

HIGH VALUE LEARNING

High Value Learning

Chemical Tank Lifting Bridle Master link Failure

Who could be interested in this?

All duty holders and contracting companies within the energy sector, supply chain companies, shipping and logistic companies, manufacturers of CCUs, lifting equipment manufacturers and providers. All Step Change in Safety members & partners e.g Marine Safety Forum, IMCA, GWO, Safer Together

What is this all about?



During cargo handling operations there was a requirement to move a full tank of chemicals weighing 4.7t to a decanting area. The crane pennant was attached to the master link of the tank lifting bridle and the crane operator began taking the weight. Whilst the crane was taking the weight the master link parted at the weld resulting in the crane pennant load hook becoming detached from the load.

The tank did not leave the deck at any point as the full weight had not been taken by the crane (3te was indicated by the Crane MIPEG at the time of failure).

The pro-active MPI of other lifting assembly master links identified some with indications of a crack in the heat affected zone of the weld. At the time it appeared these indications were more prevalent on the master links fitted to chemical tanks (tote tank) lifting bridles.

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As a result of this incident a meeting was held on the 21st November 2023, attended by representatives from duty holders, shipping logistic companies, lifting equipment providers, inspection bodies and members of the Step Change in Safety Lifting Workgroup to determine an appropriate course of action whilst waiting for the results from the metallurgy examination of the failed master link. At the time there was the obvious concern that these indications of a crack were the first stage in the development and then the progression of a fatigue crack leading to the eventual failure of the master link.

It was agreed by those present that industry should be advised to consider taking a precautionary approach until the results of the metallurgical examination had been completed. This was to consider carrying out the MPI examination of all chemical tank (tote tank) lifting bridle master links & sub link assemblies. Consideration should be given to not shipping chemical tanks unless accompanied by an MPI test certificate for the lifting bridle master link & sub links carried out within 6 months of the intended shipping date.

The industry undertook in excess of 11,000 MPI examinations of master links from multiple manufacturers and of these 55 indications of a crack were found. Sixteen of these links were replaced and link scrapped without any further examination. Of the remainder, except for one, the cracks could be dressed out without exceeding the manufacturers limit for the amount material that can be removed. The remaining link, which had a crack of a depth greater than 2mm, was sent for metallurgical examination.

The metallurgical examinations have now been completed, unfortunately in the case of the failed master link it has not been possible to positively identify the causation of the failure. The fracture face showed some evidence that it was a fatigue failure with the crack progressively making its way into the link until the eventual ductile fracture of the remaining material. The link had been manufactured in 2015 and had been in service for nearly 8 years, its last NDE was undertaken 42 months prior to the failure (the DNV Standard recommends NDE at intervals not exceeding 48 months).

The metallurgical examination of the other master link identified the crack was 8mm long, 4.26mm deep and situated adjacent to weld joint. It was initially concluded that an intergranular crack had formed during the manufacturing process, possibly a result of hydrogen induced delayed cracking in the heat affected zone prior to the heat treatment. However, following discussions with the manufacturer's metallurgist the metallurgist now considers it is more likely the intergranular crack had formed from liquidation (incipient melting) of low melting point compounds normally situated on the grain boundaries of the steel. If during the resistance welding of the link the electrode is not located with perfect contact an arc can be generated which can result in an area of localised higher heat and cause this incipient melting. Any such cracks are normally detected by the manufacturer through visual examination or by the MPI examination. These are dressed out or if they exceed the manufacturer tolerances the product is scrapped. The integrity of master links at the time of manufacture is validated by the proof load testing of each master link.

There was no evidence that this crack had grown during the 10-year service period of the link. As this type of crack is not always visible and can be formed just below the surface it explains why it was not identified at the time of manufacture or during the MPI at the 4-year inspection cycle. It is likely this crack became identifiable when wear or corrosion removed some material from the surface of the link.

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Some things to consider?

- The precautionary approach of advising industry to consider adopting a six monthly MPI of all chemical tank (tote tank) lifting bridle master links & sub link assemblies no longer needs to be adopted.
- The MPI undertaken by industry following the failed master link incident does not appear to corroborate the initial MPI data which gave cause for concern about a potential prevalence of indications of cracks on sling sets used for lifting chemical tanks.
- The available evidence suggests that the Master Link was correctly manufactured, inspected and tested in accordance with the applicable DNV standard and was considered to be suitable for service up to the time of failure. The link which failed had been in service for nearly eight years and failed 42 months after its last 48-month MPI. It is reasonable to conclude the crack had developed and progressed significantly during this 42-month period. Consideration should therefore be given to reducing the periods between MPI examinations for master links which have been in service for more than 4 years, and the subsequent frequency increased from 48 months to 24 months.
- All types of containers should be subjected to a pre use inspection prior to shipment to and from offshore installations. The appointed person should check the validity of the certification and check the lifting set is free from any obvious defects.
- When indications are found during the MPI they must be examined and if they are found to be cracks they must be dressed out by following the original manufacturer's guidance. When found it would be useful if Inspection Companies would record the type of container to which the master link is fitted to determine whether such cracks are more prevalent on a particular type of container.
- Step Change in Safety will refer these findings to DNV for consideration for changes to the applicable standard. Any subsequent changes would be expected to be communicated through appropriate industry channels.

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