COMPUTER MANAGED EMERGENCY OPERATING PROCEDURES

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ABSTRACT

New computer technology is very effective tool for developing a new design of nuclear power plant control room. It allows designer possibility to create a tool for managing with large database of power plant parameters and displaying them in different graphic forms and possibility of automated execution of well known task. The structure of Emergency Operating Procedures (EOP) is very suitable for programming and for creating expert system. The Computerized Emergency Operating Procedures (CEOP) described in this paper can be considered as an upgrading of standard EOP approach.

EmDiSy (Emergency Display System - computer code name for CEOP) main purpose is to supply the operator with necessary information, to document all operator actions and to execute well known tasks. It is a function oriented CEOP that gives operator guidance on how to verify the critical safety functions and how to restore and maintain these functions when they are degraded. All knowledge is coded and stored in database files. The knowledge base consists from stepping order for verifying plant parameters, desired values of parameters, conditions for comparatione and links between procedures and actions. Graphical shell allows users to read database, to follow instruction and to find out correct task. The desired information is concentrated in one screen and allows users to focus on a task. User is supported in two ways; desired parameter values are displayed on the process picture and automated monitoring critical safety function status trees are all time in progress and available to the user.

1. INTRODUCTION

Modern computer technology used in nuclear power plants can improve the emergency response during accidents. The operator can get the information that he needs during an emergency much faster. The idea of Safety Parameter Display System (SPDS) was proposed in the past to help the operator during accidents. The purpose of the SPDS is to help control room personnel in evaluating the safety status of the plant by rapid detection of abnormal operating conditions.

Emergency Operating Procedures (EOP) were introduced direct to operator actions necessary to mitigate the consequences of transients and accidents. EOP can be efficiently used to bring the nuclear power plant under control. EOP provides a network of predefined and prioritized response strategies that guide the operator in management of emergency transient. These strategies derive from the Optimal Recovery and Critical Safety Function Restoration concepts. Using the safety function concept, the individual procedures of operator actions during an event can be standardized [1] with separate operator diagnostic and control elements.

The EOP's structure is very suitable for programming and for creating expert system, but first we must find out the answers on two question: "Is it possible to create expert system from EOP

knowledge with standard expert system technique? Is that expert system adequate replacement for standard EOP written in paper form?" The most popular solution of introducing expert system in new NPP control room is the expert system assisted display [2]. This paper presents our view of CEOP's concept.

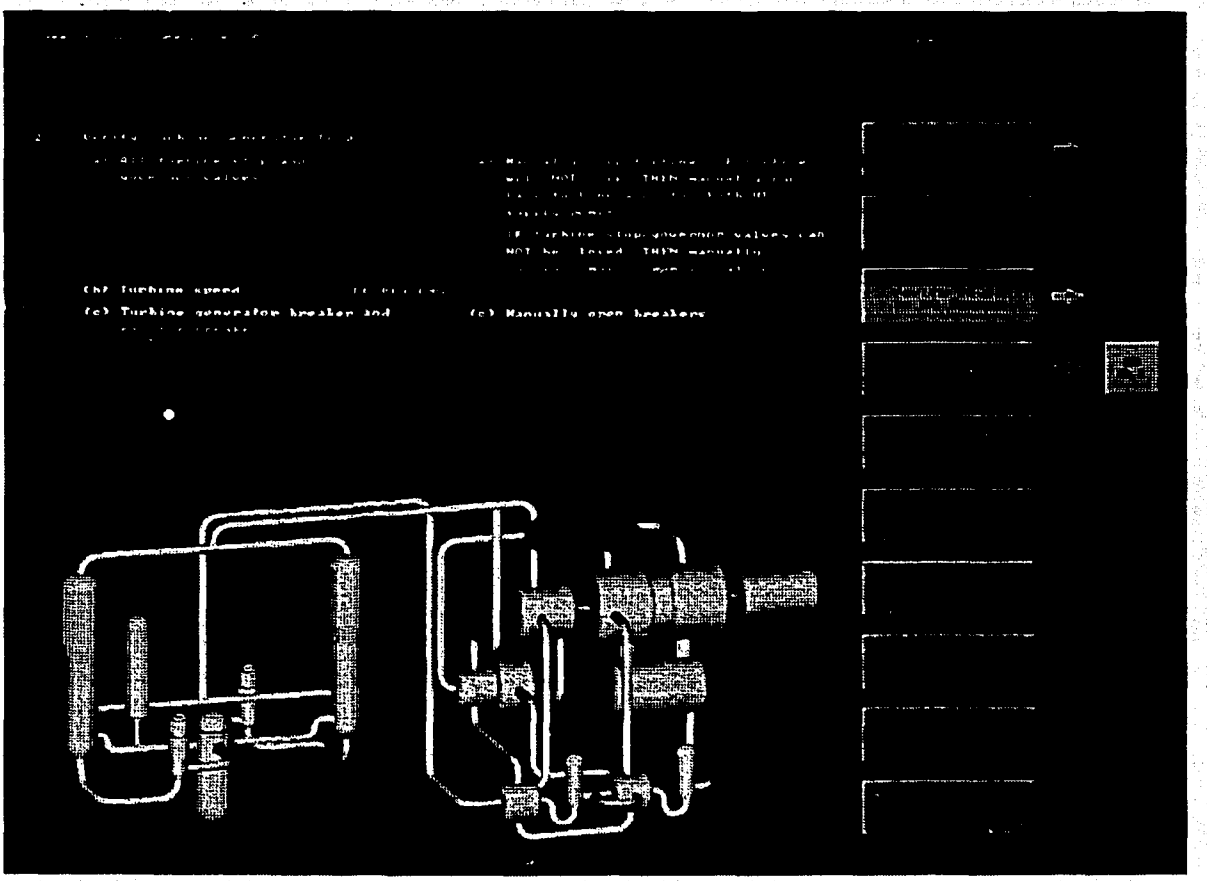

Figure 1: First design of EmDiSy computer code

2. EmDiSy (CEOPcode) CODE

Conventionally EOPs are written in the paper form. EmDiSy (Emergency Display System), which is being developed to support the operator during a transient or an accident in a nuclear power plant, is more than an electronic EOP book. It uses all recommendations for writing EOPs and makes use of advanced computer technology. It allows operator management of large database of power plant parameters and monitoring of them in different graphic form. Last year it has been updated (CEOPcode) with code for automated execution of well known tasks (CSFcode). Automated tasks enable faster diagnostic of the event and recovery procedure.

2.1 EmDiSy background

References [3][4] describe our first design of CEOP (Figure 1). The basis of the EmDiSy computer code are two groups of database files. Knowledge database files are examples of the first group, while the second group contains files needed for graphical support. Components of procedure rules are questions, instructions and pointers to the subsequent step in the procedure or to the next procedure.

This graphically designed computer code allows on-line presentation of data anywhere on the screen in any visible form. The main goal of EmDiSy code is to concentrate all main information that is needed during emergency.

2.2 EmDiSy new approach (CEOPcode)

The last release of EmDiSy code was CEOP code with the new graphical design, new concept of managing database and automatic execution of well known tasks. For graphical design (Figure 2) we used the same concept as Process Information System (PIS). That system is in the last phase of installation in Nuclear Power Plant Krško (NEK). PIS is based on the AFORA PMS™ software platform (commercial product of Asea Brown Boveri - ABB). That platform can serve CEOPcode as data acquisition system.

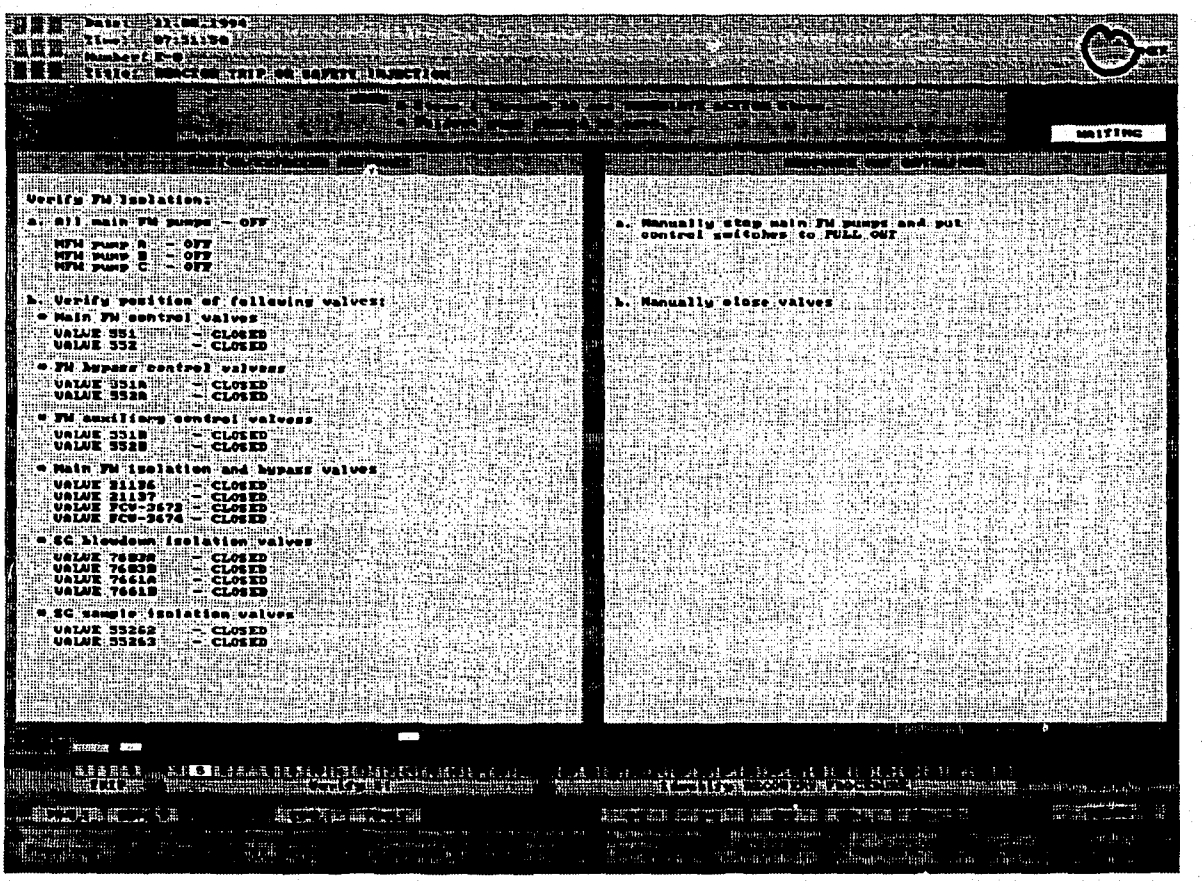

Figure 2: New concept of EmDiSy is resulted in CEOPcode

The concept of managing database allows operator to compare two values and answer to question with yes or no. In the main loop the code compares asked value with measured value but doesn't take any action by itself. It points to the first step which must be executed or compared manually. It is then waiting for the operator instructions. Only well defined tasks are executed automatically for monitoring critical safety functions (subcriticality, core cooling, heat sink, integrity, containment and inventory).

2.3 CSF status trees in CEOP code

A serious threat to the health and safety of the public could result if the radioactive materials in the reactor core of nuclear power plant were to be released to the environment. The fundamental goal of nuclear safety is the prevention of uncontrolled release of radioactive materials from nuclear power plant and ensuring that physical barriers remain intact always and under all conditions that may exist. Critical Safety Functions (CSF) are set of safety function for diagnostic the plant safety state.

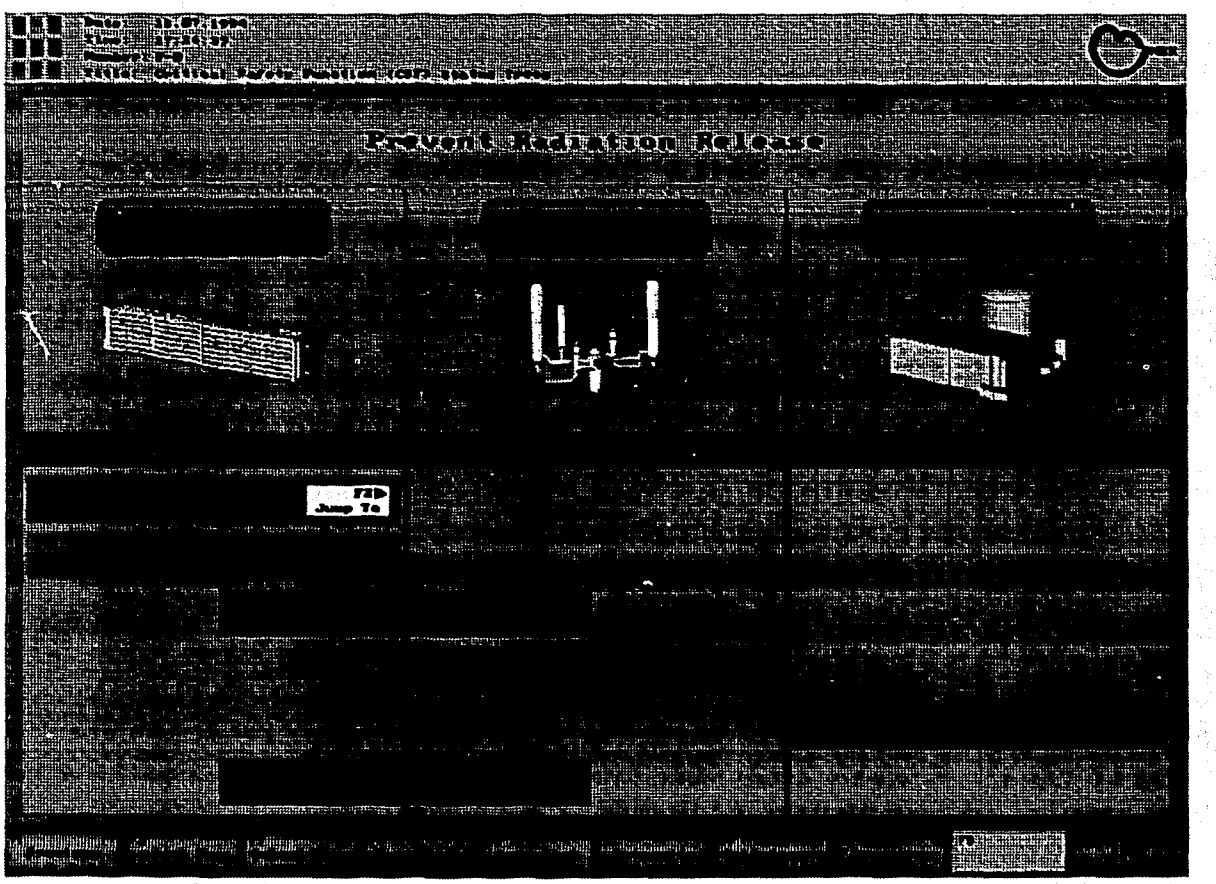

Figure 3: First level of CSFcode (physical barriers and final results of CSF)

CSFcode is part of CEOPcode and contains six automated tasks, each for every critical safety function. Purpose of this code is monitoring and diagnostic the plant safety state and (if it is necessary) selection of the adequate recovery procedure. Operator can choose different level of automated execution: fully automated, half automated and manual.

Result of fully automated execution CSF is CSF status tree's final status (colour code), selected ways trough trees and information about the possibility of the physical barrier degradation (Figure 3). The CSF status trees final results are presented in first level of CSFcode. Fully automated execution is always in progress (first and second level) and is part of SPDS. The user can select suggested action (leave CSFcode and jump to selected procedure) or calls selected CSF status tree. The selected tree is displayed in second level of CSFcode.

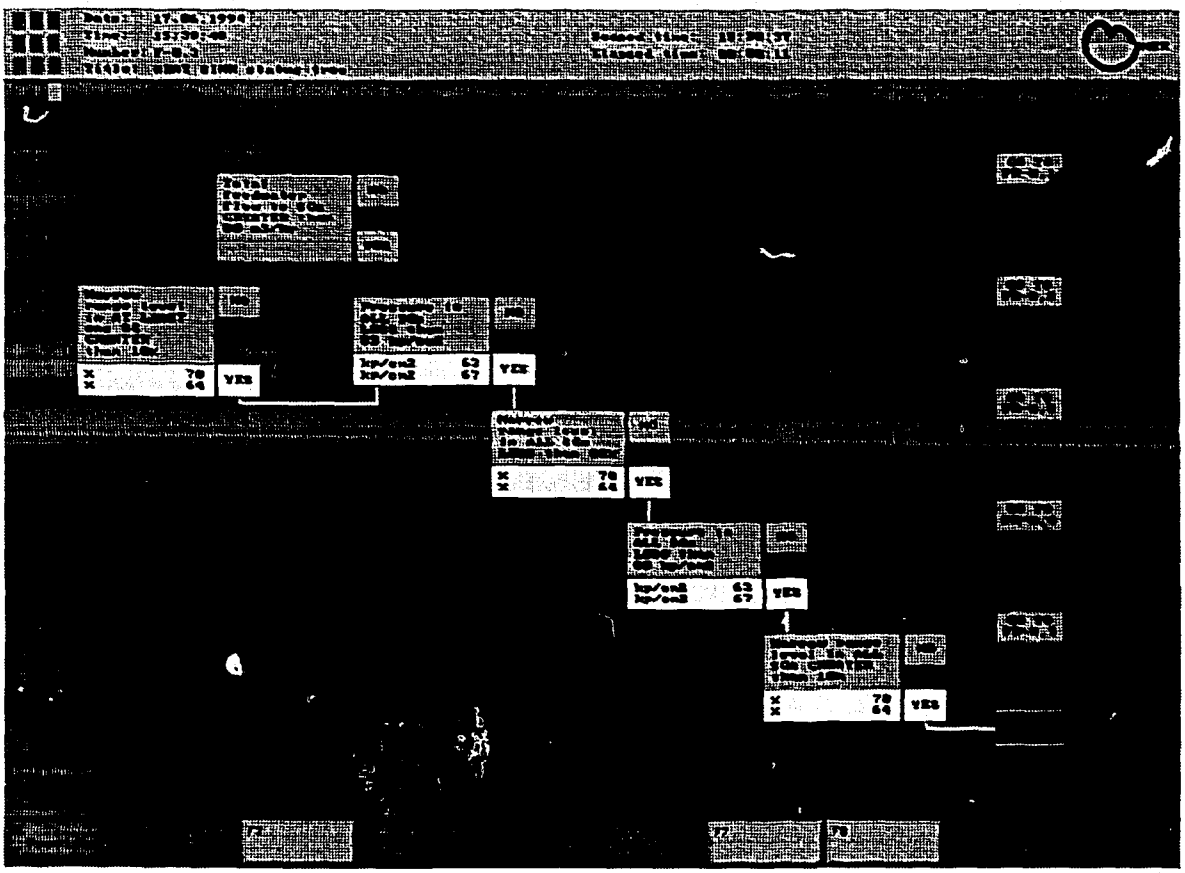

Figure 4: At the beginning in the second level of CSFcode

At the beginning in the second level (Figure 4) operator gets information how fully automated execution is performed (answers to the questions in the tree) and when has result been calculated (scanned and elapsed time). The user can now clear all answers and manually chose his way trough tree (manually execution). The second possibility is to clear just few last answers and initiates his choices (half automated execution). In this level fully automated execution is still in progress and code points on-line to the operator its final solution with marker AUTO. From this level the user can jump to selected new procedure or return to the first level.

3. RESULTS AND DISCUSSION

Computer code CEOPcode that is under final stages of development is believed to be an efficient tool to assist the operator in emergency conditions. Its main purpose is to supply the operator with necessary information and to document all operator actions. The described code has many advantages comparing with EOP written in standard format. Some of these advantages are:

- code allows selection and concentration of important plant parameters
- searching and comparing parameters is more simple
- code can do automated execution of some tasks
- part of SPDS is integrated in CEOP
- code allows double checking of all decision

- code can explain all decision
- code can store all decision for future analysis

Future upgrading calls for expert system, which will be able to analyze incoming data, recognize incoming event, point to errors in the system and execute precise defined tasks.

4. REFERENCES

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