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Development of a Flexible Computerized Management Infrastructure for a Commercial Nuclear Power Plant

By

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EXECUTIVE SUMMARY

Following the Energy Policy Act of 2005 in the United States, it is expected that new commercial nuclear power plants or utilities will emerge to meet the nation's energy requirements. In the meanwhile, the existing utilities are in the process of obtaining licenses for extended operation beyond their predetermined design life. In this beneficial yet challenging situation, it seems desirable to develop a strategic plan for smooth and seamless transition from paper based procedure systems to computer based procedure systems for improved performance and safety of the existing utilities. Many of the utilities already maintain procedures using word processing software, but print paper copies for daily use. For a contributory role in initiating a strategic plan, this report offers a comprehensive questionnaire that is suitable for conducting a survey to determine the related needs of the utilities. The questionnaire covers the following areas: Computer Based Procedure System Procedure Formatting, Navigation Tools and Methods, Calculation Tools, Reference Identification and Accessibility, Wireless technologies, Portable Computer Devices, Environmental Considerations, Physical Constraints and User Capabilities, Team Performance, Safety and Reliability, Verification & Validation, and Regulatory Requirements. This report includes a suggestion for conducting the survey in three stages.

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I. INTRODUCTION

To help meet the energy needs of the United States, the Energy Policy Act of 2005, signed into law in August 2005, encourages, amongst several measures, more nuclear and hydropower production by authorizing the Department of Energy (DOE) to develop accelerated programs for the production and supply of electricity. The Act has generated a new wave of optimism in the nuclear technology community. It will enhance the related research and development efforts. It is most likely that it will provide adequate resources to the Nuclear Regulatory Commission (NRC) to develop needed regulations to assure safety while the utilities progressively move toward automation and efficiency enhancement. The nation at large will then develop confidence in deriving benefits from nuclear power. An immediate visible outcome of the Act is that two sites in the U.S. have been selected to receive new nuclear power reactors (exclusive of the new reactor scheduled for Idaho National Laboratory). Steps toward ordering new nuclear power reactors are also expected at additional sites (see NRC's Wikipedia Web-site). The anticipated commissioning of new plants is especially noteworthy when we acknowledge that the existing 103 commercial nuclear power plants (NPPs) in the U.S. are aging, and they are aging almost all at once. It is understood that, concurrent with adding new NPPs, the Act promotes adaptation of state of the art methods for increased efficiency in the existing NPPs, and for ensuring availability of skilled labor for the emerging new NPPs. Prior to the Act, the DOE had started supporting efforts toward continued reliable, safe, and cost effective operation of the existing plants beyond their predetermined design life. The NRC has been issuing guidelines for these efforts (see NRC Web-site). Nearly half of the operating reactors have already received license extensions that will allow them to operate for 20-25 additional years.

The existing NPPs have been essentially using the Paper Based Procedure Systems (PBPSs) for their operation. Dexter (1997) has reported that staying with the use of PBPSs will lead to inefficiency of the plant and increased operating costs. It is obvious that the efficiency will further decrease as younger individuals, who are less tuned to use PBPS and more comfortable with computer consoles, join the nuclear power work force. The existing utilities have been pursuing ways to modernize their procedure systems to maintain safe, efficient and uninterrupted operation (see Dexter, 1997). Successes of several efforts in improving operation efficiency are reported in the literature. It is understood that a changeover from PBPSs to Computer Based Procedure Systems (CBPSs) must be one of the major improvement efforts. Adopting CBPSs now would become a motivating factor for students of high schools, colleges and graduate schools to look forward to careers in nuclear science and technology. It appears that in some of the utilities, various measures of adaptation of computers into the plant procedure systems have been mutually incompatible. The incompatibility between different components of the system has become a deterrent against deriving benefits from computerization of certain sets

of procedures for a plant.   A single NPP is, perhaps, not capable of undertaking the planning and implementation of smooth transition to a CBPS.

To achieve a swift yet smooth transition from PBPS to CBPS, an integrated comprehensive strategy is required for the commercial NPPs. The strategy will address common needs of all nuclear power plants in the nation while offering sufficient flexibility to accommodate their individual needs. Adequate supporting literature is available for such an attempt. Usman, Hajek and Christenson (2000) have described a Paperless Reactor Operations System. They have also provided information on many of the related recent references. For participating in the efforts to promote the development of integrated comprehensive strategy for smooth transition from PBPS to CBPS in the commercial NPPs, we have developed a questionnaire for a nationwide survey of commercial nuclear utilities. This report talks about the expected benefits and risks of the proposed transition. It highlights the areas of relevance for which the questions are developed. It provides the questionnaire in a format that is ready for conducting a survey. This report also suggests the required measures for conducting a survey.

II. MOVING FROM PAPER TO COMPUTER-BASED PROCEDURES

O'Hara and others (2004, NUREG 0711) describe the procedures in the following manner: "Procedures are essential to plant safety because they support and guide personnel interactions with plant systems and their response to plant related events. Procedures should be developed from the same design process and analyses as the human system interfaces and training. This will result in a well integrated design with a high degree of consistency." International Atomic Energy Agency's Draft Safety Guide DS 347 Draft 2 of 2005 suggests: "Administrative controls should be established to ensure that only valid operating procedures are in use and that outdated procedures are not used by mistake. The maintenance of plant procedures should ensure their rapid retrieval. Special care should be taken when new procedures are introduced and used for the first time."

Roth and O'Hara (2002, NUREG/CR-6749) have studied the control room (CR) modification project of a Swiss nuclear power plant based on pressurized water reactors. The modifications were designed by Westinghouse and included the adaptation of CBPS. Roth and O'Hara especially addressed human performance issues with regard to the new human system interface technologies. Their conclusions include the following: "The introduction of computer-based human system interface system significantly affects crew structure and crew communication. The fact that the crew is using multiple independent sources of information and multiple independent perspectives may increase the crew reliability by increasing the probability of detecting and correcting errors in situation assessment, thus reducing the potential for errors of intention. However, the improvement in performance and reliability depends on the ability of the crew to effectively communicate and maintain a shared situation awareness."

Geary et al (2005, DOE sponsored work) have compared Revision 2 of NUREG -0700 (O'Hara et al, 2002) in comparison with its Revision 1 (O'Hara et al, 1996). They have found that, in Revision 2, four hundred of the new guidelines pertain to new features and functions of the human system interface that were introduced during the last decade due to computer

automation and information technology. Montie (2003) has described the Idaho National Laboratory's simulator based on RELAP 5-3D (Reactor Excursion and Leak Analysis Program 5 – 3 Dimension). The software models neutron dynamics and fluid flow systems of light water reactors. Once data for the physical characteristics (piping and component layout, materials, control systems, and normal operating conditions) of a reactor are entered in the code, it can emulate normal operation or any number of accident scenarios to predict how the system will behave. It displays three-dimensional systems as interactive three-dimensional images. The planned developments include changes required to model Generation IV reactors, which are expected to be inherently safe. Simulators based on RELAP5 – 3D or other versatile software contribute in training of operators for procedure systems including CBPS.

White et al (1991) have presented interesting scenario of European nuclear instrumentation and controls. They said: "All European countries that operate European power plants, as well as Canada, Japan and the U.S., are moving toward use of digital computers. The role of a reactor operator (RO) varies by country. Japan and Germany are moving toward high degree of automation, whereas in France the emphasis is on computer-generated procedures to facilitate decision-making by skilled operators. In U.S. and Soviet plants, the emphasis is on using digital systems to help operator in identifying problems, deciding on corrective actions, and executing those actions."

For the procedure systems and their use in a nuclear reactor unit in the U.S., one of the authors of this report learned the following from an RO: "Eleven ROs form the work crew for a unit. They are responsible for the operation of the system from plant start up to full power steady state operations. During steady state, they align systems for maintenance and testing. They use general operating procedures, standard operating procedures and surveillance test procedures. These procedures are reproduced from read only electronic master files. Paper master control copies are located with the office that is responsible for their periodic updating. During a round, an RO uploads information on a PDA (Personal Digital Assistant), then it is uploaded on a workstation for review and comparison with previous rounds. The databases for the lubrication program, electrical feeder list and equipment identification list are available on the network. Rather slowly, but progressively, the system appears to be changing from PBPS to CBPS."

The above paragraphs are indicating that nuclear power utilities, the related government agencies, and computer hardware and software providers in the U.S. would support a strategic plan of transition from PBPS to CBPS. A need for such a plan becomes more obvious when we recognize that the existing commercial NPPs have either obtained licenses for extension beyond their pre-designed life, or they are in the process of obtaining such extensions.

One of the major concerns related to switchover from PBPS to CBPS in the NPPs is a perceived higher probability of occurrence of accidents. The concern places dual responsibility on the utilities and on the U.S. NRC for themselves to ascertain that appropriate safety measures are incorporated in the CBPS and the public is well informed on those measures. A 1998 report by Nuclear Energy Agency (NEA, 1998) summarizes observations and findings of its member states (including U.S.) on safety issues related to the use of Computer-Based Systems in NPPs.

In a study conducted in Canada the number of computer hardware faults has decreased steadily with time. A U.S. study found that software errors are the largest failure type among computer-based system failures, and failures in the software verification and validation process caused most of the software error events. A Japanese study reported that a good practice was to keep the safety related system logic simple. The report contains a study that emphasizes the need for the software to conform to stringent quality assurance standards. The Canadian approach in the reactor rehabilitation program achieved this by using Ontario Hydro/AECL Software Engineering Standards. In this family of standards, each individual standard corresponds to a defined level of nuclear safety. To comply with the standards, the utility noted the need for computer staff to acquire better knowledge of plant operation than what most of them possessed. Some of the additional important factors from the report are: (i) Feedback of operating and maintenance experience is an important input to failure analysis of complex systems such as computer-based systems, (ii) while computer-based system failures cause few significant safety events, they could cause common cause failures leading up to significant events, and (iii) software modification during operation is one of the major sources for software errors.

To develop a program for a nationwide switch over from PBPS to CBPS, it is interesting to recall the Chinese program of commissioning of new NPPs in pairs that is planning, constructing and commissioning two new plants at a time so that the experience shared amongst them and the lessons learned from them would benefit in the planning of a subsequent set of two new plants. For introducing CBPS in the U.S. NPPs, we might adopt a derivative of the Chinese program that would introduce CBPS in two or more utilities at a time instead of only two at a time. Perhaps, the U.S. DOE may offer certain incentives to five NPPs at a time to introduce CBPS within a certain prescribed time period. The choice of five can be made in a manner where they do not belong to the same group. They should be encouraged to share their experiences during and after the implementation of CBPS in their respective units. Moreover, they must be required to report in what manner and to what extent they mutually shared experiences on performance and safety. The DOE's incentives may then depend on a review of the reported shared experiences.

The first five selected plants, for their own competitive ranking, may decide to make a rapid move toward using CBPS and two or more of them may move ahead to approach automation of the plants at Level 4. According to a report (James D. White et al, 1991) on European Nuclear Instrumentation and Controls, the Level 4 of automation is described as total automation of the plant, with an intelligent control system aware of operational status and in interactive communication with the RO to keep her/him apprised of any degraded conditions, likely consequences of these conditions, and possible strategies for minimizing deleterious consequences. At this point most plant functions would be automated and robotized including maintenance and security surveillance.

III. DEVELOPMENT OF THE QUESTIONNAIRE

Through a heuristic analysis, we prepared a preliminary listing of areas to represent the primary structure of plant procedure systems and how they fit into the overall structure of plant configuration management, including the Work Control Process, maintenance, surveillance, and operations management, and required record keeping and archiving. The preliminary list

comprised of the following areas: Virtual procedure formatting, Navigation tools and methods, Calculation tools, Reference identification and accessibility, Wireless technologies, Portable computer devices, Environmental considerations, Physical constraints, Team membership, performance and interaction, User capabilities and limitations, Safety and reliability, Verification & Validation (V&V), Computer System Life Cycle Analysis, and Regulatory requirements and satisfaction, Security assurance. The preliminary list was submitted to a limited group of plant engineers and operators, who assisted in the review of the list and provided additional details under the list items. Then, the drafted questions were re-submitted to the same engineers and operators, who assisted in refining them.

The final version of the questionnaire, which is reported in the next section of this report, covers the following areas:

A.   CBPS Procedure Formatting

In the event of using two modes, PBPS and CBPS, it is understood that appropriate interfacing between the two systems would allow switching between the modes and proper representation of rules. Questions pertain to current modes of plant operating procedures, off normal procedures and surveillance procedures, frequency of changes in procedures and procedure formats, distinct best and worst features of the current procedures, and needed approvals and reviews of changes.

B.   Navigation tools and methods

Navigation with a CBPS should support the same amount of flexibility as PBPS. Navigation needs to support use of all system features. The complexity of executing an action should be minimized and support experienced operator actions. The questions pertain to kinds of navigation tools and aids and distinct most useful and least useful features.

C.   Calculation tools (including calculation aids)

User tools could be developed to support operators with calculations, viewing parameters, and identifying status, and guide operator decision-making. The questions pertain to the kinds of tools in regular use, needed improvements, ways of making them available, and anticipated training requirements and probable reluctance toward the use of improved tools.

D.   Reference identification and accessibility

The questions pertain to number of interruptions in procedures for the need of a reference, importance of ready availability of a reference for a decision to suspend a procedure, and concerns involved in the decision to seek a reference during performance of a procedure. The questions also relate to preference between seeking a reference and obtaining someone's guidance, and the most likely required reference materials before beginning a task and during a task involving procedure use.

E.   Wireless technologies

The questions require identification of wireless technologies currently in use, their importance for using portable computer based systems, and suggested proximity of plug-in locations.

F.   Portable computer devices

The questions relate to the kinds of portable computing devices in use, required training for their use in CBPS, concerns on their reliability, interruptions due to limited battery life, weights and carrying or supporting methods, and data logging options.

G.   Environmental considerations

Questions relate to environments, which would affect either the work efficiency while using portable computing equipment or the safety and performance of the equipment, and measures for moving equipment between contaminated and non-contaminated environments.

H.   Physical constraints and User capabilities and limitations

Questions relate to required ADA related accessibility options for the use of CBPS and comparing how the performance of a task is affected by carrying around portable computer as opposed to accessing PBP.

I.   Team membership, performance and interaction

Questions relate to communication among team or crewmembers, effectiveness, accuracy and efficiency of Web-based communications as compared with those of personal voice communications. Questions also consider email communications and automatic notifications, and their desirable frequencies.

J.   Safety and reliability

The questions relate to importance of the automatic permanent logging of Technical Specifications related Surveillance Requirement data and operators' awareness of transmitted data. They also highlight the effect of failure rate of CBPS and the need of carrying a laptop-size computer.

K.   Verification & Validation and Computer System Life Cycle Analysis

The questions address the concerns about authorized personnel for modification and updating, interaction of CBPS with other plant systems, and cost involved in acquisition and ongoing support of the system.

L.   Regulatory requirements and satisfaction

The questions pertain to permanent and real time logging of technical specification related surveillance requirements, tracking and verification of changes in procedures, and possible remote monitoring of performance on procedures.

M.   Security Assurance

Questions address the issues of possible access by hackers, and the need of the read only files with associated problems.

N.   Category of respondent

Here, the respondent would provide age, sex and experience related information and the kind and size of the plant.

O.   The questions inviting descriptive answers

The questions invite the respondent to talk about training requirements, future compatibility concerns, access security and respondent's own concerns and comments.

For analysis of responses, it would be desirable to divide the performance tasks into four areas; they are procedure management, procedure execution, reference management, and archiving. The helpful material for implementation would include the basic structure of a CBPS, which has been detailed for the Paperless Reactor Operations System (PROS) by Usman, Hajek and Christenson (2000), and the recent presentation by DiFrancesco and Hajek (2005) on "Conceptual Model Design for Computerized In-Field Nuclear Power Plant Procedures". Review and analysis of another computer-based procedure system, COPMA-III at the Halden Project described by Oivind and Nilsen also provides insight for implementation methods and obstacles.

IV. THE QUESTIONNAIRE

Acronyms and terms used in this questionnaire are:

CBPS   Computer-Based Procedure System
CBPs   Computer-Based Procedures
PBPS   Paper-Based Procedure System
PBPs   Paper-Based Procedures
In-field   Any location outside the Main Control Room (MCR)
NPP   Nuclear Power Plant
MCR   Main Control Room
PDA   Personal Digital Assistant
ADA   Americans with Disabilities Act

Please check appropriate number to indicate your response to a question.
Additionally, please feel free to write other alternatives, if a question has space for them. In the last section, the questions invite you to write your own complete answers, if you wish so.

We will certainly appreciate your responses to all questions, but the discretion remains yours to answer as many questions as you wish.

A.   CBPS procedure formatting

Defining the CBPS procedure format should take good paper based procedure (PBP) features, and add new capabilities, which a CBPS will allow. Depending upon the scope of integration, all "modes" (paper or computer) that a procedure may use should allow switching between the modes and proper representation of rules.

A1. What is current mode of the following operating procedures in your plant?
1 = all paper based, 2 = mostly paper based, 3 = combination of paper & computer based, 4 = mostly computer based, 5 = all computer based.

(i)	normal procedures	1 2 3 4 5
(ii)	off normal procedures	1 2 3 4 5
(iii)	surveillance procedures	1 2 3 4 5
(iv)	emergency procedures	1 2 3 4 5

A2. How many times have the following operating procedures changed in five years?
1 = 0 to 3 times, 2 = 4 to 10 times, 3 = 11 to 50 times, 4 = 51 to 100 times, 5 = 1001 or more times.

(i)	normal procedures	1 2 3 4 5
(ii)	off normal procedures	1 2 3 4 5
(iii)	surveillance procedures	1 2 3 4 5
(iv)	emergency procedures	1 2 3 4 5

A3. How many times are procedure formats changed in five years?
1 = 0 or 1, 2 = 2 or 3, 3 = 4 or 5, 4 = 6 or 7, 5 = 8 or more.   1 2 3 4 5

A4. What are the admirable features of your current procedures?
1 = not admirable, 2 = somewhat admirable, 3 = okay, 4 = admirable, 5 = highly admirable.

(i)	Easy to find information you need	1 2 3 4 5
(ii)	Easy to follow steps going from page to page	1 2 3 4 5
(iii)	Simplified steps, graphs and charts	1 2 3 4 5
(iv)	Use of cautions	1 2 3 4 5
(v)	Monitoring steps of continuous applicability	1 2 3 4 5
(vi)	Easy management of multiple procedures at a time	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5

(viii)   Other_____   1 2 3 4 5

A5. What are the worst features of your current procedures? Please feel free to add more features and rate them. 1 = *not so bad*, 5= *worst*.

(i)	Hard to find information you need	1 2 3 4 5
(ii)	Hard to follow steps going from page to page	1 2 3 4 5
(iii)	Multi page steps, graphs or charts	1 2 3 4 5
(iv)	Use of cautions	1 2 3 4 5
(v)	Monitoring steps of continuous applicability	1 2 3 4 5
(vi)	Managing multiple procedures at one time	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

A6. When implementing procedures in computer form, what changes will be required, if any, to deal with the current practice of making temporary procedure changes in pen?

(i)	Will additional approvals or reviews be needed?	No	Yes
(ii)	Will transmittal of pen & ink changes to procedure managers or plant management change?	No	Yes
(iii)	Will electronic signatures replace pen signatures?	No	Yes
(iv)	Will added security be required?	No	Yes
(v)	Other_____	No	Yes
(vi)	Other_____	No	Yes

B.   Navigation tools and methods

Navigation with a CBPS should support the same amount of flexibility as PBPs. Navigation needs to support use of all system features. The complexity of executing an action should be minimized.

B1. What kind of navigation tools and aids are used in the current procedures?

(i)	Check boxes?	No	Yes
(ii)	Signature boxes?	No	Yes
(iii)	Lining out of completed items?	No	Yes
(iv)	Ability to put N/A (not applicable)?	No	Yes
(v)	All (i) to (iv) above	No	Yes
(vi)	Other_____	No	Yes

B2. Are operators currently permitted to skip steps or move along while waiting for a step to complete automatically, such as a heatup that takes time?

      No   Yes

B3. Should electronic signatures be required in CBPS to skip steps?

      No   Yes

B4. For skipping a step in the current procedures, what are different notations required from an operator to ascertain coming back to it?

(i)	Place a colored sticker on skipped step	No	Yes
(ii)	Place a tab on the page that has skipped step	No	Yes
(iii)	Other_____	No	Yes
(iv)	Other_____	No	Yes
(v)	Other_____	No	Yes

B5. How helpful are these navigational aids.
1= *not available*, 2 = *least helpful*, 3 = *helpful*, 4 = *very helpful*, 5= *most helpful*.

(i)	Table of contents.	1 2 3 4 5
(ii)	Pointers.	1 2 3 4 5
(iii)	Section dividers.	1 2 3 4 5
(iv)	Flags.	1 2 3 4 5
(v)	Other_____	1 2 3 4 5
(vi)	Other_____	1 2 3 4 5

B6. What are the most useful navigational features of the current paper procedures?
1= *not available*, 2 = *not useful*, 3 = *useful*, 4 = *very useful*, 5= *most useful*.

(i)	Table of contents with page numbers.	1 2 3 4 5
(ii)	Separate folders for different sets of procedures	1 2 3 4 5
(iii)	Other_____	1 2 3 4 5
(iv)	Other_____	1 2 3 4 5
(v)	Other_____	1 2 3 4 5

B7. If you could design a CBPS, what navigation feature of the paper-based procedures would you want to preserve? 1 = *No need to preserve*, 5 = *Must preserve*.

(i) Numbering system be retained.	1 2 3 4 5
(ii) Other_____	1 2 3 4 5
(iii)Other_____	1 2 3 4 5
(iv)Other_____	1 2 3 4 5

B8. If you could design a computer-based procedure, what navigation feature of the paper-based procedures would you want to eliminate?
1 = *No need to eliminate*, 5 = *Must eliminate*.

(i)	Long names.	1 2 3 4 5
(ii)	Other_____	1 2 3 4 5
(iii)	Other_____	1 2 3 4 5
(iv)	Other_____	1 2 3 4 5

B9. What additional navigation aids/features would you like to recommend in a CBPS?
1 = *Not recommended*, 5 = s*trongly recommend*.

(i)	Ability to search for systems, numbers, names or phrases.	1 2 3 4 5
(ii)	Ability to sort for systems, numbers, names or phrases.	1 2 3 4 5
(iii)	Other_____	1 2 3 4 5
(iv)	Other_____	1 2 3 4 5

C.   Calculation tools (including calculation aids)

CBPS tools can support performing calculations, viewing parameters, and identifying status of equipment, procedure steps, etc., and guiding operator decision-making.

C1. What calculation tools are required on a regular basis when using procedures?
1 = *Not required*, 3 = *Desirable but not regularly required*, 5 = *regularly required*

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C2. Please indicate how important is the availability of these tools for a typical shift.
1 = *not important*, 5 = *very important*.

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C3. Please indicate how important these tools are for a typical day.
1 = *not important*, 5 = *very important*.

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C4. Please indicate how important these tools are for a typical week.
1 = *not important*, 5 = *very important*.

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C5. Please indicate how important these tools are for a typical fuel cycle.
1 = *not important*, 5 = *very important*.

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C6. Please indicate how important are these tools for use during training exercises.
1 = *not important*, 5 = *very important*.

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C7. Due to high temperature environment or otherwise, please indicate how hard it is to use the following tools.
1 = *very easy to use*, 5 = *very hard to use*.

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C8. Please indicate how hard it is to learn the use of the following tools during training exercises. 1 = *very easy to learn*, 5 = *very hard to learn*.

(i)	Calculators.	1 2 3 4 5
(ii)	Tables.	1 2 3 4 5
(iii)	Figures.	1 2 3 4 5
(iv)	Nomograms.	1 2 3 4 5
(v)	Output from risk monitor.	1 2 3 4 5
(vi)	Output from reactivity calculator.	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5
(viii)	Other_____	1 2 3 4 5

C9. Please indicate acceptable ways of making the calculation and status tools available?
1 = *Not acceptable*, 5 = *Very acceptable*.

(i)	Clicking on an icon.	1 2 3 4 5
(ii)	Automatic availability when a step is reached.	1 2 3 4 5
(iii)	Hyperlink.	1 2 3 4 5
(iv)	Popup calculator.	1 2 3 4 5
(v)	Other_____	1 2 3 4 5
(vi)	Other_____	1 2 3 4 5

C10. Please indicate preference for method of required training for the use of tools in CBPS.
1 = *not preferred*, 5= *highly preferred*.

(i)	Manually supervised rigorous training.	1 2 3 4 5
(ii)	Computer based self-training.	1 2 3 4 5
(iii)	Combined (i) and (ii)	1 2 3 4 5
(iv)	Detailed instructions available without training.	1 2 3 4 5
(v)	Periodic re-training.	1 2 3 4 5
(vi)	Other_____	1 2 3 4 5
(vii)	Other_____	1 2 3 4 5

C11. If training were needed, would it be a deterrent to the use of newly developed tools?

No   Yes

C12. Please indicate the expected degree of resistance to using new computer-based tools in lieu of familiar tools currently used. 1= *no resistance*, 5= *high resistance*.

1 2 3 4 5

D.   Reference identification and accessibility

For such questions, which do not pertain to your own work responsibilities, please provide a response based on your perception of operators.

D1. In a working shift, approximately how many operators do you supervise?
1 = *0 to 2*, 2 = *3 to 5*, 3 = *6 to 9*, 4 = *10 to 12*, 5 = *13 or more*.

1 2 3 4 5

D2. In a working shift, how often do all operators supervised by you suspend a procedure because of the need to look into a reference?
1 = *0 or 1*, 2 = *2 or 3*, 3 = *4 to 6*, 4 = *7 to 9*, 5 = *10 or more*

1 2 3 4 5

D3. Would an operator seek a reference before performing a task that s/he could complete by trial and error without affecting safety?

No   Yes

D4. Would an operator use a reference if s/he were in a location close (within 3 minutes of walking) to its availability?

No   Yes

D5. Would an operator use a reference if s/he were in a location *not* close (between 3 to 10 minutes of walking) to its availability?

No   Yes

D6. Would an operator use a reference if s/he needs to ask another person for the required reference?

No   Yes

D7. For a reference an operator otherwise would not seek, would having it immediately available on a portable computer increase her/his likelihood of using it?

No   Yes

D8. Would having a reference resident on a portable computer rather than resident on a server accessible in the plant affect an operator's likelihood of using it?

No   Yes

D9. Would having a reference available resident on a computer rather than having it readily accessible from a central Intranet site affect an operator's likelihood of using it?

No   Yes

D10. Would an operator prefer to seek help from another operator or senior operator to consulting a reference on her/his own?

No   Yes

D11. Please indicate the likelihood for an operator to use the following reference materials <u>before</u> beginning a task involving procedure use. 1= *not very likely*, 5 = *very likely*

(i)	Piping & Instrument Drawings (P&IDs).	1	2	3	4	5
(ii)	Logic Drawings.	1	2	3	4	5
(iii)	System or Component Operating Manual.	1	2	3	4	5
(iv)	Administrative Procedure.	1	2	3	4	5
(v)	System training materials.	1	2	3	4	5
(vi)	Training one-line diagrams.	1	2	3	4	5
(vii)	Technical Specifications.	1	2	3	4	5
(viii)	Updated Final Safety Analysis Report.	1	2	3	4	5
(ix)	Plant Process Computer.	1	2	3	4	5
(x)	Control Room computer displays.	1	2	3	4	5
(xi)	Equipment location determination maps.	1	2	3	4	5
(xii)	Other_____	1	2	3	4	5
(xiii)	Other_____	1	2	3	4	5

D12. Please indicate the likelihood for an operator to use the following reference materials <u>during</u> beginning a task involving procedure use. 1= least likely, 5 = most likely.

(i)	Piping & Instrument Drawings (P&IDs).	1	2	3	4	5
(ii)	Logic Drawings.	1	2	3	4	5
(iii)	System or Component Operating Manual.	1	2	3	4	5
(iv)	Administrative Procedure.	1	2	3	4	5
(v)	System training materials.	1	2	3	4	5
(vi)	Training one-line diagrams.	1	2	3	4	5
(vii)	Technical Specifications.	1	2	3	4	5
(viii)	Updated Final Safety Analysis Report.	1	2	3	4	5
(ix)	Plant Process Computer.	1	2	3	4	5
(x)	Control Room computer displays.	1	2	3	4	5
(xi)	Equipment location determination maps.	1	2	3	4	5
(xii)	Other_____	1	2	3	4	5
(xiii)	Other_____	1	2	3	4	5

E. Wireless technologies

E1. Please express your preferences regarding the following wireless technologies for your operating unit.
1 = *Not available in the plant and I do not recommend it*
2 = *Not available in the plant but I recommend it*
3 = *Not available in the plant but I strongly recommend it*
4 = *Available in the plant but I do not like it*
5 = *Available in the plant and I like it.*

(i)	Blue tooth technology.	1	2	3	4	5
(ii)	Wireless network connections	1	2	3	4	5
(iii)	Simulator wireless capability	1	2	3	4	5
(iv)	Other_____	1	2	3	4	5
(v)	Other_____	1	2	3	4	5

E2. How important is the availability of wireless technologies to you when using a portable CBPS? 1 = *not important*, 5 = *very important*.

1   2   3   4   5

E3. Is wireless technology required for a successful CBPS?

No   Yes

E4. If wireless technologies are not in use at your plant, within how many minutes of walking from an operator's work area must a plug-in location be for her/him to make regular and efficient use of the plug-in facility? 1 = 1 *minutes*, 2 = 3 *minutes*, 3 = 10 *minutes*, 4 = 15 *minutes*, 5 = 30 *minutes*.

1   2   3   4   5

F. Portable computer devices

F1. Please express your preferences regarding the following portable computing devices for your operating unit.
1 = *Not available in the plant and I do not recommend it; 2 = Not available in the plant but I recommend it; 3 = Not available in the plant but I strongly recommend it; 4 = Available in the plant but I do not like it; 5 = Available in the plant and I like it.*

(i)	Scientific calculator.	1	2	3	4	5
(ii)	Graphing calculator.	1	2	3	4	5
(iii)	Personal Digital Assistant (PDA).	1	2	3	4	5
(iv)	Notebook computer	1	2	3	4	5
(v)	Tablet computer.	1	2	3	4	5
(vi)	Cell phone with calculator	1	2	3	4	5
(vii)	Portable Data Scanner	1	2	3	4	5
(viii)	Bar Code Reader	1	2	3	4	5
(ix)	Other_____	1	2	3	4	5
(x)	Other_____	1	2	3	4	5

F2. How confident are you of the reliability of portable computing equipment?
1 = *not confident*, 5 = *highly confident*   1   2   3   4   5

F3. Please suggest minimum number of hours of battery life required for satisfactory task completion. 1 = *between 2 to 3 hours*, 2 = *between 3 to 6 hours*, 3 = *between 6 to 8 hours*, 4 = *8 to 12 hours*, 5 = *more than 12 hours*.   1   2   3   4   5

F4. Please suggest the warning time in minutes required to enable recovery from a low battery condition. 1 = *0 to 5 minutes*, 2 = *5 to 10 minutes*, 3 = *10 to 15 minutes*, 4 = *15 to 20 minutes*, 5 = *20 to 30 minutes*.   1   2   3   4   5

F5. What is the weight in pounds of portable computing equipment that you would expect an operator to carry during task completion?
1 = *1 lb or less*, 2 = *3 lb or less*, 3 = *5 lb or less*, 4 = *7 lb or less*, 5 = *10 lb or less*.
                                                       1   2   3   4   5

F6. Please indicate desirability of method of carrying portable computing equipment by an operator. (1 = *not desirable*, 5 = *highly desirable*)

(i)	Hand carried.	1	2	3	4	5
(ii)	Case with hand straps.	1	2	3	4	5
(iii)	Arm mounted.	1	2	3	4	5
(iv)	Waist mounted	1	2	3	4	5
(v)	Other_____	1	2	3	4	5
(vi)	Other_____	1	2	3	4	5

F7. Please give your recommendation for data logging options. (1 = *not recommended*, 5 = *highly recommended*).

(i)	Keyboard to insert any necessary data.	1	2	3	4	5
(ii)	Barcode type reading device.	1	2	3	4	5
(iii)	Handwriting recognition software on a tablet computer.	1	2	3	4	5
(iv)	Handwriting recognition software on a PDA.	1	2	3	4	5
(v)	Single multi-purpose device including voice recognition, automatic data retrieval and logging, GPS recording and video.	1	2	3	4	5
(vi)	Multiple devices (cell phone, hand held data logger w/ wireless data transfer capabilities).	1	2	3	4	5
(vii)	Other_____	1	2	3	4	5
(viii)	Other_____	1	2	3	4	5

F8. How strongly you recommend? (1 = *not recommended*, 5 = *highly recommended*)

(i)	Video viewing on the portable device?	1	2	3	4	5
(ii)	Video capture during step performance for documentation?	1	2	3	4	5
(iii)	Other_____	1	2	3	4	5
(iv)	Other_____	1	2	3	4	5
(v)	Other_____	1	2	3	4	5

G.   Environmental considerations

G1. With concerns about the safety of the equipment, indicate to what degree the following in your plant would be deterrents to the use of portable computing equipment? (1 = *not a deterrent*, 5 = *strong deterrent*)

(i) High heat environments.	1	2	3	4	5
(ii) Wet environments.	1	2	3	4	5
(iii) Direct Radiation environments.	1	2	3	4	5
(iv) Radiation Contaminated environments	1	2	3	4	5
(v) High chemical use areas such as boric acid batching areas or demineralizer regeneration areas.	1	2	3	4	5
(vi) Electronic interference from cell phone & other wireless devices.	1	2	3	4	5
(vii) Other_____	1	2	3	4	5
(viii) Other_____	1	2	3	4	5

G2. With concerns about work efficiency while using the equipment, indicate to what degree the following in your plant would be deterrents to the use of portable computing equipment? (1 = *not a deterrent*, 5 = *strong deterrent*).

(i) High heat environments.	1	2	3	4	5
(ii) Wet environments.	1	2	3	4	5
(iii) Direct Radiation environments.	1	2	3	4	5
(iv) Radiation Contaminated environments.	1	2	3	4	5
(v) High chemical use areas such as boric acid batching areas or demineralizer regeneration areas.	1	2	3	4	5
(vi) Electronic interference from cell phone.	1	2	3	4	5
(vii) Other_____	1	2	3	4	5
(viii) Other_____	1	2	3	4	5

G3. In your plant, will it be necessary to have one set of portable computing equipment for use in Radiation Control Areas and another set for use outside of these areas? 1 = *Not necessary*, 3 = *Desirable but not necessary*, 5 = *Necessary*)

1	2	3	4	5

G4. In your plant, are measures available for protecting portable computing equipment so that it can be transferred between contaminated and non-contaminated areas? (1 = *Not available*, 3 = *Available but not adequate*, 5 = *Available and adequate*)

1	2	3	4	5

G5. If different equipment is to be used inside and outside of radiation control areas, would then data be transferred by using (*1 = Least Preferred, 3= Acceptable, 5 = Most Preferred*)

(i) Jump drive.	1	2	3	4	5
(ii) Plug into wired Ethernet.	1	2	3	4	5
(iii) Using wireless Ethernet.	1	2	3	4	5
(iv) Other_____	1	2	3	4	5
(v) Other_____	1	2	3	4	5

H. Physical constraints and User capabilities and limitations

H1. Please indicate your recommendations for the following accessibility options (ADA related) required for use of a CBPS. 1 = *Not recommended*, 5 = *highly recommended.*

(i)	Large fonts.	1	2	3	4	5
(ii)	Large buttons.	1	2	3	4	5
(iii)	Redundant coding for color blindness.	1	2	3	4	5
(iv)	Specialized facility for handicapped.	1	2	3	4	5
(v)	Other_____	1	2	3	4	5
(vi)	Other_____	1	2	3	4	5

H2. Please indicate your recommendations for the following wearable computing devices for the use of a CBPS. 1 = *Not recommended*, 5 = *highly recommended.*

(i)	Belt worn CPUs.	1	2	3	4	5
(ii)	Arm worn CPUs.	1	2	3	4	5
(iii)	Clip-on CPUs.	1	2	3	4	5
(iv)	Eye level displays.	1	2	3	4	5
(v)	Heads up displays.	1	2	3	4	5
(vi)	Other_____	1	2	3	4	5
(vii)	Other_____	1	2	3	4	5

H3. Are wearable computing devices more desirable than carry-around devices?

No   Yes

H4. Would having a portable computer to carry around during task performance increase the difficulty of task performance relative to use of paper procedures?

No   Yes

I. Team membership, performance and interaction

I1. During in-field procedure performance, how important is communication among team or crewmembers? 1 = *not important*, 5 = *very important*.

1   2   3   4   5

I2. Would continuous Web-based communication using portable computing equipment enable an SRO to observe when each procedure step is completed, whether out in the plant or in the Control Room?

No   Yes

I3. Would continuous Web-based communication using portable computing equipment improve the operators' job performance?

No   Yes

I4. The computer-based communication is more **effective** than personal voice and/or face-to-face communications. 1 = *strongly disagree*, 2 = *disagree,* 3 = *more in some cases but less in others*, 4 = *agree*, 5 = *strongly agree*

| 1 | 2 | 3 | 4 | 5 |

I5. The computer-based communication is more **accurate** than personal voice and/or face-to-face communications. (1 = *disagree*, 5 = *strongly agree*).

| 1 | 2 | 3 | 4 | 5 |

I6. The computer-based communication is more **efficient** than personal voice and/or face-to-face communications. (1 = *disagree*, 5 = *strongly agree*).

| 1 | 2 | 3 | 4 | 5 |

I7. How frequently should task performance be communicated to crew supervision?
(1 = *not necessary*, 5 = *absolutely necessary*)

(i)	After completion of a task?	1	2	3	4	5
(ii)	After each part-evolution completion in addition to (i)?	1	2	3	4	5
(iii)	After each procedure step in addition to (i) and (ii)?	1	2	3	4	5

I8. Would email be an effective communication device to send confirmation of completed tasks?   No   Yes

I9. Should automatic notifications be included to send confirmations of completion of specific evolution events?   No   Yes

J.   Safety and reliability

J1. How important is the automatic permanent logging of Technical Specification related Surveillance Requirement data? (1 = *not important*, 5 = *very important*)

| 1 | 2 | 3 | 4 | 5 |

J2. What is the maximum permissible failure rate of a CBPS?
(1 = *once per month*, 2 = *once in 6 months*, 3 = *once per year*, 4 = *once in 4 yrs*, 5 = *never.*)

| 1 | 2 | 3 | 4 | 5 |

J3. How do you perceive carrying a laptop size computer in your hands will affect your personal safety? (1 = *no effect*, 5 = *serious effect*)

| 1 | 2 | 3 | 4 | 5 |

J4. If wireless communication is used, how do you perceive the need to connect?
1 = *only in limited hot spots is okay*, 2 = *only at specific data panels is okay*, 3 = *everywhere data must be read or entered*, 4 = *it is okay to enter data and have it transmitted later*, 5 = *everywhere at all times*.

| 1 | 2 | 3 | 4 | 5 |

J5. If wireless communication is used, and it is not available everywhere, how important is it for a procedure performer to know when delayed data transmission occurs?

    (i)   Should procedure performer be notified as a confirmatory measure?

                                        No   Yes

    (ii)   Should procedure performer have control of when data is transferred rather than permitting automatic data transmission?

                                          No   Yes

K.   Verification & Validation (V&V) and Computer System Life Cycle Analysis

K1. Would there be significant saving of time by being able to pick up a portable computer knowing its limitation that only the latest procedure will be accessed?

                                        No   Yes

K2. Are you confident that accessing an electronic procedure copy will relinquish the need to page check procedures?

                                          No   Yes

K3. Who, by plant position, should be involved in validating operation of a CBPS?
1 = *Should not be involved*, 3 = *Okay to involve*, 5 = *Must be involved*

(i)	Writer.	1	2	3	4	5
(ii)	Reviewer.	1	2	3	4	5
(iii)	Manager.	1	2	3	4	5
(iv)	Plan Operating Review Committee.	1	2	3	4	5
(v)	Other _____	1	2	3	4	5

K4. How many plant personnel should be involved in a CBP validation program?
(1 = *1 or 2*, 2 = *3 or 4*, 3 = *5 to 7*, 4 = *8 to 10*, 5 = *11 or more*)

                                  1   2   3   4   5

K5. What systems must the CBPS interact with?

(i)	System of documents.	No	Yes
(ii)	Checklist data base system	No	Yes
(iii)	Electronic Clearance Process System	No	Yes
(iv)	Prints and Drawings.	No	Yes
(v)	Technical Manuals	No	Yes
(vi)	Other_____	No	Yes
(vii)	Other_____	No	Yes

K6. Will the CBPS reduce the time required to update and replace a procedure?
(1 = *No reduction*, 3 = *Moderate reduction*, 5 = *Significant reduction*.)

                                  1   2   3   4   5

K7. How well will the CBPS work within other computerized systems?
(1 = *not well*, 5 = *very well*)   1   2   3   4   5

K8. Please tell us about flexibility of CBPS software from the following vendors.
(1 = *Not flexible*, 3 = *Moderately flexible*, 5 = *Highly flexible*)

(i)	General Electric.	1	2	3	4	5
(ii)	Westinghouse.	1	2	3	4	5
(iii)	SAP.	1	2	3	4	5
(iv)	Oracle.	1	2	3	4	5
(v)	Computer Associates	1	2	3	4	5
(vi)	General Physics	1	2	3	4	5
(vii)	SAIC	1	2	3	4	5
(viii)	Other_____	1	2	3	4	5
(ix)	Other_____	1	2	3	4	5

K9. What vendor software is likely to provide future ongoing support?

(i)	General Electric.	1	2	3	4	5
(ii)	Westinghouse.	1	2	3	4	5
(iii)	SAP.	1	2	3	4	5
(iv)	Oracle.	1	2	3	4	5
(v)	Computer Associates	1	2	3	4	5
(vi)	General Physics	1	2	3	4	5
(vii)	SAIC	1	2	3	4	5
(viii)	Other_____	1	2	3	4	5
(ix)	Other_____	1	2	3	4	5

K10. What vendor software would you recommend for cost reasons?
1 = *Not recommended*, 3 = *Recommended*, 5 = *Strongly recommended*.

(i)	General Electric.	1	2	3	4	5
(ii)	Westinghouse.	1	2	3	4	5
(iii)	SAP.	1	2	3	4	5
(iv)	Oracle.	1	2	3	4	5
(v)	Computer Associates	1	2	3	4	5
(vi)	General Physics	1	2	3	4	5
(vii)	SAIC	1	2	3	4	5
(viii)	Other_____	1	2	3	4	5
(ix)	Other_____	1	2	3	4	5

K11. Transfer of the PBPS to a CBPS will have a financial cost. Please respond to the following concerns:

(i)	Do the benefits of this system conversion justify the infrastructure costs associated with implementing this in the plant?	No	Yes
(ii)	Must the costs be bundled with other projects?	No	Yes
(iii)	Do you anticipate significant cost savings per year with a fully implemented CBPS?	No	Yes
(iv)	Do you anticipate significantly less maintenance costs for a CBPS in comparison with a PBPS?	No	Yes

L. Regulatory requirements and satisfaction

L1. How important is the automatic *permanent* logging of Technical Specification related Surveillance Requirement data? (1 = *not important*, 5 = *very important*)

           1   2   3   4   5

L2. How important is the automatic *real time* logging of Technical Specification related Surveillance Requirement data? (1 = *not important*, 5 = *very important*)

           1   2   3   4   5

L3. Given that procedure performance can be instantly logged during performance, should regulators be permitted to observe procedure performance from a distant location without an operator's knowledge?   No   Yes

L4. Will changes to procedures in a CBPS require greater regulatory scrutiny than changes to procedures in a PBPS?   No   Yes

L5. Will a new procedure/process be required for tracking and verifying changes/latest revision of a CBPS?   No   Yes

M. Security assurance

M1. Is it required that wireless communications be encrypted?   No   Yes

M2. What is the risk that hackers would alter server-based documents or test results? 1 = *no risk*, 5 = *great risk*.   1   2   3   4   5

M3. Can a CBPS be maintained on the same secure plant process computer system that provides real-time data to MCR personnel?   No   Yes

M4. Should CBPS files be read-only kind on a central web server?   No   Yes

M5. How will Completed Working Copies (CWCs) be filed/stored if CBPS has 'read only' files? 1 = *Not preferred*, 5 = *Highly preferred*.

   (i)   Store CWCs on read and write CDs with limited access.   1   2   3   4   5

   (ii)   Make CWCs available on read and write Microsoft Word or other word processor files with limited access.   1   2   3   4   5

   (iii)   Store CWCs on read and write files in jump drives with limited access. 1   2   3   4   5

   (iv)   Oracle database files   1   2   3   4   5

   (v)   SAP database files   1   2   3   4   5

   (vi)   Other_____   1   2   3   4   5

N.   Category of respondent

(Reminder: Use your discretion to answer or to leave out any of these questions.)

N1. Your present position, please.
1 = Executive or manager or engineer, 2 = Senior Reactor Operator, 3 = Licensed Reactor Operator, 4 = Non-licensed Reactor Operator, 5 = Other_____

1	2	3	4	5

N2. Your experience at present position. *1 = Less than 5 years, 2 = 5 years or more but less than 10 years, 3 = 10 years or more but less than 20 years, 4 = 20 years or more but less than 30 years, 5 = 30 years or more.*

1	2	3	4	5

N3. Your overall experience in nuclear science or technology work (excluding formal education but including training or re-training). *1 = Less than 5 years, 2 = 5 years or more but less than 10 years, 3 = 10 years or more but less than 20 years, 4 = 20 years or more but less than 30 years, 5 = 30 years or more.*

1	2	3	4	5

N4. Completed duration of your formal education, beyond eighth grade of school education, excluding training or re-training. *1 = Less than 3 years, 2 = 3 years or more but less than 6 years, 3 = 6 years or more but less than 9 years, 4 = 9 years or more but less than 12 years, 5 = 12 years or more.*

1	2	3	4	5

N5. Your age, please. *1 = Less than 25 years, 2 = 25 years or more but less than 35 years, 3 = 35 years or more but less than 50 years, 4 = 50 years or more but less than 65 years, 5 = 65 years or more.*

1	2	3	4	5

N6. Please indicate your gender: Female   Male

N7. Your NPP Unit is what kind?

(i)	Pressurized water reactor.	No	Yes
(ii)	Boiling Water Reactor.	No	Yes
(iii)	Other_____	No	Yes

N8. What is the rated net capacity of your unit in Mega Watts Electrical?
1 = 0 to 200, 2 = 201 to 500, 3 = 501 to 1000, 4 = 1001 to 1200, 5 = 1201 or more.

1	2	3	4	5

O. The questions that need descriptive answers

Please answer as many questions as you wish in as much detail as you like.

O1. If a CBPS were implemented at your plant, how many weeks of training (initial training, dual operation training, frequency and length of retraining) you would suggest for yourself.

O2. How can procedures be written to ensure future compatibility with new systems and avoid legacy software issues?

O3. What is the minimum CBPS access security that should be implemented?

O4. Please provide additional comments, suggestions and concerns that you wish to express, including suggestions for cost savings.

V. CONDUCTING THE NEEDS SURVEY

We believe that the survey conducted by using the proposed questionnaire would help appreciably in preliminary planning and decision making to introduce CBPSs in commercial NPPs in the U.S. Certain challenges, however, are associated with the exercise of conducting the survey. Three major challenges are: (i) Respondents should be motivated to devote the time for providing requested information or suggestions. (ii) Respondents should be convinced that their anonymity will be maintained. (iii) The utilities must be convinced that security of the sensitive information will be guarded.

Motivation of the respondents is necessary in this survey because the survey does not have a limited objective of seeking opinions only, it treats the respondent as a resource for providing ability and experience based information and suggestions. Anonymity of the respondent is desired for the obvious reason that the respondent must feel free to provide useful information and comments. The security of information is necessary because spontaneously a respondent might provide sensitive information while the survey is in process.

The enunciated three challenges necessitate that a commercial or a government agency should be a coordinator in the conduct of the needs survey. Perhaps an organization like the Electric Power Research Institute (EPRI) or the Institute of Nuclear Power Operations (INPO) would be forthcoming to coordinate with a DOE sponsored team in taking up the survey task. Involvement of EPRI or INPO like organization may not merely motivate the respondents to participate in the survey, it might even generate enthusiasm amongst them. The enthusiasm would be further enhanced if the respondent would expect to receive feedback of the

development of a strategic plan to implement switchover from PBPS to CBPS. It is suggested that for determining the needs of commercial NPPs for introducing CBPS, the survey may be conducted in the following three stages. Perhaps these stages would be equally relevant whether the survey task is taken up at the national level or it is done by a group within its own utilities.'

A. <u>Needs Survey Amongst Senior Reactor Operators</u>:

The first stage of the survey may be conducted amongst all the Senior Reactor Operators (SROs) of the participating commercial NPPs. An experienced SRO has indicated to one of the authors of this report that, in general, the SROs have adequate experience and knowledge in the areas that are addressed in the questionnaire. For SROs, the full questionnaire may be used in its present format. For easy but secure access by the invited respondents, the questionnaire may be placed on a Web site. On the Web site, the questionnaire can be made available on a computer screen programmed in a manner that the responses would be stored in a database, and statistically they may be directly analyzed from the same database. Descriptive answers may be processed in a different category. It is expected that a well-motivated respondent would fill in 340 boxes and 45 blank spaces and would provide four descriptive answers to complete the response. It is estimated that a respondent would take 50 to 80 minutes for a complete response to the questionnaire. Therefore, it would be advisable that the Web site offers flexibility to the respondent to provide answers in two or three brief sessions before clicking in a completion prompt.

B. <u>Needs Survey Amongst Operators</u>:

Based on the results of the survey responses of the SROs, the questionnaire may be modified for ROs. Additionally, a few ROs at different utilities may be consulted to consider dividing the questionnaire into three or four modules. Some of the questions may be included in all modules. The Web-site program may then offer a flexibility feature. In a preliminary interaction with the Web site, a respondent would indicate her/his area of expertise. An appropriate module of the questionnaire would then appear on the Web site inviting the respondent to fill that in. This second stage of the survey may be conducted amongst all the ROs of the participating commercial NPPs. The responses would be stored in a database and statistically directly analyzed from that database. There is an interesting possibility that the ROs' and SROs' answers to the common questions would be significantly different. One of the causes of the anticipated difference in responses might be the operators' frequent and intimate use of certain procedure whereas the SROs have the supervisory, somewhat distant and a system perspective of the procedures.

C. <u>Needs Survey Amongst Engineers, Managers and Executives</u>:

A survey amongst the engineers, managers and executives is necessary to obtain a comprehensive perception of the needs of commercial NPPs for a planned introduction of CBPS. The questionnaire for them can be better designed once the results are available from the surveys amongst SROs and ROs. The methods of conducting the survey and analyzing the data should be the same as used for the SROs and ROs.

VI. INFRASTRUCTURE DEVELOPMENT

A combined consideration of the surveys and holding of formal conferences amongst representatives of the utilities would lead to the development of a flexible computerized management infrastructure for commercial NPPs. The international scenario of competition and progress in nuclear power production and the emphases of the 2005 Energy Policy on more nuclear power production in the U.S. appear to invite us to expedite introduction of CBPSs in our existing commercial NPPs. Accordingly, it appears advisable to conduct the first stage of the proposed survey within the next few months.

VII. CONCLUSION

For continued safe and efficient operation of the one hundred and three commercial nuclear power plants in the U.S., it is desirable to develop a flexible computerized management infrastructure. To meet this objective, a comprehensive survey is required to compile data on the current modes of operation procedures in the existing power plants, and on their needs for a smooth transition to computer based procedure systems. This report has offered a questionnaire as a survey instrument. The instrument is suitable for completing the first stage of the proposed three-stage survey.

VIII. REFERENCES

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