 13	Conduct of Operations
Chapter 14	Verification Programs
Chapter 15	Transient and Accident Analyses
Chapter 16	Technical Specifications
Chapter 17	Quality Assurance and Reliability Assurance
Chapter 18	Human Factors Engineering
Chapter 19	Probabilistic Risk Assessment and Severe Accident Evaluation
PART 3	**ENVIRONMENTAL REPORT**
Chapter 1	Introduction
Chapter 2	Environmental Description
Chapter 3	Plant Description
Chapter 4	Environmental Impacts of Construction
Chapter 5	Environmental Impacts of Station Operation

A P P E N D I X 4

Table of Contents for a COL Application

Section	Title
Chapter 6	Environmental Measurements and Monitoring Programs
Chapter 7	Environmental Impacts of Postulated Accidents Involving Radioactive Materials
Chapter 8	Need for Power
Chapter 9	Alternatives to the Proposed Action
Chapter 10	Environmental Consequences of the Proposed Action
PART 4	**TECHNICAL SPECIFICATIONS**
PART 5	**EMERGENCY PLAN**
PART 6	**LIMITED WORK AUTHORIZATION (LWA)/Site Redress Plan** – if applicable
PART 7	**DEPARTURES REPORT (VARIANCES & EXEMPTIONS)**
PART 8	**SAFEGUARDS/SECURITY PLANS**
PART 9	**NON-PUBLIC INFORMATION** - if applicable
PART 10	**LICENSE CONDITIONS AND INSPECTION, TESTS, ANALYSES AND ACCEPTANCE CRITERIA (ITAAC)**
PART 11	**REFERENCE MATERIAL**

A P P E N D I X 5

Compliance Scorecard- DOE Notice of Financial Assistance Award DE-FC07-05ID14635

On March 31, 2005, the United States Department of Energy (DOE) awarded Dominion Nuclear North Anna, LLC (DNNA) financial assistance in the form of a cooperative agreement to facilitate a COL demonstration project to further the development of new nuclear plants and to take such actions as may be necessary to lead to a decision by Dominion on whether to build a new nuclear power generation unit at the North Anna Power Station near Mineral, Virginia. The agreement included a number of requirements; this "scorecard" is intended to aid in the assessment of compliance with the requirements.

Scorecard Completed By: _____ Organization: _____

Date (MM/DD/YYYY): _____

Requirement	Reference	Responsible Party[1]	Completed? Y/N	Proficiency (5= Highly Proficient; 1= Not Proficient)	Comments
Completion of Responsibilities					
Define approaches/plans, submit plans to DOE for review, and resolve DOE comments	*Part V, 8(b)1	DNNA			
Review and concur with project work plans and deliverables within 30 days after receipt	*Part V, 8(a)1	DOE			

A P P E N D I X 5

Requirement	Reference	Responsible Party[1]	Completed? Y/N	Proficiency (5= Highly Proficient; 1= Not Proficient)	Comments
Manage and conduct the project activities, including providing the required personnel, facilities, equipment, supplies and services	*Part V, 8(b)2	DNNA			
Coordinate with DOE management and operating contractors on activities THAT may be performed under their contracts that are related to the project	*Part V, 8(b)3	DNNA			
Conduct program review meetings	*Part V, 8(a)2	DOE			
Attend program review meetings and report project status	*Part V, 8(b)4	DNNA			
At the annual project review meetings, provide progress status/issues and present the detailed work plan/budget requirements for the following year	*Part V, 8(b)4	DNNA			
Participate in DNNA progress meetings and conference calls	*Part V, 8(a)2	DOE			

A P P E N D I X 5

Requirement	Reference	Responsible Party[1]	Completed? Y/N	Proficiency (5= Highly Proficient; 1= Not Proficient)	Comments
Submit technical project deliverables and resolve DOE comments	*Part V, 8(b)5	DNNA			
Notify DOE when decision is reached to proceed from Phase 1 to Phase 2 of project	*Part V, 8(b)6	DNNA			
Ensure the intended results are achieved from this nuclear power plant licensing demonstration project	*Part V, 8(a)3	DOE			
Promote and facilitate technology transfer activities, including dissemination of program results	*Part V, 8(a)4	DOE			
Collaborate to jointly develop the DOE Interface and Oversight Agreement to implement the principles of DOE Order 413.3	*Part V, 8(a)5 *Part V, 16	DOE/DNNA			

A P P E N D I X 5

Requirement	Reference	Responsible Party[1]	Completed? Y/N	Proficiency (5= Highly Proficient; 1= Not Proficient)	Comments
Include an acknowledgement of federal support and a disclaimer in the publication of any material, copyrighted or not, based on or developed under the project	*Part V, 11(b)	DNNA			
Obtain a yearly audit from an independent auditor in accordance with the requirements in 10 CFR 600.316 (applies for each year DNNA expends $500,000 or more in a year under federal awards)	*Part V, 20	DNNA			
Obtain any required permits and comply with applicable federal, state, and municipal laws, codes, and regulations for work performed under the award	*Part V, 12	DNNA			
Comply with intellectual property provisions applicable to the award	*Part V, 13	DNNA			

A P P E N D I X 5

Requirement	Reference	Responsible Party[1]	Completed? Y/N	Proficiency (5= Highly Proficient; 1= Not Proficient)	Comments
Obtain DOE approval in advance of changing designated key personnel or participating organizations	*Part V, 18	DNNA			
Obtain DOE approval on all subcontracts or subagreements associated with the award with a value greater than $5 million, including all options and/or modifications thereto	*Part V, 21	DNNA			
Submit continuation application documents at least 90 days before the end of any budget period	*Part V, 14(a)	DNNA			
Adhere to the lobbying restrictions described in the award document	*Part V, 15	DNNA			
Manage confidential or proprietary business, technical or financial information in accordance with the Trade Secrets Act	*Part V, 22	DOE			

Requirement	Reference	Responsible Party[1]	Completed? Y/N	Proficiency (5= Highly Proficient; 1= Not Proficient)	Comments
Process any request for release of confidential or proprietary business, technical or financial information consistent with the Freedom of Information Act and DOE FOIA regulations	*Part V, 22	DOE			
Submit deliverables in a timely manner (i.e., in accordance with the schedule established in the award)	*Part III	DNNA			
Meet or exceed Cooperative Agreement time milestones	*Part III	DNNA/DOE			
Fulfillment of Cooperative Agreement Objectives					
Prepare and submit the ESBWR design certification application	*Part III	GEH via DNNA before 4/1/2007; GEH after 4/1/2007			

A P P E N D I X 5

Requirement	Reference	Responsible Party[1]	Completed? Y/N	Proficiency (5= Highly Proficient; 1= Not Proficient)	Comments
Obtain NRC design certification for the ESBWR	*Part III	GEH via DNNA before 4/1/2007; GEH after 4/1/2007			
Prepare and submit a COLA for the ESBWR at the North Anna site	*Part III	DNNA			
Obtain NRC approval of the COLA	*Part III	DNNA			
Complete the ESBWR standardized and site-specific design and other site-specific engineering	*Part III	GEH (technology) and DNNA (site-specific)			
Develop the business case necessary to support a decision on building a new nuclear power plant	*Part III	DNNA			

*DOE Notice of Financial Assistance Award, North Anna Construction and Operating License Demonstration Project, Instrument Number DE-FC07-05ID14635, Revision A001

[1]DOE= U.S. Department of Energy; DNNA= Dominion Nuclear North Anna, LLC; GEH= General Electric-Hitachi Nuclear Energy, Inc.

A P P E N D I X 5

Please provide general comments on the North Anna COL Demonstration Project (What worked well? How might the process be improved? How successful was the project in advancing the goals of the NP 2010 program?)