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AUTH.NAME AUTHOR AFFILIATION
VANBRUNT,E.E. Arizona Public Service Co.
RECIP.NAME RECIPIENT AFFILIATION
KNIGHTON,G. Licensing Branch 3

SUBJECT: Forwards program plan issues & areas for outstanding items re NUREG-0737,Item I.D.1 re detailed control room design review per NUREG-0700 requirements & SER,NUREG-0857.Generic Ltr 82-33 issues addressed.

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June 17, 1983
ANPP-24121 - ACR/ECS

Director of Nuclear Reactor Regulation
Attention: Mr. George Knighton, Chief
Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Docket Nos. STN-50-528/529/530
File: 83-056-026; G.1.01.10

Reference: (1) NUREG-0857, "Safety Evaluation Report" (SER) related to the Operation of Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2 and 3 dated November, 1981.

(2) NUREG-0857, Supplement 1, "Safety Evaluation Report" related to the Operation of Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2 and 3 dated February, 1982

(3) APS Letter from E. E. Van Brunt, Jr., APS, to George W. Knighton, NRC, dated March 14, 1983

(4) APS Letter from E. E. Van Brunt, Jr., APS, to R. L. Tedesco, NRC, dated June 16, 1982

(5) APS Letter from E. E. Van Brunt, Jr., APS, to R. L. Tedesco, NRC, dated August 14, 1981

(6) NRC Letter from George W. Knighton, NRC to E. E. Van Brunt, Jr., dated May 10, 1983; Subject: Response to Generic Letter 82-33.

(7) NRC Letter from Frank J. Miraglia, NRC, to E. E. Van Brunt, Jr., dated May 11, 1982; Subject: Status Report of the Control Room Design Review of Palo Verde.

(8) APS Letter from E. E. Van Brunt, Jr., APS, to George Knighton, NRC, dated April 14, 1983

Dear Mr. Knighton:

In Reference (6), the NRC provided their comments on the APS response to Generic Letter 82-33 (Reference 8), concerning the PVNGS Detailed Control Room Design Review (DCRDR) and requested, from Arizona Public Service

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Company (APS), the Program Plan that was used in performing the PVNGS DCRDR. In lieu of the requested Program Plan submittal, this letter addresses, in Attachment A, the nine issues or areas described in Reference (6) that are necessary to be included in the Program Plan. A Program Plan which includes these nine areas or issues was not created for the PVNGS DCRDR due to the timing of our study in relation to the issue of NUREG-0700. Attachment A will provide guidance as to where in our DCRDR the items are addressed. The following describes what was developed and gives a status of where we currently stand.

In June, 1980, APS committed to performing a DCRDR in response to NUREG-0660 and 0737, Task I.D.1. APS in an effort to maximize the benefits of this effort in a timely manner began this control room design review, in good faith, prior to the NRC finalizing their guidance (NUREG-0700). This was due to the stage of construction of the Palo Verde Nuclear Generating Station at that time where the results of such an undertaking would be successfully implemented into the base design (thereby be included in the bases for operating procedures, staffing, training) prior to receipt of an operating license.

To administer the program and also to be flexible to new information and guidance, an internal program plan was prepared in August, 1980. This internal program plan was intended to be an evolving document wherein new material which developed as the program progressed was added to provide overall program guidance. Material included in this internal program plan was later used in producing the final report (Executive Summary Report) submitted to the NRC staff by the Reference (5) letter.

All the available guidance published (NUREG/CR-1580) at the time was used to formulate the DCRDR. The DCRDR was performed at the PVNGS control room simulator which is a replica of the plant's control rooms. The use of the PVNGS control room simulator allowed APS to proceed in an actual control room environment rather than in a mock up, or the postponing of the DCRDR until after commercial operation where implementation of fixes would be more difficult and would require operator re-training. Since the design basis criteria used to build the simulator control boards and the Units' control boards were the same, this assured that what was studied was the actual PVNGS control room configuration.

To provide Human Factors expertise to the review team, APS through our Architect/Engineer, Bechtel Power Corporation, engaged Torrey Pines Technology (TPT), who brought on board human factors experts from McDonnell-Douglas Corporation to aid in the performance of the PVNGS Human Factors Study. The PVNGS Human Factors Study also received input from APS operators and Combustion Engineering, PVNGS Nuclear Steam Supply System (NSSS) supplier. In August, 1981, the study was completed with the exception of the following items:

1. Operator Training and Preparedness: Survey questions on final operator preparedness;

2. Operator Task Analysis: Evaluate operator functional capability via walk-throughs of operating procedures; and

3. Environmental Survey: Study of HVAC, sound and lighting.

An Executive Summary Report was transmitted to the NRC on August 14, 1981, Reference (5). This Executive Summary Report gave the basis by which the program was performed and the basis by which all identified Human Engineering Discrepancies (HED's) were resolved. The Executive Summary Report described the multi-disciplinary review team and the type of analysis and surveys that were performed during the study. The NRC Human Factors Engineering Branch (NRC/HFEB) performed a CRDR Audit from September 15 through September 17, 1981 at the PVNGS control room simulator. The Staff also briefly reviewed the PVNGS control room in Unit 1 and verified that the simulator and control rooms(s) would, in fact, be identical. The NRC/HFEB review team identified a number of HED's in addition to those identified in the PVNGS DCRDR. These additional HED's were transmitted to APS on October 28, 1981. The results of the NRC reviews were documented in Section I.D.1 of NUREG-0857, Reference (1) and Section I.D.1 of NUREG-0857, Supplement 1, Reference (2).

The open items, listed in Section I.D.1 of the SER, Reference (2), will be dispositioned as indicated in Attachment B. This commitment was made in the March 23, 1983 meeting between the NRC/HFEB staff and APS.

Previous to that, a meeting was held on July 1, 1982, between the NRC/HFEB and APS concerning the new guidance of NUREG-0700. This is discussed in our letter, Reference (4). We indicated in that letter that our review was a Detailed Control Room Design Review (DCRDR) and not a Preliminary Design Assessment (PDA). As a result of the meeting, APS is to provide the following backup information to ensure that the NRC has sufficient documentation on the DCRDR performed by APS. Action 1 will be included in the Supplement to the PVNGS Control Room Human Factors Executive Summary Report due to be issued by July 1, 1983.

1. Status sheet of HED fixes
2. Description of System Factors review (Attachment D)
3. Human Factors Experts qualifications (Attachment C)
4. Description of how HED's were categorized (Attachment E)
5. Status report of open items (Attachment B)

In summary, the DCRDR performed by APS, using NUREG/CR-1580 as a guideline and reviewed against NUREG-0700, identifies all HEDs at the PVNGS control room simulator which is an exact replica of the PVNGS

control rooms. HEDs identified by the NRC Human Factors Engineering Branch (NRC/HFEB) review team during their audit at PVNGS have also been included into the PVNGS DCRDR. As a result of those actions, APS has complied with the intent of the requirements of NUREG-0700 pending the disposition of already identified outstanding items and, thus, have satisfied the requirements of Task I.D.1 of NUREG-0737, Supplement 1.

Very truly yours,

E. E. Van Brunt

E. E. Van Brunt, Jr.
APS Vice President,
Nuclear Projects
ANPP Project Director

EEVB/ECS/wp
Attachment

cc: A. C. Gehr (w/attach.)
E. Licitra "
A. Ramsey-Smith "
D. Tondi "

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

I, Edwin E. Van Brunt, Jr., represent that I am Vice President, Nuclear Projects of Arizona Public Service Company, that the foregoing document has been signed by me on behalf of Arizona Public Service Company with full authority to do so, that I have read such document and know its contents, and that to the best of my knowledge and belief, the statements made therein are true.

Edwin E. Van Brunt, Jr.

Edwin E. Van Brunt, Jr.

Sworn to before me this 17th day of June, 1983.

Nora E. Meador

Notary Public

My Commission Expires:

My Commission Expires April 6, 1987

ATTACHMENT A

PROGRAM PLAN ISSUES AND AREAS

1. Qualifications and Structure of the DCRDR Review Team

Qualifications of the PVNGS DCRDR Review Team are addressed in Attachment C of this letter. The structure of the PVNGS DCRDR program is shown on Figure 1-1 of the Reference (5) letter attachment.

2. Function and Task Analysis

The System Factors Study (Function and Task Analysis) performed in the PVNGS DCRDR is addressed in Attachment D of this letter. Attachment D discusses the program APS will perform to complete the Remote Shutdown Panel Review. Section 2.2.3 of the Reference (5) attachment describes the tasks that were developed to assess the plant systems and control board configuration in terms of required system functions and operator functions.

3. Control Room Inventory

The Human Factors Study, Section 2.2.1 of the Reference (5) letter attachment, describes the guidelines used in performing the Human Factors Study which is an assessment of the control room and environment in terms of accepted human engineering principles. An explicit inventory of the control boards was not made prior to the control room survey. All items on the boards were checked during the control room survey.

4. Control Room Survey

The Human Factors Study, Section 2.2.1 of the Reference (5) letter attachment discusses the guidelines used in performing the PVNGS control room survey. These guidelines were used to assess the control room and its environment in terms of accepted human engineering principles.

5. Assessment of HEDs

The assessment of the PVNGS HEDs is addressed in Section 2.4 of the Reference (5) letter attachment. This section describes in detail the data evaluation performed by APS in assessing all HEDs. Attachment E of this letter provides the HED categorization process employed by APS during the HEDs assessment.

6. Selection of Design Improvements

The selection of design improvement for the PVNGS DCRDR descrepancies is documented in Section 2.4 of the Reference (5) attachment and Attachment F of this letter. Section 2.4 and Atttachment F describe the process of selecting the design improvement by the Management Team and Result Review Committee during the PVNGS DCRDR. The selected design improvements for the PVNGS DCRDR have been addressed by APS in the Reference (4) and (7) letters. Reference (4) contains: (1) a listing of each HED, (2) correction action for each HED, and (3) implementation schedule for each HED.

7. Verification That Improvement Will Provide Necessary Correction

Verification that improvements will provide the necessary corrections at PVNGS have been addressed by completing the Supervisor/Operators Questionnaires and follow-up operator interviews. Interviews were conducted by APS' Human Factors consultants (TPT). This area was also addressed during the PVNGS control room validation which consisted of operator performance of procedures. TPT conducted the procedure performance consisting of a Start-Up and a Small Break LOCA procedure. The start-up procedure was selected because of the board range of activities that are required by the operator. The LOCA procedure was selected

due to the required rapid action and the complex situations that can develop. The Supplement to the Executive Summary Report will address these tasks and will be submitted to the NRC by July 1, 1983.

8. <u>Verification That Control Room Modifications Do Not Introduce New HED's</u>

Verification that the PVNGS control room modifications have not introduced any new HEDs have been addressed by completing the Supervisor/Operator Questionnaires and follow-up operator interviews. Interviews were conducted by TPT. Verification was also accomplished by performance of selected procedures in the control room. These procedures consisted of a Start-Up and a Small Break LOCA (refer to Item 7 for reasons behind procedure selection). The Supplement to the Executive Summary Report will address these tasks and will be submitted for NRC review by July 1, 1983.

9. <u>Coordination of the CRDR With Other Improvement Programs, e.g., SPDS, Operator Training, Upgraded EOPs, New Reg. Guide 1.97 Instrumentation</u>

As a part of our overall commitment to address all the TMI improvements, the new instrumentation, e.g., SPDS and Reg. Guide 1.97 instruments, was included in the original scope of the PVNGS DCRDR. The operator training and EOPs received their basis from the PVNGS DCRDR. The same personnel from APS Operations were involved in all three activities (DCRDR, training and EOPs).

ATTACHMENT B

STATUS REPORT OF OPEN ITEMS

A meeting was held on March 23, 1983 with the NRC Human Factors Engineering Branch (HFEB) to address Item 2 of the Reference (3) letter concerning the apparent slippage of Items 1 through 9 and 13 listed in Reference (2), Section I.D.1. APS indicated that the reasons for the delay of these items in Reference (3) was the lack of final physical configuration of the control room proper in Unit 1 due to Starup testing.

The original concept of the APS DCRDR was to study the final physical configuration of the PVNGS Control Room and report. Pursuant to the discussions with the NRC/HFEB staff, APS will change their basis of its study to perform the DCRDR for the items indicated below on the design drawings and will report by July 1, 1983. This will close nine of the thirteen SER, Reference (2), Section I.D.1 items.

SER Item 1 - A detailed comparison of the simulator with the Unit 1 control room could not be performed to identify all differences that might exist.

APS Action: APS will compare the configuration at the time of the study of the Unit 1 control boards to the PVNGS simulator control board to address this item. This item will be completed by July 1, 1983.

SER Item 2 - General Layout

- Document organization and storage
- Spare parts, operating expendable and tools
- Supervisor access
- Non-essential personnel access

<u>APS Action</u>: APS will utilize the design drawings as the basis for review of these items. This item will be completed by July 1, 1983.

SER Item 3 - <u>Emergency Equipment</u>

- ° Operator protective equipment
- ° Fire, radiation, and rescue equipment
- ° Emergency equipment storage

<u>APS Action</u>: APS will study the design criteria as the basis for review of these items. This item will be completed by July 1, 1983.

SER Item 4 - <u>Environment</u>

- ° Temperature and humidity
- ° Ventilation
- ° Emergency lighting
- ° Auditory
- ° Personal storage
- ° Ambience and comfort

<u>APS Action</u>: APS will delay and complete per Reference (3) prior to plant operation exceeding 5% power.

SER Item 5 - The absence of documents made it impossible to evaluate consistency of procedure terminology with labels, displays, abbreviations, or document indexing and cross-referencing.

APS Action: APS will review the design documents as the basis for review of this item. Ths item will be completed by July 1, 1983.

SER Item 6 - Due to the existing state of the system, it was not possible to adequately evaluate all of the CRT displays for content and data presentation format.

APS Action: APS will review the design documents as the basis for review of the CRT displays. This item will be included in the Supplement to the PVNGS Control Room Human Factors Executive Summary Report due to be issued on July 1, 1983.

SER Item 7 - Lack of actual emergency gear prevented the evaluaton of the operation of controls while wearing or using the emergency gear, or the availability of face masks with diaphragms capable of transmitting speech.

APS Action: APS will use the PVNGS control room simulator to evaluate the operation of contols while using emergency gear. This item will be included in the Supplement to the PVNGS Control Room Human Factors Executive Summary Report due to be issued on July 1, 1983.

SER Item 8 - The actual discernability and reliability of audio signals above ambient noise could not be measured.

APS Action: APS will delay and complete per Reference (3) prior to plant operation exceeding 5% power.

SER Item 9 - The capability of complete internal and external communications during emergencies (i.e., paging at the remote shutdown panel and/or direct communication with back panels, shift supervisor's office, etc.) could not be evaluated.

<u>APS Action</u>: APS will delay and complete per Reference (3) prior to plant operation exceeding 5% power.

SER Item 10 - Since only Panel B06 had color-shaded background panel sections, it was not possible to evaluate the effectiveness throughout the entire control room of the use of shading colors to identify groups of functionally related controls and displays.

<u>APS Action</u>: APS will complete by July 1, 1983.

SER Item 11 - The proposed Plant Protection System logic alarm box on Panel B05 could not be evaluated because it is not yet installed.

<u>APS Action</u>: APS will complete July 1, 1983.

SER Item 12 - The out-of-service and temporary labeling systems had not been developed.

<u>APS Action</u>: APS will complete by July 1, 1983.

SER Item 13 - The following instrumentation systems which HFEB typically reviews were not available:

a. In-Core Thermocouple Instrumentation Displays
b. Sub-Cooling Monitor Instrumentation Displays

APS Action: The core level following equipment will not be functional until after fuel load. APS will evaluate and report prior to plant operation exceeding 5% power.

ATTACHMENT C

HUMAN FACTORS EXPERTS QUALIFICATIONS

Attachment C

VIRGIL J. BARBAT *
Project Manager
Torrey Pines Technology

PROFESSIONAL SPECIALTY

Management and coordination of multi-disciplined engineering projects.

EDUCATION

B.S., Engineering Physics, University of Michigan, 1961
M.S., Nuclear Engineering, University of California, Berkeley, 1963

PROFESSIONAL EXPERIENCE

Currently Project Manager of a wide variety of commercial projects including Class 1E equipment qualification, reactor control room human factors review and synthetic fuels, reliability and hazards analysis. Primary functions include establishment of program objectives and performance requirements, budget allocation and expenditure monitoring, resolution of schedule and budget problems, customer liaison, and monitoring of engineering performance. Responsible for a 1980 budget of more than $4,000,000.

Previously assigned to the Fort St. Vrain Nuclear Generating Station Project and responsible for component performance analysis and overall plant steam system design verification.

Other assignments at General Atomic included the aerodynamic design and performance analysis of rotating machinery, establishing and supervising component and full-scale aerodynamic tests of the constructed equipment, and Section Leader responsible for testing and analysis of all rotating equipment designed and built at General Atomic.

PROFESSIONAL ASSOCIATIONS

Member, American Society of Mechanical Engineers
Registered Professional Mechanical Engineer, California

* TPT Program Manager for the PVNGS DCRDR.

Attachment C

CHARLES R. BOLAND *
Project Manager

PROFESSIONAL SPECIALTY

Operational, training, startup, design and project management experience related to gas turbine, steam and nuclear power plants.

EDUCATION

- B.S., Marine Engineering, U. S. Merchant Marine Academy, 1956

EXPERIENCE

Responsible for the design and development of an 1170 MW(t) process steam/cogeneration reactor capable of producing steam for either electric or process applications.

Responsible for the design and development of an 1170 MW(t) nuclear reactor capable of demonstrating the full scale components to be utilized in follow-on reformer, gas turbine and process steam/cogeneration reactors.

Responsible for the development of the turbomachinery, generator, heat exchangers and control systems associated with the gas turbine nuclear reactor including technical and programmatic direction.

Acted as site representative during the startup and testing of the Fort St. Vrain nuclear power plant. This work included coordination of site personnel and customer interfacing as required to conduct startup testing and perform system modifications.

Responsible for the development of development plans for the gas turbine and process heat reactors.

Responsible for the preliminary engineering of a 1000 MW(t) fossil fired test loop capable of testing the power conversion components of gas turbine nuclear reactors.

Responsible for the development of all of the power plant systems other than the prime mover. This included generator, switchgear, enclosures, lubrication systems, fuel systems, and inlet and exhaust systems for the 100 MW(e) FT50 industrial gas turbine power plant.

Responsible for the work by the design department of Turbo Power and Marine Systems covering all of the industrial and utility applications of the FT4 industrial gas turbine engine.

Responsible for the design, development and construction of the first combined cycle power plant built by United Technologies Corporations. This work included customer involvement with Public Service of New Jersey as well as coordination of the efforts of De Laval for steam turbine development and waste heat engineering for boiler development. The 125 MW(e) plant is presently operating in Trenton, New Jersey.

Responsible for the design, development, startup, testing and operator training of the world's largest mobile power plant (20 MW(e)).

Responsible for the safe and efficient operation of a prototype nuclear submarine power plant. This involved overall responsibility for the operation and maintenance of the reactor as a test reactor and a training facility for the nuclear Navy.

Operation of turboelectric and geared turbine tankers; design and testing of aircraft gas turbine engines; application of process control instrumentation.

PROFESSIONAL ASSOCIATIONS

Member, American Nuclear Society

* TPT Plant Operation Specialist. Developed the Operator Preparedness Checklist 9, 10, and 11.

Attachment C

A. JOHN ESCHENBRENNER *

PROFESSIONAL SPECIALTY

Psychological research

EDUCATION

B.S., Psychology, Saint Louis University, 1964
M.S., Psychology, Saint Louis University, 1967
Ph.D., Experimental Psychology, Saint Louis University, 1968

EXPERIENCE

In his present capacity at McDonnell Douglas, Dr. Eschenbrenner is assigned to the Human Performance Laboratory and has responsibility for the design and conduct of human performance and applied human factors design studies, particularly in the areas of training/selection technology and computer-based instructional systems. Recently, he was principal investigator on Air Force contract F33615-77-C-0076, Methods for Collecting and Analyzing Task Analysis Data. He is currently program manager on Army contract MDA903-79-C-0390, development of a Mission Track Selection Process for the Army Initial Entry Rotary Wing (RERW) flight training program.

He was Deputy Program manager for the Air Force (AF) AIS Utilization Project. This project included a system analysis of AF training and education requirements.

He directed the AIS Instruction Materials, Instructional Strategies, and Personnel and Training Subsystem efforts. He also served as MDC Engineering Representative on a major AIS subcontract with Applied Science Associates.

He was responsible for in-house and contract research and development (CRAD) training technology studies.

When he first joined McDonnell Douglas Corporation in 1968, Dr. Eschenbrenner participated in human factors research and development work on earth resources reconnaisance systems, perceptual motor skills, and human information processing.

PROFESSIONAL AFFILIATIONS

Member American Psychological Association, American Education Research Association, Human Factors Society, Sigma XI, Missouri Psychological Association

PROFESSIONAL ACTIVITIES

Consulting Editor - Human Factors, The Journal of the Human Factors Society (1969 - 1974)
Member - Scientific Affairs Committee, Missouri Psychological Association (1971 - 1973)
Review board, Division C. (Learning and Instruction), American Educational Research Association Annual Meeting (1977)

LICENSE

State Board of Registration for the Healing Arts of Missouri
State Committee of Psychologists
License No. 00366, 13 August 1978

* Human Behavior Specialist with McDonnel Douglas Corporation and TPT's Human Factors Consultant. Developed the Human Factors checklists 1 through 8. Conducted, collected data and performed evaluation of data for the Human Factors checklist 1 through 8. Also conducted the Operators interviews and assisted in the development of the Operator Preparedness Checklist 9, 10 and 11. [illegible]

ERROL P. GAGNON *
Licensing Engineer

PROFESSIONAL SPECIALTY

Licensing, safety criteria and technical specification preparation and review.

EDUCATION

B.S., Engineering, San Diego State University, 1965

PROFESSIONAL EXPERIENCE AT GENERAL ATOMIC COMPANY (Since 1969)

Chairman of the Results Review Committee of the Human Factors Evaluation program for the Palo Verde Nuclear Power Generating Station control room and responsible for coordination of the program tasks.

Developed safety/licensing positions and criteria for various applications of nuclear power plants.

Evaluated nuclear power plant systems and components to identify and prioritize technical, safety and licensing issues.

Developed nuclear power plant transient performance specifications.

Senior Technical Representative at Fort St. Vrain responsible for technical coordination and guidance on the conduct and evaluation of the startup test program.

Manager of the French Licensee Program responsible for the administrative and technical-transfer aspects of the nuclear power plant licensing agreements and contracts.

Performed simulation studies and evaluations of nuclear power plant transient performance/safety analyses, control systems, control room configurations and plant startup procedures.

OTHER PROFESSIONAL EXPERIENCE

General Dynamics Corporation (1965-1969). Performed dynamic analyses of missile control systems.

PROFESSIONAL ASSOCIATIONS/HONORS

Member, American Nuclear Society

* TPT Licensing and System Specialist. Participated in conducting the Operators Interviews. Assisted in the development of Operator Preparedness Checklist 9, 10 and 11. Coordinated the Human Factors, Operator Preparedness, and System Factors activities. Chairman of the Results Review Committee. Responsible for all the DCRDR documentation (Summary Report, Technical Report).

Attachment C

JOSEPH K. LONIGRO, JR. *

PROFESSIONAL SPECIALTY

Industrial/aerospace training

EDUCATION

A.A.S., Electrical Engr., DeVry Inst. of Technology, 1963
B.S., Management Science, Southern Illinois University, 1973
M.A., Curriculum and Instruction, University of Northern Colorado, 1976

EXPERIENCE

Senior Human Factors Engineer - McDonnell Douglas (1963)

Responsible for the design and application of advanced audiovisual techniques to control and display simulations, part-task trainers and maintenance simulators. Responsible for the human engineering evaluation of the control rooms at Arizona Public Service's Palo Verde Nuclear Generating Station. Control room and panel design and layout are being evaluated using detailed human factors checklists that assess plant operability in terms of the man/machine interface.

Subsystem Manager - Responsible for the management of the Air Force AIS including design, implementation and testing of the Media Subsystem; including design of carrels based on course parameters and on human factors data; the selection of media hardware based on instructional objectives, engineering reliability and maintainability, and human factors data; the design and production of all mediated courseware (software); and the facility design for the AIS learning centers; and surveying training requirements.

PROFESSIONAL ASSOCIATIONS

Member American Educational Research Association
Association for Educational Communications and Technology
Human Factors Society
Member Audio Visual Technology Faculty Advisory Committee, Community College of Denver, Colorado (1976-1979).

* Human Factors Specialist with McDonnell Douglas Corporation and TPT's Human Factors Consultant. Assisted in the development of the Human Factors Checklist 1 through 8. Assisted in the execution, data collection and data evaluation of the Human Factors checklist 1 through 8. Documented descrepancies associated with the Human Factors checklists 1 through 8. Conducted the Operators Interviews and was a partime member of the System Factors Review Team.

Attachment C

SAL F. LUNA *
Senior Staff Engineer
General Engineering Division

PROFESSIONAL SPECIALTY

Design and development, instrumentation and control; human factors

EDUCATION

B.S., Chemistry, Magna Cum Laude, Niagara University, 1947
Specialty courses: Seismic - Wyle Labs, Human Factors - University of Tennessee and Electric Power Research Institute.

EXPERIENCE

Project Engineer for TPT in joint program with McDonnell Douglas for EPRI RF-2011-1 "Development of an Alarm System Improvement Guide."

Project Engineer, Probabilistic Risk. Assessment Study for Fire Protection Program Assessment of Northeast Utilities Nuclear Plants - Connecticut Yankee, Millstone 1, and Millstone 2.

Project Engineer, Human Factors review of Palo Verde Nuclear Generating Station control rooms. Performed Annunciator Prioritization Study for same.

Consultant, review of PG&E equipment qualification documents for NRC approval. Developed formats and organized walk-down teams for PP&L equipment qualification program.

Design of a wide variety of systems for advanced HTGR plants. Special studies for application of all technology for modernizing existing nuclear power plants featuring a "Diagnostic Console."

Directed development of in-core and ex-core instrumentation to study Fort St. Vrain core fluctuation phenomena.

Directed site engineering and craft effort to provide fire protection of critical Fort St. Vrain cabling.

Prepared specifications, designed special testing equipment conducted qualification tests, evaluated results and prepared reports for cabling and instrumentation for Fort St. Vrain equipment qualification program.

Directed design of advanced control room control consoles and unitized cabinets including: human factors engineering, full scale mock-ups, modular construction and seismic qualification.

Managed a wide variety of instrumentational control and development groups at Westinghouse Electric Corp. for the nuclear navy and commercial nuclear programs. Cognizant engineer for Annunciator Systems for same.

Directed the design and development of a wide variety of processing plant instrumentation systems for Catalytic Construction Co.

PUBLICATIONS

Editor of Cassette Control Valve Training Program.
Author of chapter on Maintenance - ISA Control Valve Handbook.
Author of chapter on Liquid Level Measurement - ISA publication.
Also authored a wide variety of technical papers including methodology and results of human factors review of Palo Verde, and advanced control room design.

PROFESSIONAL ASSOCIATIONS

Registered Professional Engineer (control) California
Fellow Grade Member of ISA
Past Vice President Long Range Planning Department of ISA
Nuclear Power Plant Standards Committee of ISA
Member Human Factors Society

* TPT Project Engineer for the PVNGS DCRDR.

Attachment C

ANTHONY J. SPURGIN *
Senior Staff Engineer
General Engineering Division

PROFESSIONAL SPECIALTY

Control Systems Design and Analyses, Safety Analyses and Probabilistic Risk Assessment.

EDUCATION

B.S., Engineering, London, 1952.

EXPERIENCE

Currently working on an indicator readout system for BWR control, the Disturbance Analysis and Survellance System, for EPRI. This requires an intimate knowledge of the systems response to operator actions and reactions.

Responsible for conducting System Factors Task for the Human Engineering Review Program at the Palo Verde Nuclear Generating Station.

Senior Staff Engineer responsible for work proceedings on application of Probabilistic Risk Assessment techniques to petro-chemical, chemical, and coal plants. Directed the controls system design and transient analysis groups working on the Fort St. Vrain plant and several large High Temperature Gas-Cooled plants. While attached to the Fort St. Vrain project at the site directed the redesign of several systems and subsystems.

Project engineer of the Diablo Canyon Project for two years. Prior to this was responsible for the Electrical and Control System design of a hydraulic rod drive system. Designed the Protection and Control System for Westinghouse 3-loop PWR plants. Undertook studies of transient behavior of PWR plants of various types including writing the simulation for these studies.

PROFESSIONAL ASSOCIATIONS

Professional Nuclear Engineer, California, 1978
Professional Controls Engineer, California, 1977
Senior Member of IEEE
Chairman, IEEE Working Group working on Standards
Member of Power Generating and Nuclear Power Engineering Committees.

* TPT System Factors Specialist. Directed the System Factors Study for the PVNGS DCRDR.

Attachment C

THOMAS O. SARGENT *
Director ConServ

PROFESSIONAL SPECIALTY

Counselor, teacher, consultant in human behavior.

EDUCATION

M. Ed., Counseling, University of Hartford, 1969
M. Div., Yale Divinity School, 1954
A.B., Yale University, 1951

EXPERIENCE

Director, ConServe. Experience includes training for work in high stress situations (as medical, nuclear facility), executive consultation, workshops in alcoholism, stress management, motivation, communications and versatility.

Staff instructor, CATI (Change Agents Training Insitute).

Assistant Psychiatric Social Work Supervisor at New Jersey Neuro-Psychiatric Institute. Including program development and administration; student supervision and training; case management; public relations.

Vocational Counselor, Division of Vocational Rehabilitation, State of Connecticut. Counseling and job placement; supervision in work situations; consultation with supervisors and managers regarding problem people on the job.

Staff Member, The Communicators, Pomfret, Connecticut. Film writer, editor and salesman in both narrated filmstrips and motion pictures. Primarily public relations and sales promotion..

PROFESSIONAL ASSOCIATIONS

American Nuclear Society. Chairman, Program Committee, ANS
Technical Group for Human Factors
American Personnel and Guidance Association
Fellow American Orthopsychiatric Association
National Association of Social Workers

* Human Behavior Specialist with Conserv Company and TPT's Human Factors Consultant. Provided groundwork for the Operator Preparedness Study checklist 9, 10 and 11.

ATTACHMENT D

DESCRIPTION OF SYSTEM FACTORS REVIEW

During the period of the PVNGS DCRDR and System Factors Review, NRC guidance in NUREG-0700 was not available. Based on NUREG/CR-1580, APS conducted, in good faith, a System Factors Review to study operator and systems functions or tasks. The review was conducted in the following manner.

A multi-discipline, multi-organizational team was formed consisting of design engineers, operators (an integral part as they assisted in identifying the function of each system), human factors experts, and representatives of the Architect/Engineer (A/E), NSSS supplier, consultant and utility. An intensive training program was provided for those not familiar with the PVNGS design. This training included interviews and discussion with cognizant Bechtel systems engineers. Prior to the detailed review of the systems, the team convened to develop guides in the form of questions. These questions were developed to be the framework around which the system factors review was performed. The process was an analysis of the systems by discussion which was generated by the questions. The uniform set of questions assured the consistancy of analysis for all sections. The following is the list of questions that were developed by the systems factors team, December 1980.

1. What is the primary function of the system?

2. What are the basic requirements of the system?

3. Is the system related equipment mounted on the control board readily discernable as part of the system?

4. How does an operator know that the system is available to perform its function?

5. How does an operator know the system is working?

6. What are the operational modes of the system?

7. Can the system be easily operated when it is put in the most stressful mode of operation?

8. Are there adequate indicators and other control board devices to permit system operation from the Main Control Board?

9. What is the relationship between alarm windows and the system?

10. What is the equipment line-up criteria?

11. What specific actions does the operator take for each system related alarm?

12. Does the system have Main Control Board equipment which is unnecessary or better located remotely?

13. Does the system lack any Main Control Board equipment?

14. Is the control board equipment located on the correct control board? Is it arranged on the control board in a manner to minimize human error?

These criteria were applied during the analysis discussions to ensure system functionality and the ability of the system to meet operator task needs. Also developed during these initial meetings was the criteria listed below:

1. Systems within a functional group should be grouped together.

2. Layout of identical systems within a group should be identical, not mirror images.

3. Associated controls and displays should be in close proximity (i.e., within 2 feet from each other).

4. Displays which have to be compared should be adjacent and values easily readable and comparable.

5. Displays and controls which are considered to be either the most important or are used extensively should be placed in the optimum viewing use areas.

6. Devices of lesser use or importance should be placed in lower, optional areas.

7. Devices which are used infrequently should be removed to local boards.

8. Alarms, displays and controls for systems should have identical spatial arrangements.

9. Relationships between functional characteristics of systems and components should be the same on all of the control boards.

10. Boundaries between systems should be demarked and the areas so contained should be single (i.e., one system should be clearly separated from another system).

11. Systems and subystems should be clearly identified as systems, not by the identification of each individual component.

12. An annunciator system should show a distinction between safety and economics functions with plant safety having the highest layout priority.

13. Easiest line up function during accident and check out.

14. For process flow type systems, other than the CVCS system, the arrangement of components should follow the process flow (e.g., valve suction then pumps, recirculaton alongside pumps, discharge valves, etc.).

15. The layout of control variables, controllers and systems should not be ambiguous. It should be clear which system is which.

16. Between a safety related system and a normally operating system, the safety related system layout should have the highest priority. Between two safety related systems, the one required for instantaneous use should show priority layout over one required for long term use.

17. The operator shall have an immediate and adequate indication of the primary safety response of a system to his control actions.

18. Status instruments and recorders shall be clearly readable by the operator from his normal working position.

19. All controls, switches, valves, and other devices shall be designed to be easily operated by the operator but not be subject to inadvertent operation.

20. The design of displays and controls should enhance functional grouping.

21. All labels shall be as brief as possible, but consistent with clarity of purpose and of systematic hierarchy based on system, subsystem, and component designation.

22. For a given function, the simpler control/device design is to be preferred over a more complex control/device.

23. Alarm systems with audio signals shall be pleasant sounding and readily detectable.

24. Where possible, primary reactor protection systems devices shall be color coded for easy identification.

25. Sufficient instrumentation shall be provided for each system subsystem to optimize that systems/subsystem's safe operational control.

The review team then began their study by breaking the plant down into functional groups, called systems, (i.e., electrical system, condensate, Chemical and Volume Control System (CVCS), etc.). Note that this breakdown was not by control board, but by functional blocks that an operator will be recognizing in plant operation. This follows as the plant will be operated by tasks rather than by control board. The systems were then broken down further into subsystems; subsystems into sections; and sections into subsections. How extensive the breakdown became was based in system complexity.

The team then started to work on the subsections using the System Review questions to generate the basis of the review and then applied the criteria to the basis. All the possible actions of the subsection were reviewed, based on the task requirements of that subsection. Because this task would be the same in all procedures, particular procedures were not used in this context.

The questions were used to review the interrelationship of the pieces at each level of the functional breakdown. Each subsystem, section, etc. was reviewed for its function and the operators ability to monitor and control this function. Particular attention was given to the "primary stress mode." That is the time the operator may be most prone to error due to a large amount of sensory loading and rapid response requirements. An example is the Low Pressure Safety Injection (LPSI) and Containmant Spray (CS) systems. These systems were identified as having least seven possible system lineups (this is independent of which procedures a lineup would be used in, emergency or otherwise). The analysis reviewed the functions of the system regardless of the specific valve lineups. The controls and instrumentation were analyzed to assure the ability of the operator to control and monitor the system.

As a conclusion, the systems were reviewed against the boards for proper placement of the subsystems to support the systems. A summary of the systems and their resulting placement in given below:

B01 - Electric Distribution Panel
- ° Switch Yard
- ° Unit Distribution
- ° Diesel Generators

B02 - Engineered Safety Features
- ° Active Safety Injection Systems
  - High Pressure Safety Injection
  - Low Pressure Safety Injection
  - Containment Spray
- ° Passive Safety Injecton System
  - Safety Injection Tanks

B02 – Engineered Safety Features (continued)

- ° Safety Systems Support Systems
  - – Essential Spray Pond
  - – Essential Cooling Water
  - – Essential Chilled Water
  - – Essential HVAC
  - – Post Accident Monitoring System
- ° Safety Equipment Status System

B03 – Chemical and Volume Control Systems

- ° Reactor Coolant
- ° Charging and Letdown
- ° Boric Acid

B04 – Reactor Systems

- ° Reactor Coolant
- ° Reactor Control
- ° Pressurizer Control

B05 – Plant Protection and Condensate Systems

- ° Reactor Protection System
- ° Core Protection Calculator
- ° Engineered Safety Feature Actuation
- ° Condensate

B06 – Steam Generator/Turbine Generator Systems

- ° Mainsteam
- ° Feedwater
- ° Auxiliary Feedwater
- ° Condensate Transfer and Storage
- ° Turbine Generator

B07 - Miscellaneous and HVAC

- Auxiliary Steam
- Containment Purge
- Cooling Tower
- Circulating Water
- Gas Radwaste
- Plant Cooling Water
- Instrument and Service Air
- Nuclear Cooling Water

Operators Console

- Plant Monitoring Computer Interactive CRT
- Core Monitoring Computer (COLSS) Interactive CRT

Communications Console

- Radiation Monitor CRT and Typewriter
- Communication Equipment
- Fire Protection Alarm CRT

The Systems Factors review discovered more discrepancies than any other part of the DCRDR. Some examples are:

1. The adding of pressurizer pressure and level indication to the CVCS system.

2. Reorientation of the B06 panel (containing Feedwater and Aux feedwater systems).

3. Performance of a separate demarcation study.

4. Performance of an annunciator priority study.

5. Addition of instruments to B06.

It is clear to see that significant improvements were made to the PVNGS control boards as a result of the Systems Factors review.

The Operators Task Analysis, deferred in the first part of the CRDR, will take place via procedure performance. This task is designed to verify the previous systems factors work. The two procedures performed will be the Start-Up and Small Break LOCA. The Start-Up procedure was picked because of the broad range of activities that are required by the operator. The Small Break LOCA procedure was also picked due to the required rapid actions and the complex situations that can develop.

APS is reviewing the Remote Shutdown Panel for human factors problems using knowledge gained from DCRDR performed for the Control Room. A strict application to NUREG-0700 is not being performed.

APS' review of the Remote Shutdown Panel will consist of:

1. Walkdown of the remote shutdown procedure, which is an abnormal operating procedure.

2. Analysis of problems raised during operator training.

3. Witnessing of demonstration of remote shutdown panel during start-up testing.

4. Assuring consistency of labeling.

As a result of the Remote Shutdown Panel review so far, APS has committed to removing the doors off this panel once plant security is in place.

DESCRIPTION OF HED CATEGORIZATION

Each checklist discrepancy (CLD) written described the discrepancy to the guideline and the potential operator error. These inputs, plus the guidelines, were the basis of discussion through which the Results Review Team analyzed the CLD to determine which category in Table 1 it fell into. During the results review teams evaluation, if the CLD was deemed to be a Human Engineering Deficiency (HED), it was assigned one of the four categories as detailed in Table 1 based on the listed criteria. If the CLD was not deemed to be a HED, it was returned to the particular task group for reevaluation.

Prioritized HED's were forwarded to the Management Team for review of the Results Review Team's recommendations and application of the HED criteria. If accepted, an HED fix was implemented. If not accepted, the HED was returned to the Results Review Team for re-review. This procedure was followed until all CLD's were disposed of.

TABLE 1
HUMAN ENGINEERING DISCREPANCY DISPOSITION CRITERIA

Category	Criteria Description	Implementation
A	Safety	Mandatory-Prior to Fuel Loading
B	Reliability (90% Availability Criterion)	Mandatory-Prior to Fuel Loading
C	Reliability-Enhancement	Mandatory-Convenient Outage
D	Minor	Non-Mandatory

Category D discrepancies were not considered as human engineering discrepancies and will be reviewed as plant betterment items.

The four categories detailed in Table 1 were selected by the Management Team and agreed upon by the Results Review Committee. The criteria used by the Management Team in selecting these four categories was based on the concern of personnel safety and the safe operation of the plant.

ATTACHMENT F

SELECTION OF DESIGN IMPROVEMENT

Design improvement recommendations were first made by the Human Factors Evaluator on all descrepancies discovered during the PVNGS DCRDR. The Human Factors Evaluator's criteria for these design improvement recommendations was based on correcting descrepancies by the use of proper Human Engineering Principles.

These recommendations were then submitted to the Results Review Committee for their review. The Results Review Committee members being technical and system oriented, evaluated the selected design improvement provided by the Human Factors Evaluator. Through the process of discussion, the Results Review Committee analyzed the descrepancy to determine if the selected design improvement was appropriate. The Results Review Committee criteria for agreeing or disagreeing with a selected design recommendation was based on personnel safety and safe operation of the plant.

The approved Results Review Committee design improvement recommendations were than submitted for review to the Management Team. Management Team members being technical oriented management individuals further reviewed the Results Review Committees' design improvement recommendations. The review performed by the Management Team was also accomplished through the process of analyzing the descrepancy and selected design improvement by discussion. Criteria used by the Management Team in agreeing or disagreeing with the submitted design improvements was also based on the safety of personnel and safe operation of the plant.