Steam Turbine Pipe Strain Case Study Texas A&M Turbomachinery Symposium

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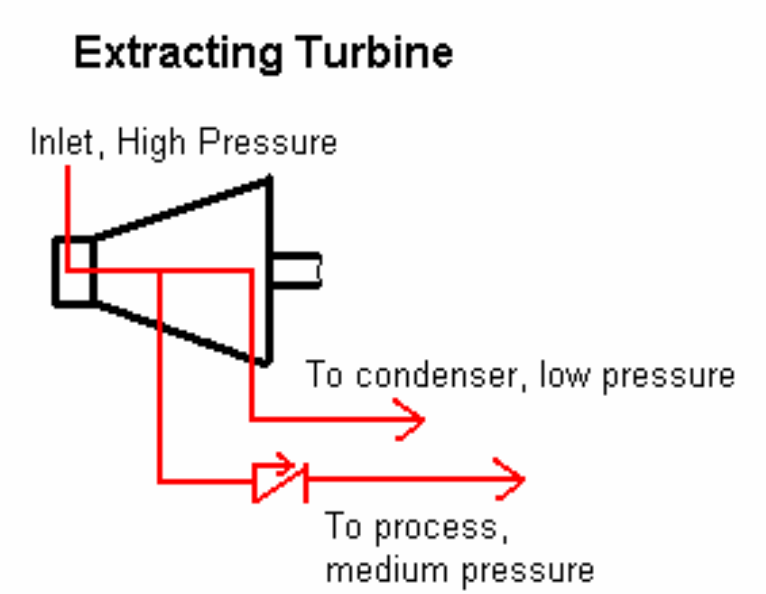
Abstract

This is a case study of a new steam turbine installation in which pipe strain became an issue after commissioning and start-up. This case study will bring light to the use of shaft indicator movement vs. turbine casing foot movement for pipe strain verification. The turbine's bearing housings and process casing are independent of each other. With this type of arrangement, pipe strain would have to be at the extreme to see movement at the coupling. Instead, the casing foot movement should have been monitored. This case study will present the initial as-built conditions vs. the after 6 months of service pipe strain findings and resolution.

As-Built Conditions

- New 50,000 Hp steam turbine installation
- Replaced dual driver arrangement (gas and steam turbines)
- 1,250 psig steam service, chrome-moly piping
- Steam piping designed and fabricated with field weld requirements and witness points



As-Built Conditions

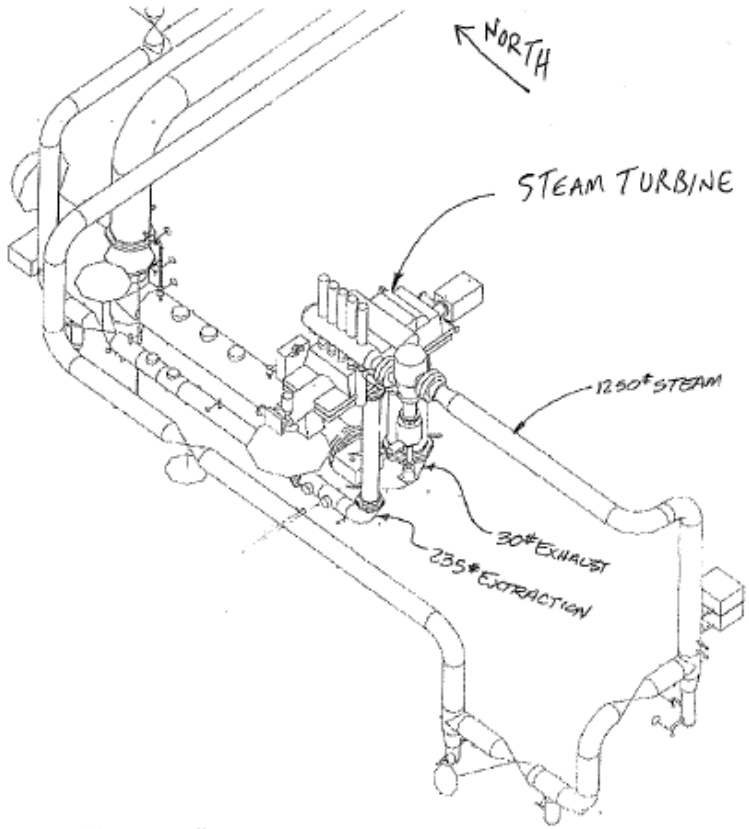
- Installation completed on time
- Field welds and pipe strain witness points conducted
- Monitored pipe strain via shaft end indicator movement
- Successful startup with no known pipe strain

Pipe Strain Findings

- Turbine shutdown due to unrelated maintenance issues
- Difficulty in removing inlet flange bolts
- Galling and pipe strain after only 6 months of runtime

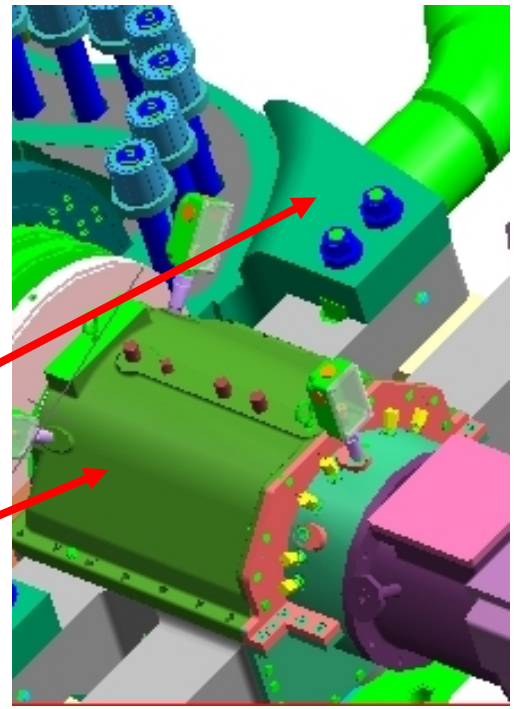
Pipe Strain Findings

- Significant north to south flange gap / strain observed
- Significant flange angularity was also detected
- As the inlet and exhaust flanges were tightened, the turbine's north feet would lift up with the majority of the movement found on the north east foot
- The 3 constant load springs on the inlet were found to be in the hot position / sagging with steam system cold
- Observed that the cold position of the piping was 2-3 inches further north than the original cold constructed position



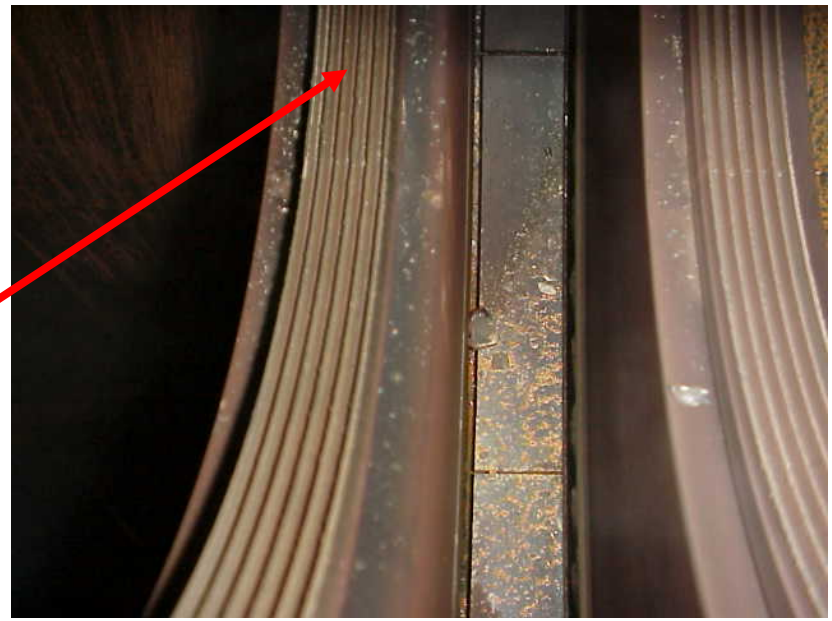
Pipe Strain Findings

- Questioned construction group regarding their initial pipe strain checks
- Dial indicators were installed across the coupling hub with no movement observed
- This would be acceptable except for the fact that the turbine case is independent of the bearings.



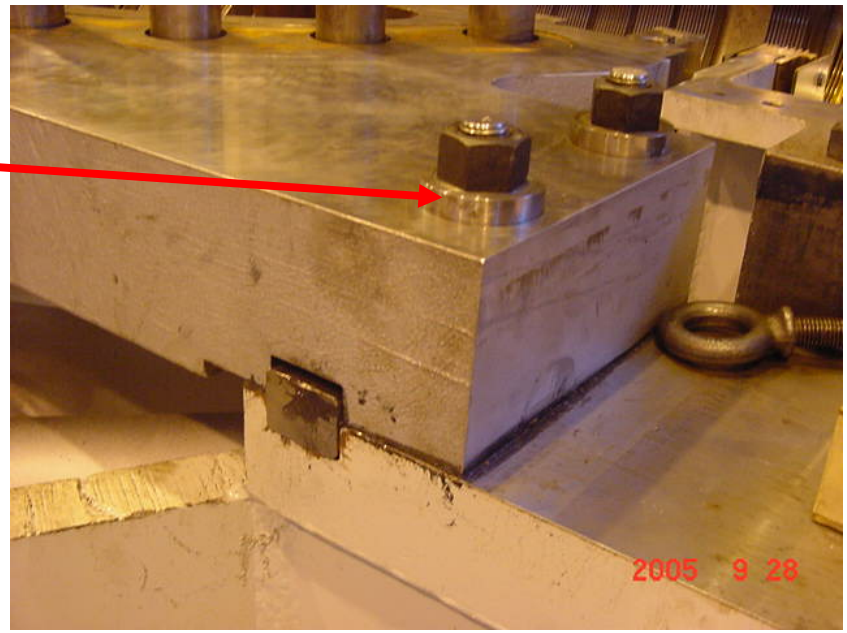
Pipe Strain Findings

- Pipe strain was not detected at the coupling during construction
- Pipe strain could be detected if monitoring the casing foot movement during inlet flange installation and tightening
- The internal shaft packing was rubbed hard on one side
- The orientation of the rub agreed with the case lifting up on the north side



Pipe Strain Findings

- The shipping washers allow for thermal expansion of the casing
- There should have been clearance between the washer and case
- The pipe strain lifted up the case which eliminated the clearance
- The turbine case with rotor weight is ~110,000 lbs

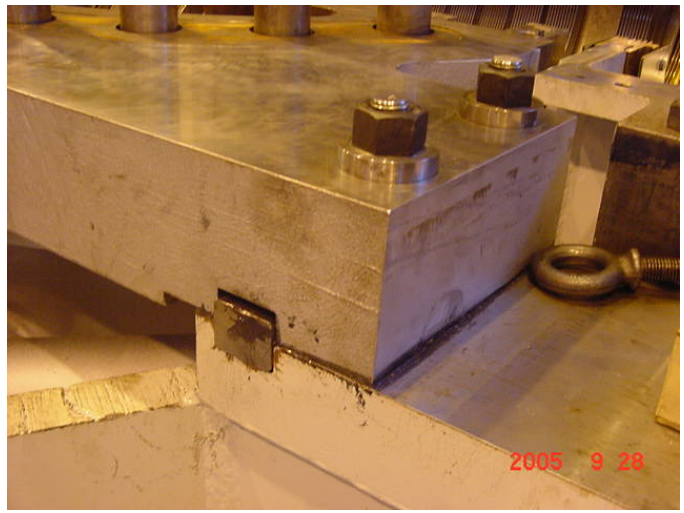


Pipe Strain Resolution

- Pipe stress analysis conducted
- Pipe strain was due to a combination of improper fit up and unbalanced thermal expansion of inlet piping (MOV block valve location)
- Used tensioning method (instead of torque) with new inlet flange bolting
- Ensured the bolts and nuts were properly lubricated with high temperature grease

Pipe Strain Resolution

- Monitored the casing feet as the inlet flanges were tensioned
- Piping and spring adjustments were made to ensure the casing was sitting flat on its foundation
- Casing feet clearance check was added to the maintenance procedure



Pipe Strain Resolution

- Upgraded 2 of 3 constant load springs
- Painted supports to visually observe piping thermal growth
- Long term plans include further piping modifications (new field fit-up welds, spring relocation / changes, etc.)

Lessons Learned

- Common method of pipe strain measurements at the coupling should not be the only measurement for pipe strain when dealing with equipment that have independent case to bearing housing connections.
- Simple field measurements, observations, and data collection techniques can provide valuable information.
- Attention to the details is critical.

Questions?