INFORMATION ON PROBLEMS POSED BY THE 1000 MW TURBINE IN THE TEMELÍN NPP

Special Characteristics of the 1,000 MW Turbine at the Temelín Power Station

The 1,000 MW turbine, supplied by the Škoda Energo company, ranks among the biggest machines operating at a speed of 3,000 rpm. Although the design of a large number of parts of its turbo-generator was based on long-standing experiences with lower-output machinery destined for classical as well as nuclear power stations, this particular - considerably larger - type called for a new design solution. That was why the turbine rotors (low-pressure welded rotors, long moving blades of the last low-pressure stages), radial bearings, and measuring and regulating devices were newly designed and manufactured. Whenever possible, the new elements were tested in the manufacturing plant before being mounted in the machine, and most of them are today posing no problems whatsoever when putting the whole set into operation. The assembled set was tested without load in November 1996. Its turbine was then driven by steam from an auxiliary boiler house at Temelín. This particular test proved to be successful. Still, all the performed tests had revealed a number of minor imperfections that were subsequently removed. What persisted, however, are conditions that can be introduced and fine-tuned only after the actual start-up of the turbine with a nuclear reactor in operation. In the past, it was virtually impossible to produce a sufficient quantity of steam with appropriate parameters corresponding to those characterizing steam generated by a nuclear reactor.

Three unexpected technical problems occurred during the start-up of the turbo-set:

• High vibrations of the steam piping in the section between the high-pressure control valves and the high-pressure turbine. Problems of this extent have not been experienced in any of the previous types of turbines nor in the 220 MW turbines operating at nuclear power plants, for example at Dukovany. Piping vibrations are excited by steam flow in the control valve seats. Steam flow’s excitation effect is known to disappear at higher outputs (over 60% of the rated power). For lower output levels, the shape of the throttle valve cone is being adjusted in the manufacturing plant in order to calm down steam flow.

• Vibration problems occurred in the control oil piping system (none were detected during the 1996 testing). There were vibrations in the control oil system, leading to several unscheduled shutdowns, and to a minor local fire. This particular problem has already been eliminated, and final adjustments, aimed at further enhancing resistance to oil vibrations, will be made in June of this year.

• Since the start-up of the set, its speed rotor vibrations have been kept within acceptable limits. During the recent commissioning of the regeneration system, unfavourable temperature differences were detected in the steam coming from separators-heaters at the outlets to low-pressure turbines. Since the turbine was put out of operation at the time of higher temperatures differences, a swing of the rotors and their contact with the stator part occurred during the shutdown, i.e. during speed reduction through the resonance area. This caused a minor permanent deformation (only some 0,25 mm), which subsequently lead to higher vibrations at operating speed and during load. That is why the low-pressure turbines are being currently checked. The flowthrough section is expected to be modified, and the rotor newly balanced.

It should be stressed that all the failures and defects mentioned above are related solely to the power plant’s secondary circuit, and have nothing to do with its nuclear safety whatsoever. The nuclear section of the power plant as well as its control and electric systems have been operating faultlessly.

Even though the above-mentioned problems accompanying the commissioning of this equipment are unpleasant, and their removal will require time and money, one can hardly speak of the power station’s alarming state. Such a complicated equipment, as Temelín´s 1,000 MW turbo-generator undoubtedly is, has to pass through its period of “teething troubles“. For the sake of comparison, let us mention that a number of defects and initial hitches also had to be tackled during the start-up of the blocks containing 220 MW turbines at Jaslovské Bohunice. Serious problems were caused in the 220 MW turbines by failures of the moving blades of their high-pressure rotors, while extensive erosion problems occurred both at control valves and in the flowthrough section. Another headache was caused by vibrations in the rotor systems. More than a year was needed to remove most of the troubles besetting the 220 MW turbines. Numerous problems also had to be solved during the start-up of the classical 500 MW unit in the Melník power plant. Spindles kept cracking in high-pressure control vales and medium-pressure retaining valves. Eventually, the solution applied in Melník employed - among other measures - a modification of the valve cones similar to that currently used in the Temelín power station. Considerable problems were also posed by steam dump stations whose thermal shielding was destroyed. Moving blades of the low-pressure turbine were also torn off. At present, the above-mentioned power plants are running without any problems. All over the world, repeated start-up of units is now known to proceed much more favourably. It is all a matter of mastering new technologies.

These examples make it quite clear that any new equipment, as complex as the turbo-generator in the Temelín power plant, can hardly be commissioned without experiencing initial operating problems. However, the Škoda´s turbine experts have invariably succeeded in solving such start-up problems elsewhere, and their turbines have now been running to the full satisfaction of their operators for a long time indeed.