Contributions of Modřanská potrubní, a.s. to the safety improvement of piping systems and valves of NPS type VVER 440 and VVER 1000

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1. Installation of pipe whip restraints on piping for high pressure and temperature steam and feed piping

On the basis of methodology ANSI/ANS-58.2.-1999 the inspection of steam piping and feed piping of both types of power stations was performed from the rupture possibility point of view, and the places have been predicted, which by their location (e.g. end of line) or state of stress size comply with the conditions for presumptions. In these places, the pipe whip restraints have been designed and installed, which at rupture will catch, moderate and distribute the dynamic impact into further parts of piping.

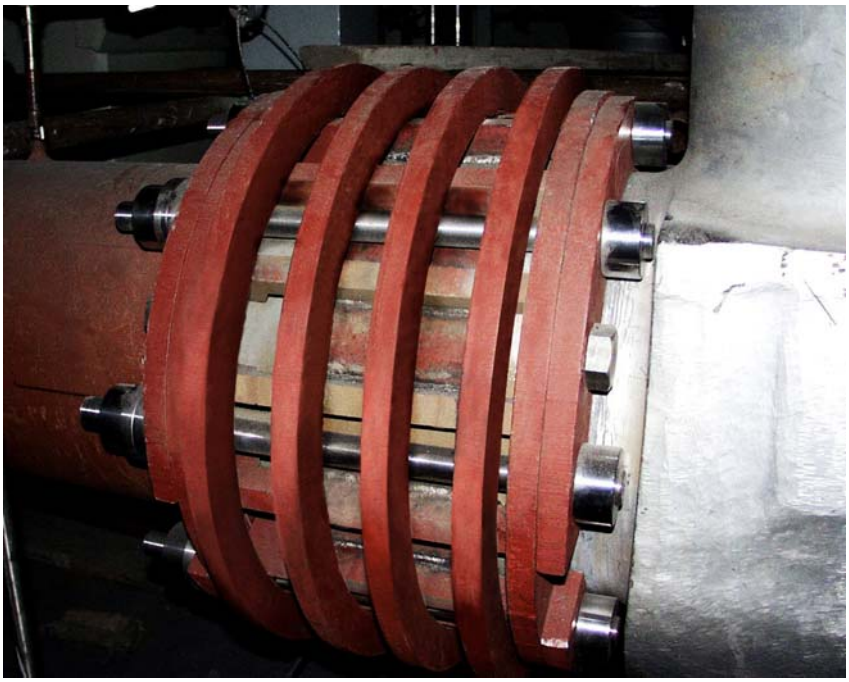

Fig. 1.

There have been designed two types of whip restraints and that the whip restraints for straight piping (Fig.1) and whip restraints for branch pipes and T-pieces (Fig.2). Both types work on a principle of interception of broken away part of piping by means of supporting plates, carrying flanges and damping elements from soft metal materials, which transform the prevailing part of energy into the deformation and heat energy. In addition the whip restraints are designed to catch the leakage of medium from piping (steam, water) and so prevent the damage of surrounding equipment by jetting medium.

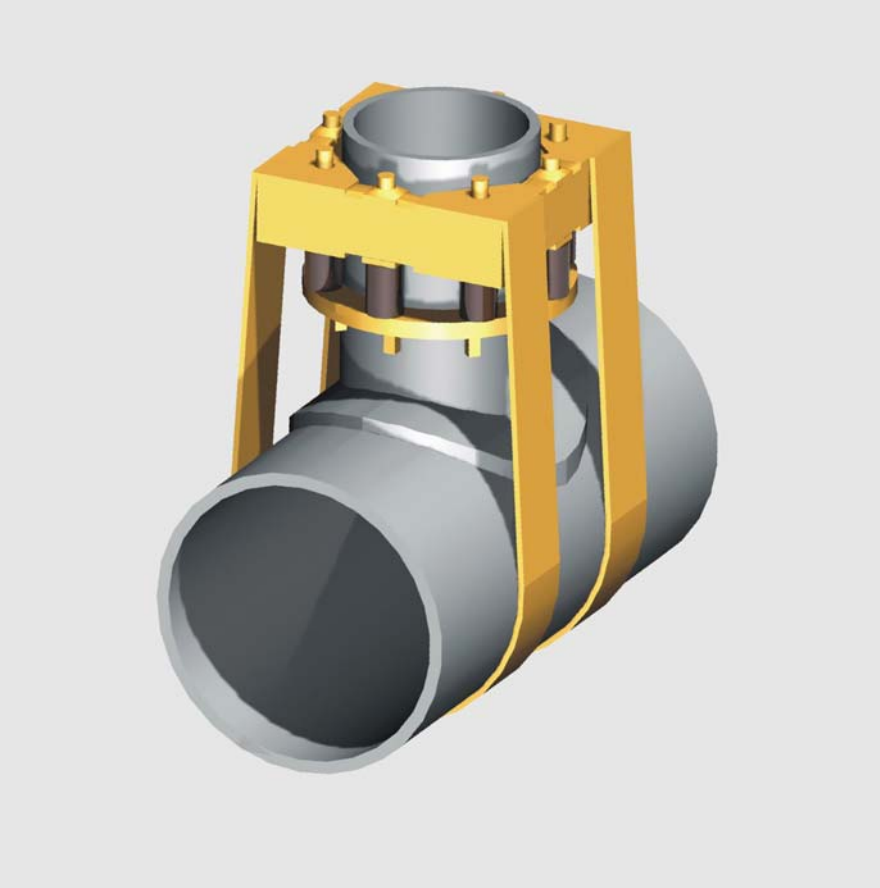

Fig. 2.

In this way the steam and feeding piping of the units VVER 440 in the nuclear power station at Dukovany and Bohunice were equipped, and that on the straight piping in the longitudinal cell of main insulation and safety valves in hermetic bushings, and in the nuclear power station VVER 1000 on the steam piping in room 820 and inside the hermetic zone. It is prepared the realization of pipe whip restraints on the branch pipes of DN 300 and DN 150 from steam collectors in the cell of main insulation and safety valves of the units VVER 440 in NPS Dukovany.

2. Installation of air receivers for quick-acting valves with air actuator on the units VVER 440 in Jaslovské Bohunice – NPS V2

Most of quick-acting valves on the units VVER 440 in the Czech and Slovak Republic are already from the time of construction equipped with the air actuator on a principle air-air, and it means that the air actuator sets the valve into operation and emergency condition. With these quick-acting valves the air receiver is directly on the valve so that the safety function of valve is ensured also at fail or breakdown of supply air piping.
Air receivers and interconnecting piping were dimensioned so that the volume of air would ensure 3 to 4 functions of valve (open x close) and were manufactured of stainless steel so that the products of corrosion would not get into the control magnetic valves.
All quick-acting valves in the units VVER 440 and 1000 are in this way secured against the fail of air and so fulfil their safety function independently of the source of pressure air in the case of breakdown.

3. Replacement of material of technical waters distributions in the reactor hall of the units VVER 1000 in NPS Temelín

Distributions of technical cooling waters are in the whole power station i.e. in the reactor hall, machine hall and outside distributions installed of carbon material. Because of corrosion processes, the fouling of corrosion products from this piping, of which total area is several hundreds m^2 , occurs into the heat exchangers, into the tapping chambers of measuring elements, into the blind corners of valves and into the tubes of small dimensions (e.g. drainages and deaeratings) and by that to the faults of their function. It was, therefore, decided to change step by step these distributions of carbon steels for piping of stainless steel. For financial reasons, the exchange is performed from the smallest diameters towards greater diameters, while predominant part of valves – also for financial reasons is left of carbon material. For stainless piping, the material has been selected corresponding to the W. No. 14571 Standard , i.e.: austenitic chrome-nickel steel stabilized by titanium and containing 2 to 2,5% of molybdenum, thus ensuring the high resistance of the base material and weld joints against area, pitting and intercrystalline corrosion in operation parameters, i.e.: temperature and content of chlorides, which mainly during winter months (road salting), in this water prevail. In a similar way the sequential exchange of distributions of cooling waters occurs also in the units VVER 440 in Dukovany, where the use of piping of fiberglass-reinforced plastic is considered.

4. Installation of measuring nozzles on the main steam piping of DN 600 of the units VVER 1000 in Temelín

The necessity of measurement of steam in the main steam piping of DN 600 between the steam generator and turbine has been created by the installation of feeding regulator of the Westinghouse company, which operates on so-called 3-point principle of inlet impulses: it is sensed and continually measured the quantity of feed water, quantity of steam and temperature of steam. The original regulation was only 2-point (quantity of feed water and temperature of steam), and so the quantity of steam was not necessary to measure. The quantity of steam was measured by means of Venturi tubes, immersed into the velocity profile of flowing steam, and it was sensed an average pressure difference between the leading and following edge. This method, however, was shown as operationally unreliable, because owing to the vibrations and pulsations of steam piping, the leakage of welds between these tubes and piping took place and also their inside damage. It has been, therefore, proceeded to the dismantling of these Annubar sensors, including the appropriate section of piping, and to their replacement by measuring nozzles.

Design solution of the whole measuring element

- it is a compact, rotary symmetrical and resistant by its rigidity not only against seismic effects, but also other dynamic excitations
- it enables a solution surely resistant also against breakdown modes – nozzle although stops to be functional in this modes what concerns the measurement of flow, but with guarantee keeps its stability inside the piping
- it enables by choice of suitable measuring diameter d_{20} (in combination to **Δp total** and **Δpdif.**) such „dynamic tuning“, not to occur the resonance with excitation frequencies of piping

- it makes possible a solution of all welded-on nozzles and other welds of measuring nozzle in full compliance with the principles valid for weld joints of the exposed piping of nuclear power stations
- it is markedly cheaper than Annubar sensors

A certain problem of this solution is finding of piping sections on the steam piping so that the length of straight sections before and behind the measuring nozzle approximates to the lengths required by the applicable ISO Standard.
An arrangement of measuring nozzles and their tapping points of pressure – see Fig. 3, 4 and 5.
As of today the measuring nozzles are installed on both units of NPS Temelín and operate reliably.

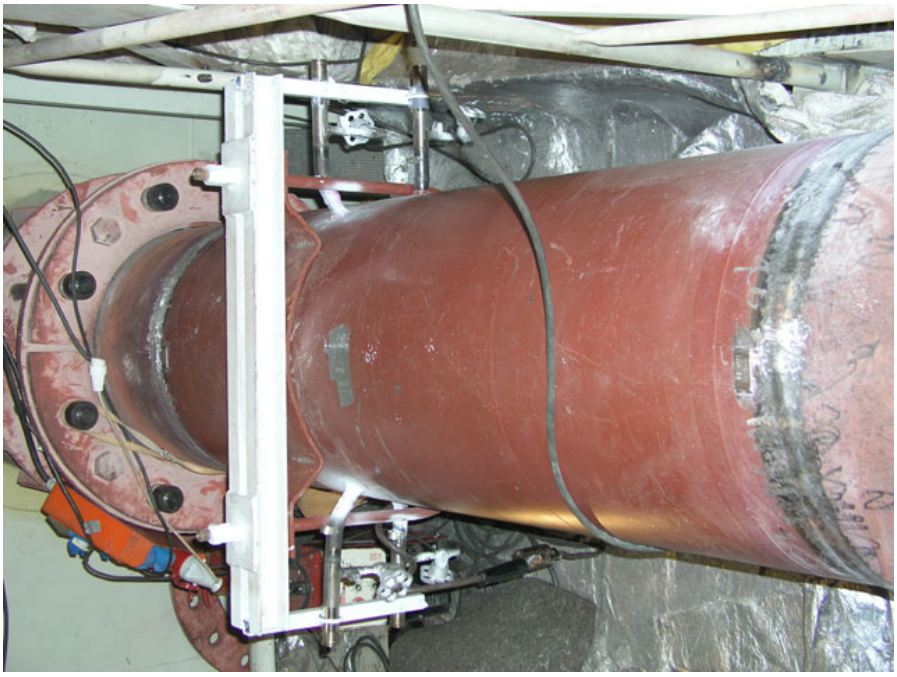

Fig. 3

Fig. 4.

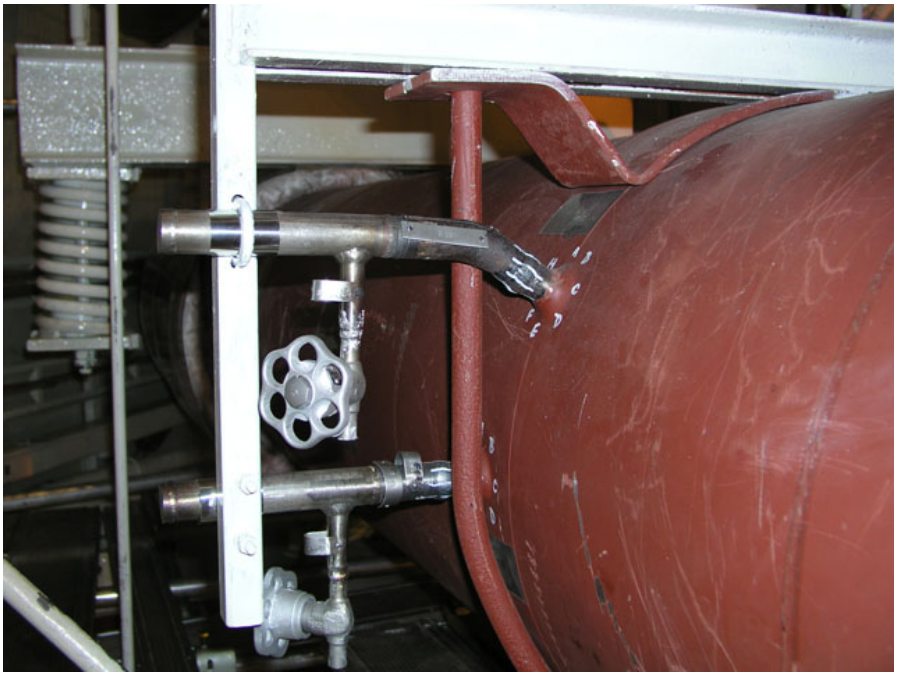

Fig. 5.