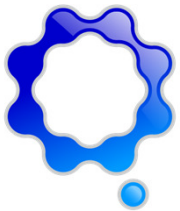
Qenos

T-509 ACOUSTIC EMISSION TESTING

14/07/2016



1. T-509 Acoustic Emission Testing

TEAM MEMBERS

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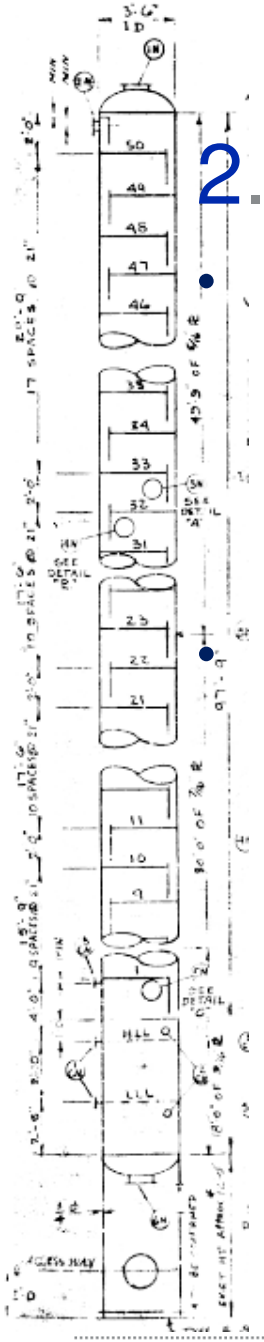
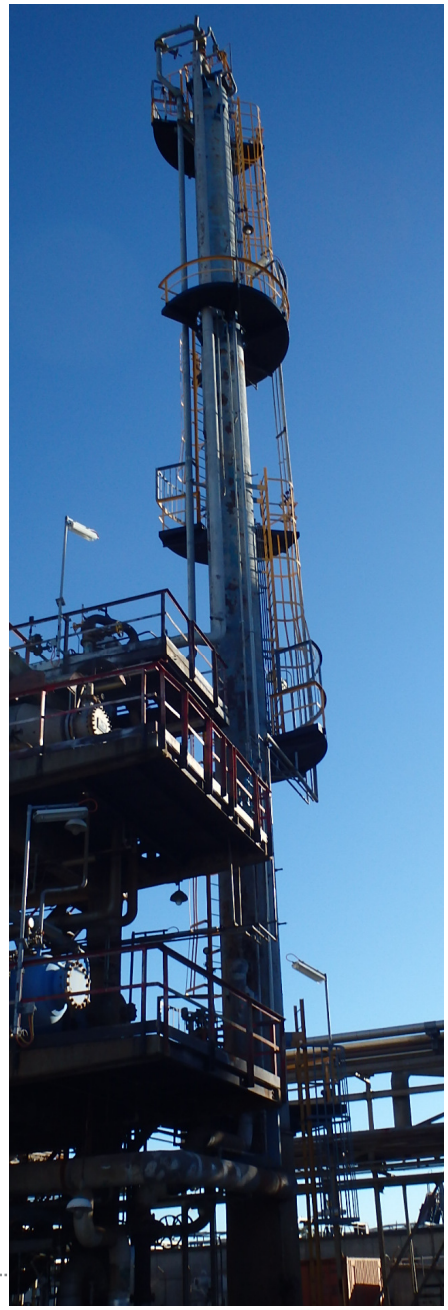


2. Background

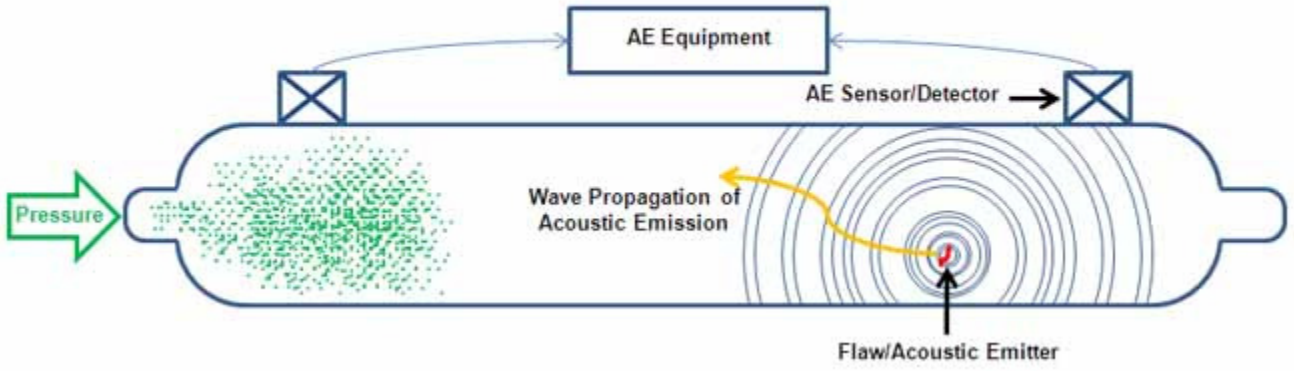
- In 2015 T-509 was required to have an internal inspection. Risk Based Inspections had been completed to extend the interval, but identified a key area of concern which limited the possibility for extension.
- T-509 (Olefins Dependaniser Tower) is around 35m tall with 50 internal trays installed.



2. Background

- Acoustic Emission (AE) testing is an established Non Destructive Examination (NDE) technique that can assess a vessel condition (by identifying the presence of active cracking) without a requirement to enter the vessel.
- AE testing works by applying a controlled and staged pressure range and taking acoustic measurements throughout. Any active cracks will appear on the instrumentation during the process and their location determined.

Diagram of Acoustic Emission Test on a Pressure Vessel



3. SHE issue / improvement opportunity

- Entry for inspection of T-509 typically takes weeks and costs in excess of $100K. It also has a number of inherent hazards.
- T-509 and associated equipment contain high levels of Benzene and potential pyrophoric material. Safe entry to the tower requires process preparation which can take a number of days (to week+). With entry there is a host of confined space and access hazards as work crews enter the tower to remove trays and inspect.
- An inspection technique which eliminates entry avoids all requirements to prepare the tower, eliminates confined space and a number of working at heights hazards. It also reduces down time for the equipment and associated process impacts.

4. Solution

- External NDE was not a viable test for the failure mode of concern.
- Acoustic Emission Testing was selected as a low risk option (Financial and process). This has been used previously by Qenos for spheres, however this was the first use at Olefins and on this type of equipment.
- Integrity Engineering review was undertaken to confirm suitability of the technique (and likelihood of success)
- Process Engineering review to determine the requirements to safely and adequately carry out the test and an Operations procedure was developed
- A specialist NDE contractor (ATTAR) was engaged for the AE testing and they assisted with the development of the test requirements and procedures.

5. Implementation of the solution

Day 1 T-509 was taken out of service, inventory removed and was nitrogen filled. The preparation work was completed as per the procedure by a dedicated Operator for a planned testing window.

ATTAR placed 14 sensors around the tower at various locations accessible from the existing platforms.

Day 2 Final setup/connection then testing. The AE testing started at around 200kPa and was increased in stages to 110% of the maximum pressure the tower is likely to see (330kPa). Testing took around half a day then the instrumentation was removed.

Day 3 T-509 was returned to service as per the procedure.

From this testing a report was created that confirmed the integrity of the tower.

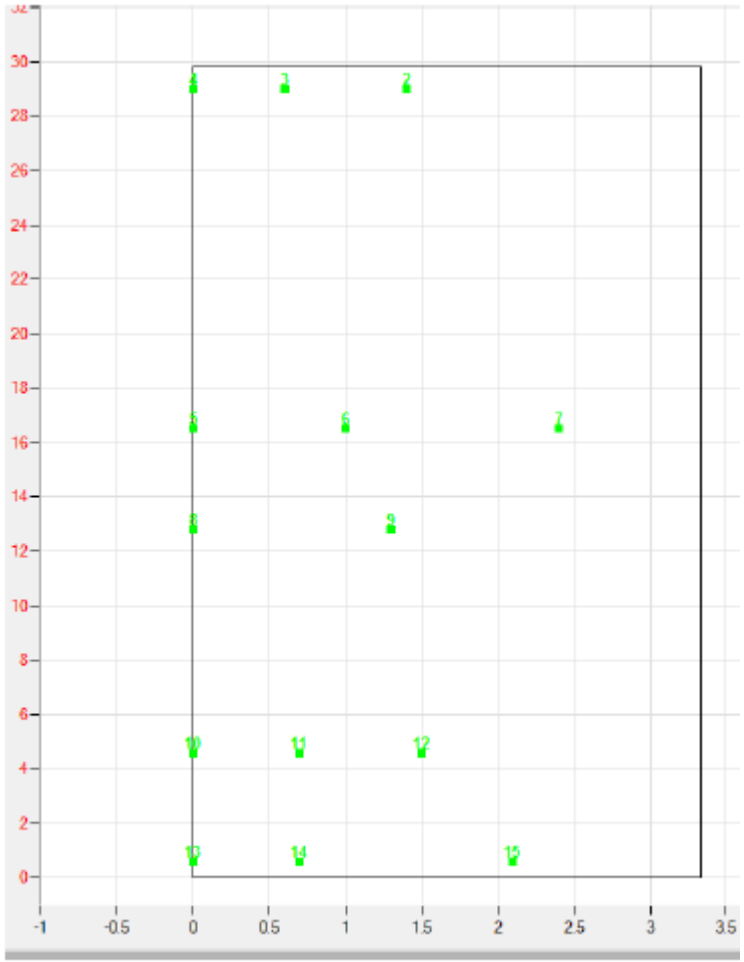
The testing did not have any process impact or loss

Other than Qenos personnel, the inspection required only the AE Testing contractor (no scaffold, cranes, lagging etc.)

6. Outcome of this project/activity

- T-509 inspection completed within one day (with one day either side to prepare the tower)
- Total cost of around $18K ($17K for inspection)
- AE testing did not identify any active cracking defects
- Testing was completed in a timeframe significantly less than for full entry, and at a fraction of the cost.
- There was no exposure to Benzene or other harmful components as part of preparation or entry requirements
- Minimal flaring requirements for preparation and no waste disposal.
- No entry required – eliminated confined space hazards, manual handling risks, working at heights
- Opportunity for future T-509 testing as well as other vessels at Olefins (and other sites)

6. Outcome



Located AE events.

Note: The Areas missing from pressure versus time graph due to d

Top - Pressure versus time.
Bottom - AE hits versus time.