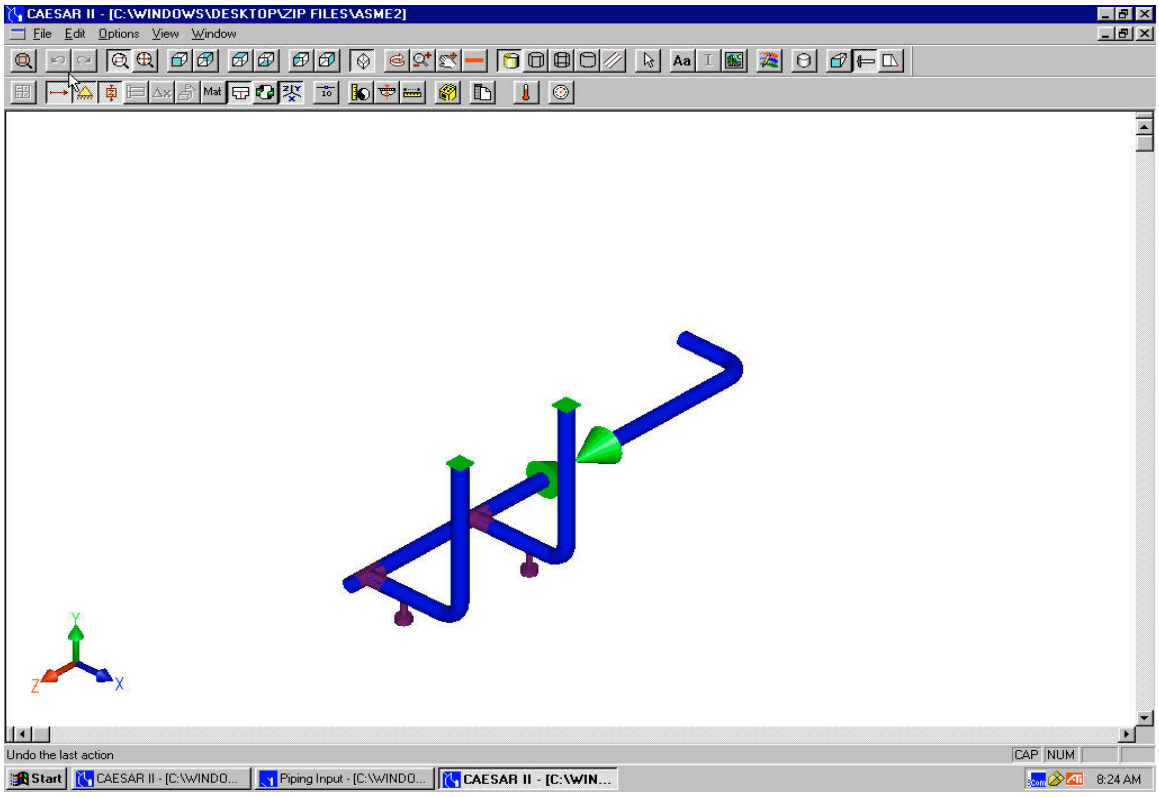
STEAM TURBINE INLET PIPING- A CASE STUDY

Steam turbines are one of the most CRITICAL and SENSITIVE equipment in a process plant. Especially so, in the case of turbines driving multistage compressors, because now we are coping with two critical equipment coupled with each other forming complex problem patterns. These problem patterns give rise to more elaborate maintenance techniques and more sophisticated CONDITION MONITORING. With this prologue in mind, I would like to discuss a case history of a problematic turbine in a urea fertilizer facility (Dh Chemicals-Pakistan).

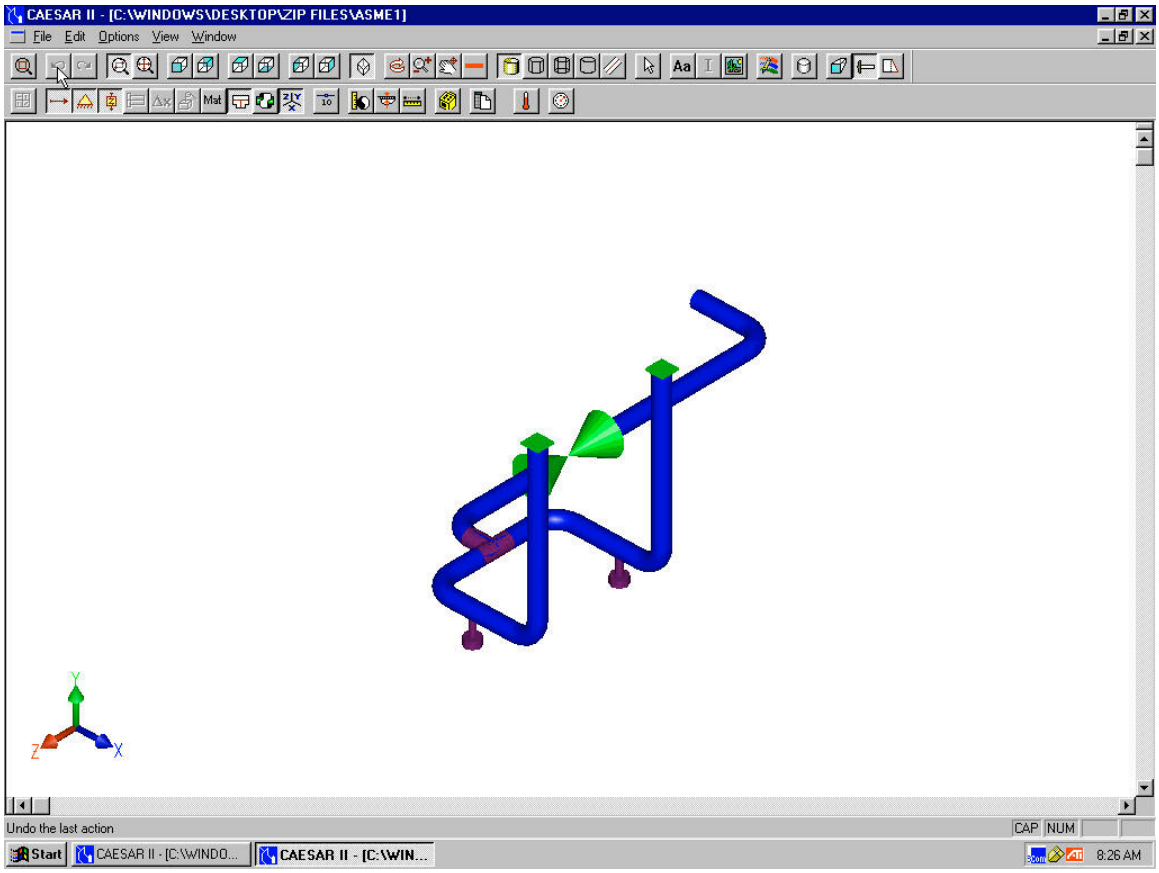
The steam turbine along with other two turbines of similar design was mounted on an elevated compressor deck. As a rule, the inlet piping ran from below the turbine, and outlet vice-versa. The working fluid of the driven compressor was Synthesis Gas (N2+H2). While on the turbine side the temperature & pressure conditions were, 900 Deg F, and 1500 psi. Rotational speed of the turbine was 6000 RPM above second critical. Turbine had significant thermal growth on operating conditions.

The turbine was serviced & overhauled on annul basis (Annual Turnaround) in the presence of vendor service man. The turbine maintenance procedures mainly comprised of Rotor Balance Check, Bearing Clearance Check, and Coupling Inspection. In a certain turnaround, when turbine was to be boxed-up, after maintenance, the piping flanges and turbine nozzle flanges, showed some degree of misalignment (Cold spring) condition. At that moment, further plant down time was unacceptable, and production schedules were stringent. So the piping flanges were bolted up, with slight leverage (A Practice Which Should Not Be Followed).
The whole INCIDENT was forgotten, considering it as it to be within nozzle alignment tolerances. This misalignment however aggravated in the successive shutdowns. In addition to that turbine in-board bearings and compressor to turbine coupling displayed extra-ordinary wear.

This situation was discussed in the higher quarters, and it was unanimously decided to get the piping of the turbine & compressor re-stress analyzed. Below is the previous configuration of the entire inlet piping – Steam Side



Piping Isometrics and operating conditions were sent to an offshore Stress Analysis company. The experts gave the opinion that piping has been fatigued. The cause of fatigue was higher through put than the deigned value. The throughput was increased during he BMR (Balancing, Modernizing, Revamp). The results of the fatigue are permanent, plastic de-shaping. The situation could get worse, so two recommendations should be followed on urgent basis. Firstly, the routing should be changed as below.



Secondly the material should be changed to Low-Chrome alloy.

There are one or two very significant features about these recommendations.

Firstly as can be seen that entire Z-Z AND X-X (Transverse and Lateral), thermal growth of turbine, has been compensated in the piping configuration, which previously was not as efficiently done.

Secondly, the new material recommended, has better severe temperature endurance properties, thus preventing it to be plastic at ultra-high temperatures and thus give better long-term trouble-free service.

This 8” Sch XXS, pipe has also special fabrication requirements, 100% Radiography, and Post Weld heat treatment (Stress Relief). Secondly, in order that welding contraction stresses, for such heavy thickness, should not pull the finished piping out of alignment, one spool should be Bolt tightened along with the turbine, and insulating joint to be used for such flanges so that welding currents should not deteriorate lube-oil of he turbine in the console.

With these recommendations, the piping was fabricated, and turbine and piping are giving perfect service till now.