QUARTERLY PROGRESS REPORT

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Institution: The Pennsylvania State University

DE92 003996

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Principal Investigator: Edward H. Klevans

Contract: DE-FG07-89ER 12889

Title: INTELLIGENT DISTRIBUTED CONTROL FOR NUCLEAR POWER PLANTS

ACTIVITY: This report covers the 4 month period from June through September 1991 in order to adjust the quarterly progress reporting interval to the end of the 2nd year budget period. The major accomplishment of this period was the preparation and presentation of 4 papers at the ANS meeting *AI 91: Innovative Frontiers in Innovative Computing for the Nuclear Industry*, September 15-17 1991, in Jackson Wyoming: 1) H.E. Garcia, et al, "On-line Diagnostics and Intelligent Control for the Steam Plant at EBR-II", 2) C.M. Chavez, et al, "A Human Factors Evaluation of a Highly Automated Nuclear Power Plant", 3) J.A. Turso, et al, "Experience with Developing a Real-World Advanced Control and Diagnostic Testbed Using a University Research Reactor", and 4) Adel Ben-Abdennour, et al, "MIMOML Robust Control for Accommodating EBR-II Feedwater System Faults". Each paper is a good summary of the second year's effort on the related task(s).

INTERACTIVE SIMULATION USING VAX <-> SUN COMPUTERS: (AI 91 paper 1) All three subsystems of the EBR-II steam plant are now operational in the distributed simulation testing environment. The three subsystems are the condensate system with the condensate pump and feedwater heaters #1 and #2, the feedwater system with the feedwater pump and heaters #3 and #4, and the steam system with the evaporators, steam drum, superheaters, and main steam bypass valve. Each subsystem simulation operates in a VAX computer and transfer required data using a centralized data base in a UNIX based computer. (Humberto Garcia, EE PhD candidate, and James Turso, NucE PhD student)

STEAM PLANT DIAGNOSTICS: (AI 91 paper 1) The DISYS diagnostic system was also made operational with the complete distributed steam plant simulation and the current effort is refining the data base to identify steam plant faults directly from real-time simulated data. (Phillip Walter, NucE PhD student, and R.M. Edwards, NucE professor.)

LEARNING SYSTEMS: The learning systems approach to reconfigurable control is implemented in a Bailey Multifunction Controller (MFC). All previous simulation testing of this algorithm has interfaced the MFC directly to a VAX computer. Current work is developing an interface to the centralized plant data base in the UNIX computer of the distributed simulation using both serial and IEEE 488 communication procedures. This capability will provide more flexibility in interfacing simulations with the Bailey system and in actual EBR-II experiments. EBR-II has UNIX computers more readily available than VAX computers for communicating with Bailey controllers and monitoring experiments. (Humberto Garcia)

VERIFICATION AND VALIDATION: (AI 91 paper 2) The optimal temperature control algorithm for the Penn State TRIGA reactor has now been successfully demonstrated using a Bailey MFC and provides practical experience to help prepare experiment design (data) packages for the proposed intelligent distributed control demonstrations at EBR-II. (James Turso and R.M. Edwards)

OVERALL PLANT DESIGN OF DISTRIBUTED CONTROL: (AI 91 paper 3) Carlos Chavez (Nuc.E. PhD fellowship student) implemented the top level operator control interface with the EBR-II main iconic display using DATAVIEWS software. This operator interface is now used for monitoring and selecting the power level of the distributed simulation of the EBR-II steam plant through the centralized plant data base.

MIMOML ROBUST CONTROL: (AI 91 paper 4) The E.E. master thesis of Adel Ben-Abdennour on multivariable robust control of the EBR-II deaerator was completed.

OTHER MEETINGS: R.M. Edwards presented two summaries at the ANS Annual Meeting in Orlando in June. Harry Alter, DOE technical co-monitor for the project, visited Penn State on July 30 and 31st, received demonstrations of most of the activities, and met with students and faculty working on the project.

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