MATTHEWS INTEGRITY HUB

FAILURE BRIEFING

HEAD OFFICE

MULTIPLE FAILURE OF STEAM DUCT WELDS

MECHANICAL FATIGUE

THE ARRANGEMENT

The power plant 7m diameter steam duct is constructed to ASME VIII-I for pressures of +1barG to full vacuum. Dump steam enters the duct through the inlet nozzle shown under some plant fault conditions. As the vessel is rated for full vacuum is has circumferential stiffeners to resist buckling

The steam duct

THE FAILURE

The photos show cracks propagating from welds. The stiffener crack had started from the mousehole spanning the vessel longitudinal weld ,propagated up the stiffener web and continued along the toe of the stiffener flange.

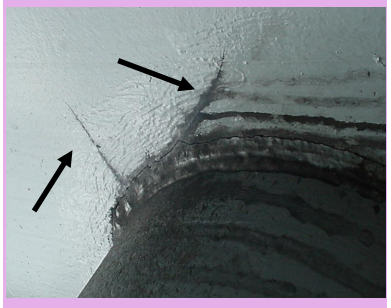
Failed stiffener weld

One nozzle weld crack had initiated at the weld toe and then propagated around the weld periphery before branching off in to the vessel shell in a longitudinal direction. It went straight across the vessel circumferential weld .Other cracks had propagated in random directions from similar nozzle welds.

Nozzle weld cracks

THE CONSEQUENCES

The cracks caused continual loss of vacuum so the plant had to be completely shut down for repairs



More nozzle weld cracks

WHAT WAS THE CAUSE?

There are two design issues to consider ;the asymmetric and convex profile of the nozzle welds and the proximity of the vessel circumferential weld to the nozzle weld. Would you consider they had any influence on the failure? See the next page: **Failure Diagnosis and Lessons learned**

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FAILURE BRIEFINGS

We think it is important in the asset integrity industry to **SHARE INFORMATION** on equipment accidents and failures. This is the main way in which people learn how failures can be prevented and that the same mistakes do not happen again and again.

Most causes of failure are well known and can be prevented by learning from things that have happened in the past

WE INVITE YOU TO PARTICIPATE

The more failure briefings we can show on these pages the better the chance of failures not repeating themselves unnecessarily. If you want to pass on details of failures you've experienced we will be pleased to edit them into our failure briefing format so they can be of greatest benefit to others in the plant integrity community.

HEAD OFFICE

MECHANICAL FATIGUE: LESSONS LEARNED

THE DIAGNOSIS

This is a straightforward mechanical fatigue failure caused by flow-induced vibration of the duct. It had been observed to be vibrating heavily, particularly under steam dump conditions. The widespread nature and number of failures suggests that it was not a problem with individual welds.

The proximity of the nozzle weld to the vessel circumferential weld is allowed by ASME VIII-I ,although not by some other codes.

The asymmetric leg-length and rough convex profile of the nozzle-to-shell welds may be marginally outside code acceptance criteria but these are regular features of ASME VIII-I fabrications. Overall it was considered unlikely that these had anything to do with the failure and that, under such severe mechanical fatigue conditions, failure was inevitable, whatever the quality of the welds

LESSONS LEARNED :How not to let it happen again.

Mechanical fatigue conditions do not go away by ignoring them. Vibration is easily measured in mm (amplitude) ,mm/sec (velocity) and mm/sec per sec (acceleration) using a hand-held meter .Standard ISO 1940 gives some useful guidance on acceptable vibration levels but there is no real 'safe' level ,particularly with high-cycle vibration.

Mechanical fatigue is an unpredictable damage mechanism. The initiation point and propagation path of cracks are next to impossible to predict. They commonly occur around rough or sharp-edges weld profiles changes of section, and other areas of stress concentration .

For fabrications that have to exist in fatigue service, blending of the weld caps to a smooth profile can help reduce the risk of fatigue cracking. Peening of the weld surface can also help. Ultimately however the best long-term solution is to eliminate the source of the mechanical vibration.

Matthews Integrity Notes: HEAD OFFICE is **OPEN EVERY DAY....0730-2200 Monday-Sunday**...That's correct, all week, including holidays.

If we miss your call, leave a message and we will call you back just as soon as we pick it up. Sorry, there's no automated messages, call queueing, voice recognition robots or garbled music. Try it and see.