

THE SUPPLY MODEL OF THE I & C SYSTEM MODERNIZATION AT VVER 1000 UNITS OF THE NPP TEMELÍN

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1. INTRODUCTION

As it is generally known, the project of two nuclear units VVER 1000 of the NPP Temelín has been based on the Soviet design of a nuclear unit ranking with so called "large series" of unified nuclear units VVER 1000 which are in operation in some countries of former USSR (NPP Rovno, NPP Zaporozhje, NPP Balakovo, etc.). This original Soviet design was partially modified by the Czechoslovak general designer (EGP Praha) in a close cooperation with the general supplier of technology (ŠKODA PRAHA) and the Russian design organization (ATEP Moskva) in years 1984 - 1988. The modification was aimed at increasing of the share of deliveries of Czechoslovak equipment. A survey of main Czechoslovak producers and suppliers which have supplied the technological equipment for two units of the NPP Temelín under the leadership of the ŠKODA PRAHA, is provided in Tab.1. Also the structuring of the original I & C system of those two units had been based on the above mentioned unified design and it was redesigned as well in order that more Czechoslovak automation parts and equipment could be utilized (see Tab. 2 and Fig. 1).

2. I & C SYSTEM UPGRADING

The investor of the NPP Temelín (ČEZ PRAHA) initiated two international competitions - tenders (for deliveries of the nuclear fuel and I & C system) aimed at enhancement of nuclear safety and at increasing the economical effectiveness of the electricity production. Several renowned companies took part in the "nuclear fuel" competition: Atomenergoexport, Siemens A.G, Westinghouse Electric Co. Finally, Westinghouse Electric Co. succeeded in the competition and it concluded a contract with the NPP investor (ČEZ PRAHA) on the delivery of nuclear fuel for both units of the NPP Temelín.

ABB, CEGELEC, IVO International, REGULA PRAHA, Siemens A.G. and Westinghouse Electric Co. took part in the competition on the delivery of the I & C system and submitted their bids. Again, Westinghouse Electric Co. succeeded and concluded a contract on the delivery of the I & C system with ŠKODA PRAHA in this case. More detailed information on the structure and functions of this new I & C system are provided in ref. /1/, /2/.

The new I & C system is divided into 4 operating groups (PS) at both two units:

- PS 201 - I & C for normal operation
- PS 202 - I & C of the reactor and limitation system



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PS 203 - I & C of the reactor protection and safety system
PS 204 - I & C unit information system.

Another operating group PS 0.205 (non-unit CIS) is designed to attend both units and it assists in providing a communication with computer systems of other operational groups.

ŠKODA PRAHA is the final supplier of this I & C system and it concluded a contract on the delivery of the I & C equipment for both NPP Temelín units with Westinghouse Electric Co. as its sub-supplier on 14.5.1993.

It is suitable to note that most of control, monitoring and protection algorithms has been preserved in the I & C modernization, as practically no technological equipment of units (reactor, steam generators, main circulating pumps, turbine, alternator) have been changed. Some changes have been made in control and protection algorithms of reactor I & C, which were caused mostly by the implementation of the new nuclear fuel. It can be said that in the case of modernization of the I & C of 1-st and 2-nd units of the NPP Temelín, a complete exchange of original I & C equipment is being made and it is being replaced by a distributed digital monitoring and control technology (see Fig.2). Only one subsystem of the original I & C system (ASD SO, the automated diagnostic system of the secondary system technology) stayed without changes of both hardware and software. At present, ŠKODA PRAHA as the supplier of this sub-system, solves its linking up to the new I & C system. It is necessary to mention here, that functions of the ASD SO have been made more significant for the period of commissioning and initial operation of the 1-st unit, which has the reason in requirements on more detailed and enhanced monitoring of new technological equipment (turbine 1000 MW, alternator 1000 MW, main feeding pumps, etc.). Those new equipment have not been proven yet in a real long-time operation. A special monitoring system NEMES will be utilized for performing high-quality measurements during the start-up of the 1-st unit. More detailed information on structures and functions of ASD SO and NEMES systems are provided in the paper / 3 /. Some problems connected with preparations of tests and start-up programmes of the new I & C system are discussed and summarized in the paper / 4 /.

The implementation of the modernized I & C system into the general design of units is assured by the general designer (EGP PRAHA) in the form of supplements to the Basic Design of units. The principal organization of links between main partner solving the I & C system modernization is provided in Fig. 3.

3. CONCLUSIONS

- ◆ Above mentioned information indicate that by the modernization of the I & C system, conditions have been created for the realization of an up-to-date unit of the VVER 1000 type which copes with present world requirements to nuclear safety and operational economy,

- ◆ However, such an updated VVER 1000 type unit is not in operation anywhere in the world, so that the 1-st unit of the NPP Temelín represents a demonstrating unit; it is not a repeated construction of a nuclear unit as it was before at constructions of VVER 440/213 units at NPPs Bohunice and Dukovany,
- ◆ It is obvious, that a succesfull solution of updating I & C Systems of 1-st and 2-ud units of the NPP Temelín will prove the correctness of using such a supply model of modernization of VVER 1000 type units; arguments will be obtained for a support, modification or abandoning this model at modernizations of further VVER type units in the country and abroad.

REFERENCES

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- /4/. B. Lněnička:
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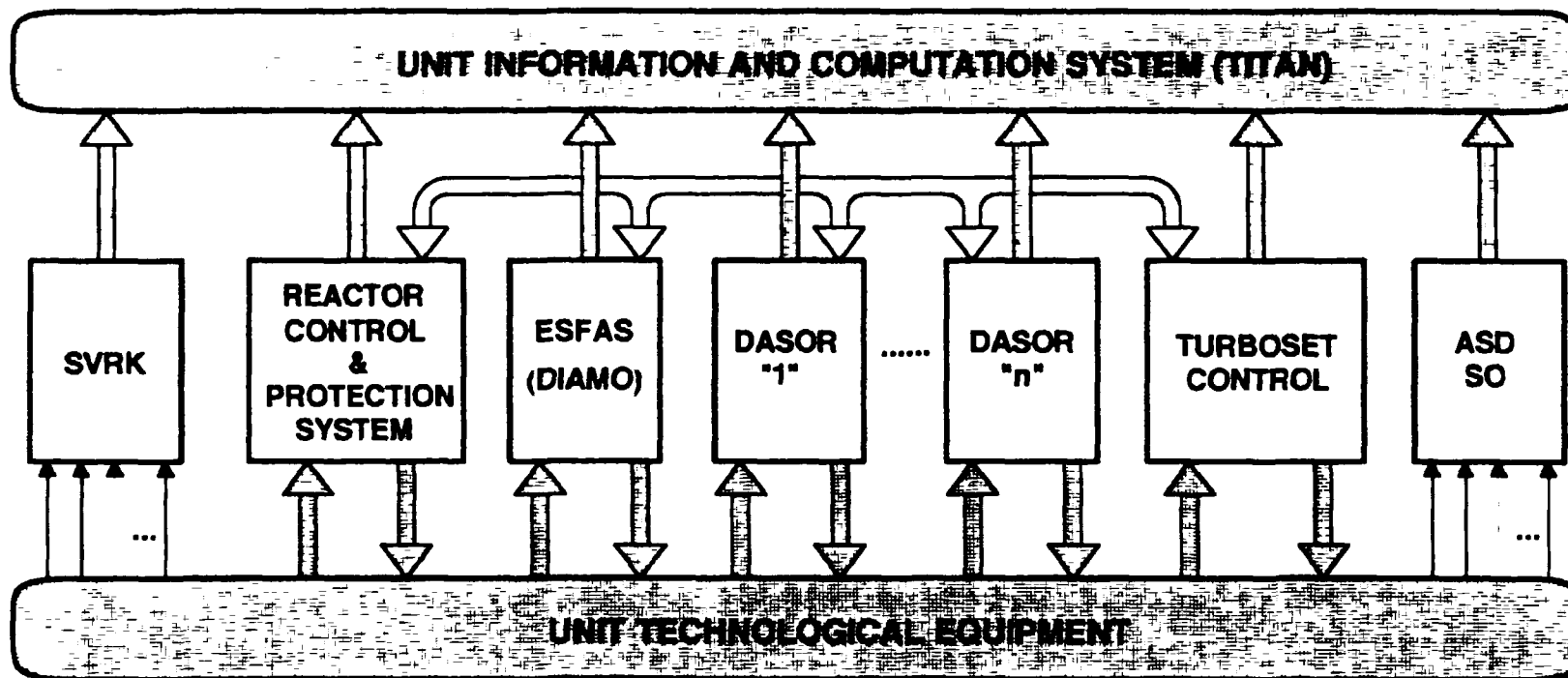
Technological equipment	Manufacturer	Subsupplier
Reactor VVER 1000 (without fuel) 1)	ŠKODA JS, s.r.o. Pízeň	ŠKODA JS, s.r.o. Pízeň
Steam generators 1)	Vitkovice, a.s.	ŠKODA JS, s.r.o. Pízeň
Main circulating pumps	Russia	♦ ŠKODA JS, s.r.o. ♦ SIGMA
Turbine 1000 MW	ŠKODA Turbiny, s.r.o., Pízeň	ŠKODA PRAHA, a.s.
Turbine generator 1000 MW	ŠKODA ETD, s.r.o., Pízeň	ŠKODA PRAHA, a.s.
Feed turbopumps	♦ ŠKODA Turbiny, s.r.o., Pízeň ♦ SIGMA	ŠKODA PRAHA, a.s.

1) based on russian licence

Table 1 Subsuppliers of main technological equipment for NPP Temelín, Unit 1,2

Subsystem	Manufacturer	Subsupplier
Unit Information & Computation System (TITAN)	Russia	ZPA Praha
Reactor Control & Protection System	Russia	ŠKODA JS, s.r.o. Plzeň
In-core Information System (HINDUKUŠ)	Russia	ŠKODA JS, s.r.o. Plzeň
Engineered Safety Features (ESFAS)	<ul style="list-style-type: none"> ◆ ZPA Praha ◆ VZÚP 	ZPA Praha
Digital Control Units (DASOP + DIAMO)	<ul style="list-style-type: none"> ◆ METRA Blansko ◆ VZÚP 	ZPA Praha
Turboset Control	<ul style="list-style-type: none"> ◆ ŠKODA ETD, s.r.o. ◆ ŠKODA Turbiny, s.r.o. ◆ VZÚP 	ŠKODA PRAHA, a.s.
Monitoring & Diagnostic System of Secondary Circuit	ŠKODA PRAHA, a.s	ŠKODA PRAHA, a.s

Table 2: Main subsuppliers of previous I & C subsystems for NPP Temelín, Unit 1,2



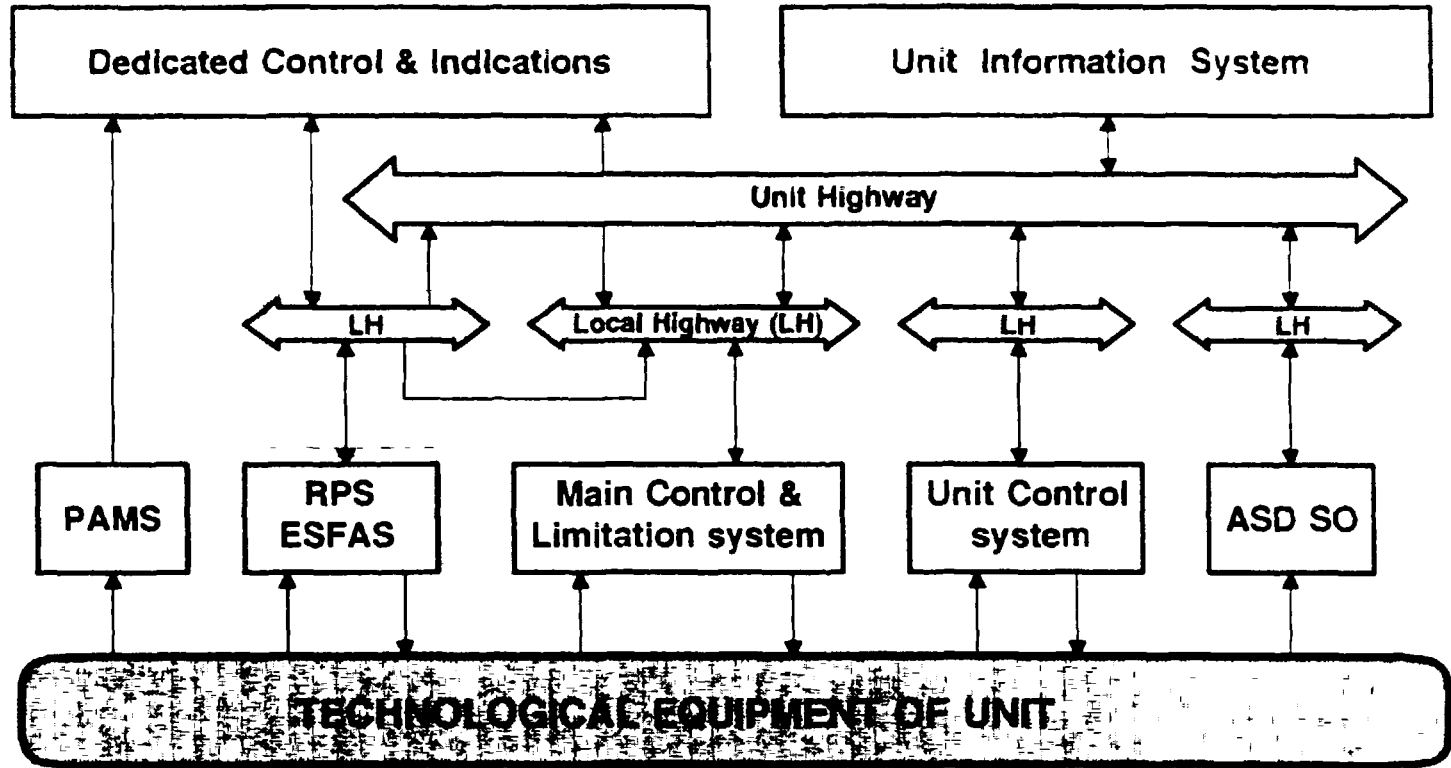
SVRK ... In-core Information System

ASD SO ... Monitoring and Diagnostic System of the Secondary Circuit

ESFAS ... Engineered Safety Features Actuation System

DASOR ... Digital Control Unit

Fig. 1: Basic structure of the previous I & C System of 1-st and 2-nd units of the NPP Temelín



PAMS : Post Accident Monitoring System ASD SO . Monitoring & Diagnostic System of secondary circuit
RPS, ESFAS . Reactor Protection System, Engineered Safety Features Actuation System

Fig. 2: Basic arrangement of the modernized I & C system of the NPP Temelin, Unit 1, 2

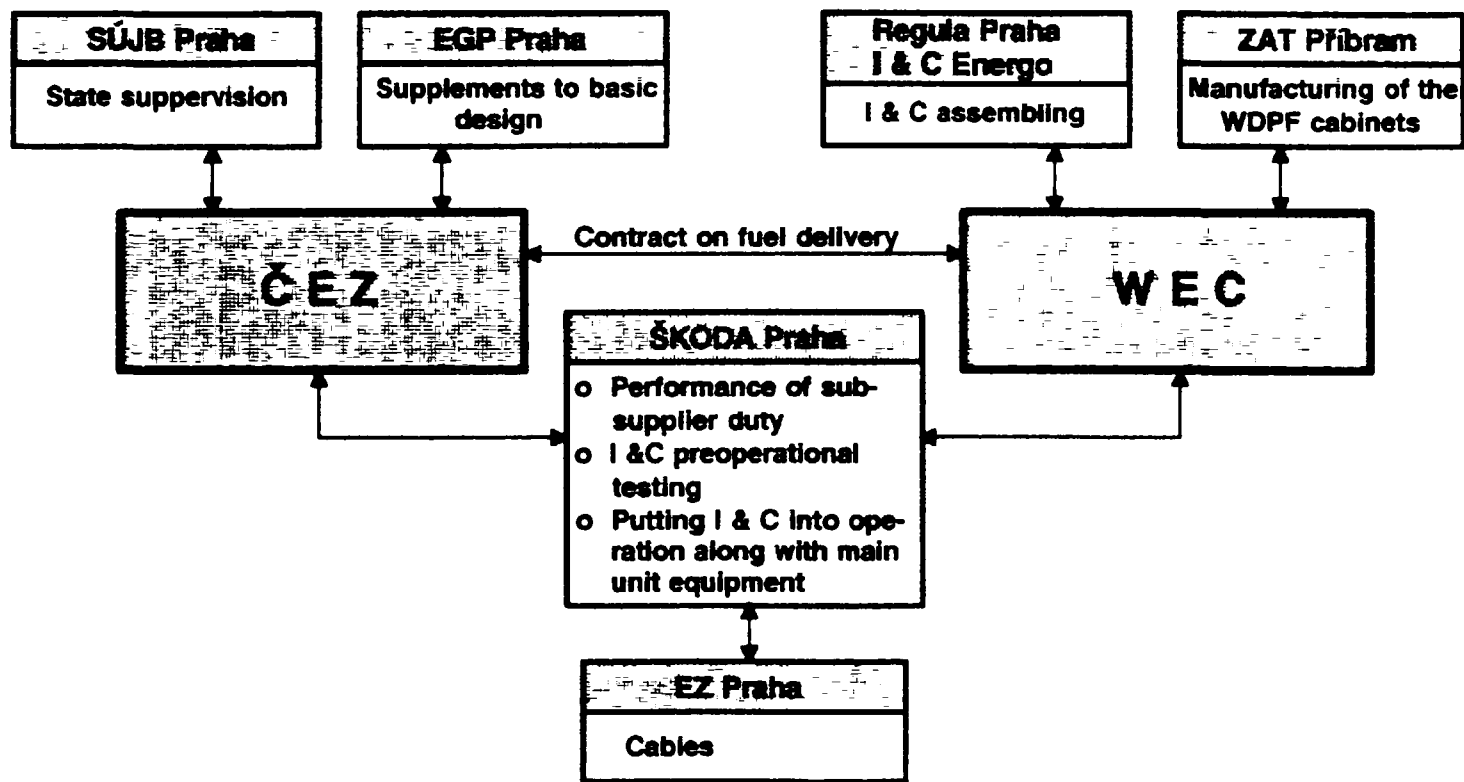


Fig. 3: Relations between main participants of the I & C modernization on 1. and 2. units of the NPP Temelin.