

DESIGN WORKS ORGANIZATION DURING THE I&C SYSTEM UPGRADING ON AN OPERATING VVER POWER PLANT FROM THE GENERAL DESIGNER'S STANDPOINT

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1. Introduction

In the role of a general designer Energoprojekt has already designed 2 replacements of nuclear power plants (NPP) I&C systems, in particular the Mochovce - VVER 4x440 MW NPP I&C system and the Temelin - VVER 2x1000 MW NPP I&C system.

This contribution should demonstrate,

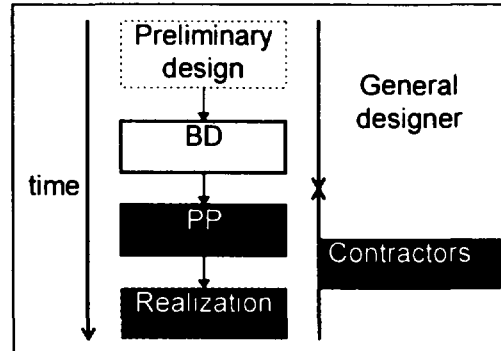
- which problems with design works were encountered during the above I& C systems replacement
- what was the cause of the problems and
- what should be the mode of organizing the design works during an I&C system replacement on an operating VVER which would delete such problems.

All the information in this report are simplified and limited to such extent only which is essential for the above described problems clarification.

2. Design works normal organization

Design works normal organization:

- preliminary design works
- Basic Design (BD)
- Detailed Design (DD)
- realization



3. Normal content of an I&C Basic Design

The I&C BD technical part includes the following:

- general requirements on the works
 - applied regulations specification
 - design concept
- detailed requirements on individual circuits function
 - specification of requirements on PMI (Process Machine Interface) (lists of measuring and control circuits, technologic diagrams, ...)
 - specification of automated functions (descriptions or algorithms, technologic diagrams, ...)
 - specification of requirements on MMI (Man Machine Interface) (lists of requirements, technologic diagrams, ...)
- solution in process of completion, so that it would be possible to input the data for the other design parts
 - specification of the I&C devices and requirements on their procuring (lists of cabinets, ...)
 - location of the I&C devices and of main cable routes in a building (layout drawings, ...)

4. Input data for the I&C BD

Input data for the I&C BD are, in particular, the following items:

- general principles and regulations
- inputs of requirements from other parts of the project (in particular a general solution concept and input of requirements from the technological part designs)
- data on the I&C devices used

Part of the design	Input data
general requirements on the I&C design	general principles and regulations, general concept of the solution inputs from other parts of the concept (in particular a general concept of the solution)
detailed requirements on individual I&C circuits function	inputs from other parts of the concept (in particular an inputs from the technologic part)
I&C design in process of completion	data on the utilized I&C devices

5. Expected impact of the I&C system modification on the BD content

It was decided to modify the I&C system long after the BD was finalized, however prior to the I&C realization. For organization of the other design works it will be necessary to decide whether

- either to return the whole design procedure to the BD level, therefore the realization itself would be substantially delayed,
- or to incorporate the I&C system change directly into the DD.

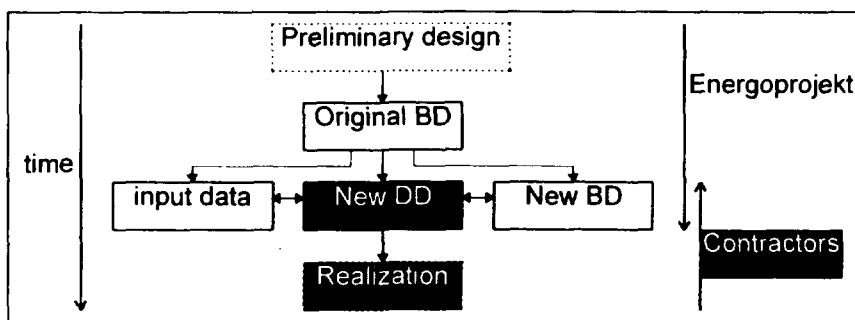
Since major changes were to concern those I&C devices only, which would be used it was assumed there would an essential impact on the I&C solution which is in the process of completion only. Substantial changes in other parts of the BD were not expected.

6. Way of design works organization which was used during previous I&C systems on NPPs replacement

Elaboration of a DD for a new I&C system on the basis of

- BD for the original I&C system and
- input data for the BD upgrading for the original system

Elaboration of the BD for the new I&C system in parallel with the DD for the new system



7. Actual impact of the I&C system change on the I&C BD content

The I&C system modification had a substantial impact on the whole I&C BD content.

The technical part of the I&C BD was substantially modified in all parts:

- general requirements on the design
 - specification of applied regulations was modified according to the existing situation and it was completed in compliance with the requirements and recommendations of competent bodies and organizations
 - the design concept was changed in compliance with the newly applied requirements and according to the new system properties
- all detailed requirements on individual circuits function were modified substantially even in those areas where there was no change of the technologic requirements
 - modifications due to modifications in the design concept (different mode of circuits sharing, circuits redundancy)
 - addition of other data which are necessary for correct designing of the system (1E category, diversely redundant functions, MMI functions which besides realization on a workstation require realization on working places with classic design, too, speed of inputs monitoring under 1s, functions for fulfilling the PAMS requirements, mutually redundant equipment, ...)
 - modifications due to technologic requirements modifications
- the I&C design in process of completion was as expected changed completely, however, compared to expectation there were substantial impacts of the above modifications into other parts of the design

The unexpected modifications caused an increase of unplanned works, impacts into those parts, which were finalized already, they prevented finalizing of uncompleted parts of the design and. they required a large amount of additional corrections and changes.

8. Reasons for the I&C BD large scope of modifications

Compared to expectations the I&C system replacement had always a substantial impact on all the I&C BD data.

- general principles and regulations and general design concept
 - different type of the system (computer system), time development (new standards), different recommendations of the system supplier (in relation to standards and customs in the Supplier's country of origin)
- input data from other parts of the design
 - change of requirements on the input data content, change of assumptions for the input data

9. A possibility to simplify design works for an operating NPP I&C system replacement

A new I&C BD shall have to be elaborated.

New BD of all concerned parts (civil part, electrical part, HVAC, ...) shall have to be elaborated.

Is it possible to avoid a new technologic input data for the new BD? Is it possible to define input data for the new I&C system BD according to those functions, which were to be provided by the original system?

- analogy of an incorrect assumption from preceding replacements of an I&C system
- necessity to add those data, which were never determined for the original solution

An example how to utilize the original solution for a control room design in compliance with the IEC 964 requirements, "Design for control rooms of nuclear power plants"

Activity in compliance with IEC 964	Utilization of the original NPP design
goals and principles	partially - modifications caused by requirements development and by the system change
functional analysis	partially - modifications caused by changes of goals and principles
specification of functions	partially - the original I&C functions have to be assigned to the new functional analysis results and information necessary for their new distribution between man and machine have to be added
distribution of functions between man and machine	small - distribution in compliance with new requirements
V&V functions distribution	small - the new distribution V&V according to the new requirements
requirements on the control room design	small - new requirements
proposal of the control room integrated system (layouts, boards and panels of information and control systems, of the communication system, ...)	small - new possibilities and requirements
operating regulations and training	partial - they have to be adjusted
V&V of the control room integrated system	small - new design V&V

New input data shall have to be elaborated for the new BDs.

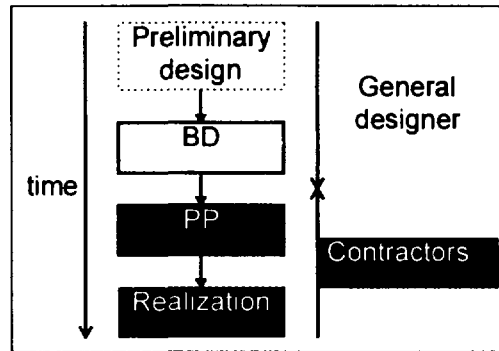
10. Recommended organization of design activities during the I&C system replacement

The BD of I&C and of all concerned parts to be elaborated. New input data shall have to be elaborated for the new BD.

The design procedure to be joined together with the verification and validation (V&V) procedure

Normal course of design works:

- preliminary design works
- basic design (BD)
- detailed design (DD)
- realization



11. Content of the preliminary design works

- goals of the replacement
- requirements which shall have to be fulfilled in the course of the replacement duration
- scope of modifications of the existing site and their distribution (phases, operating systems]
- necessary documentation scope
- requirements on the documentation contents
- new input data and basic data which are essential for the BD elaboration in the required scope
- selection of the BD documentation and related documentation compiler