21 Chemical Tanker Explosion

Technical Investigations

ConsulMar
Naval Architects,
Marine Engineers & Surveyors

- Investigation of the Cause of the Explosion
- Research to determine if the tank was correctly designed and built

A chemical tanker completed loading Sodium Methylate/Methanol solution and the cargo line was being blown with nitrogen for final stripping; suddenly, a blast followed by a white cloud emerging from the bow area, evidenced the explosion.

No personal injuries happened.

The stainless-steel tanks bulkheads rip up in several places and the tanks in the area remained connected.

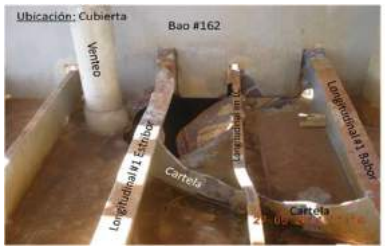
The ship was interdicted to navigate.

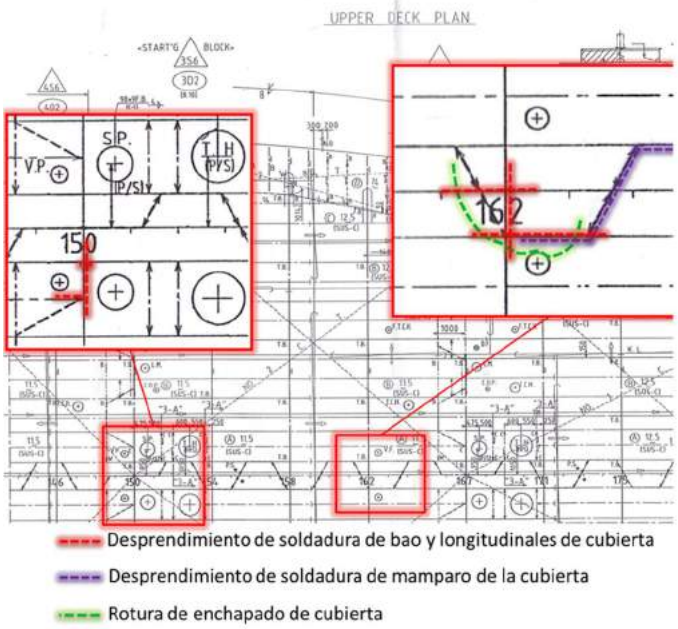
The cargo resulted contaminated.

ConsulMar was appointed to ascertain the nature, extent, and cause of the casualty, but we will focus on the ship's structural aspect of the investigation only, because of its' distinctive procedure and findings, compared with other similar cases.

CORRUGATED BULKHEAD FAILURE ANALYSIS.

Extent of the damages.





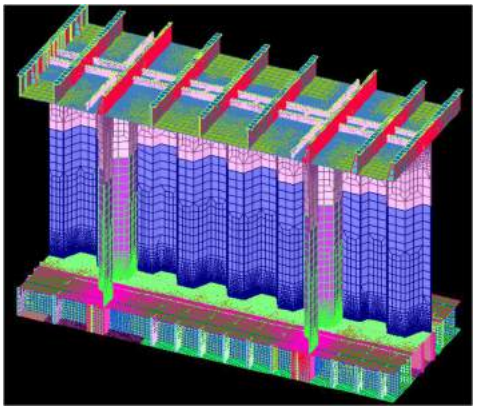
The nature and extent of the damages and other evidences found leaded to a failure hypothesis that was analyzed by means of a technical-scientific approach.

Key parts of the damaged structures were recovered and sent to the National Atomic Energy Commission

Laboratory, for macrographic, metallographic, electronic microscopy, microhardness, and spectrometric chemical analysis.

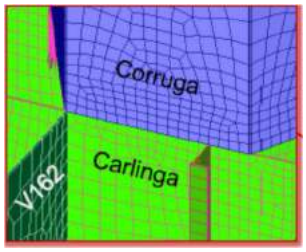
In the photos to the sides, a welding at the foot of the bulkhead was removed and investigated.

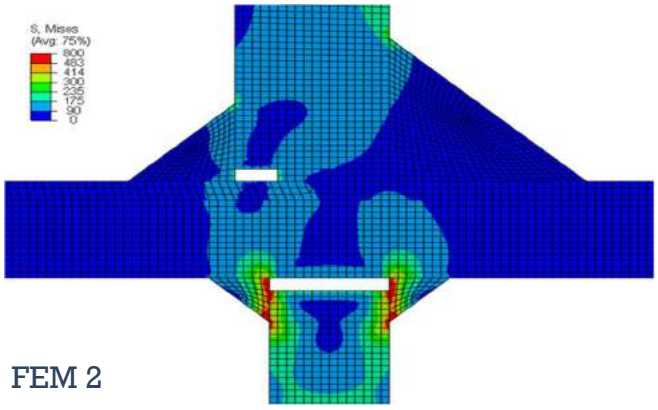
In search of the bulkhead failure mechanism, two Finite Element Analysis models were developed: a general one (FEM1) and another one focused on constructive details (FEM2).
FEM1 analyzes the behavior of the structure as the relevant loads vary. FEM2 studies the stresses concentration due to the geometric discontinuity of the fillet weld connecting the bulkhead to the double bottom structure.



FEM 1

Note the very fine mesh in the detail below.

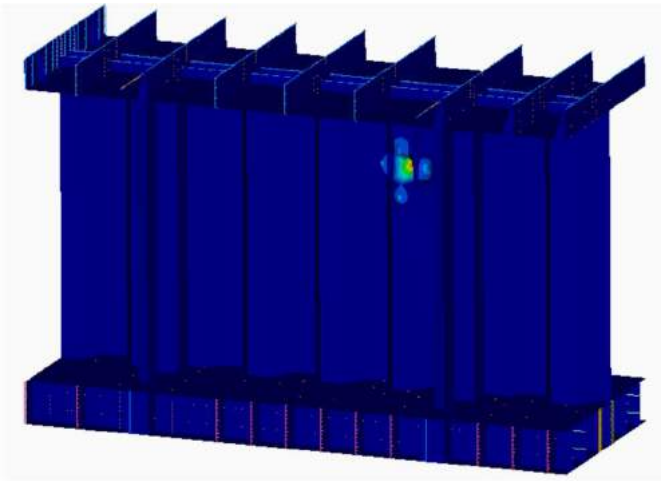




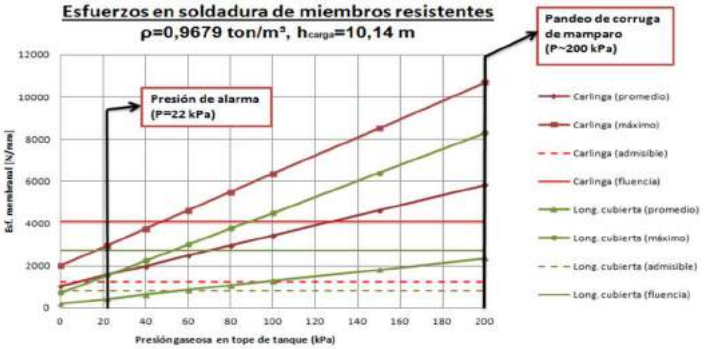
FEM 2

Different possible loading conditions were defined:

- cargo density and height, and different possible gas phase pressures at the time of accident.
- sea water hydrostatic load with different possible heads and no gas phase pressure.
- hydrostatic load corresponding to the tank design maximum cargo density at different possible heads and cero gas phase pressure.
- additional dynamic loads were not considered.
- The gas phase pressure provoking the bulkhead buckling was calculated.

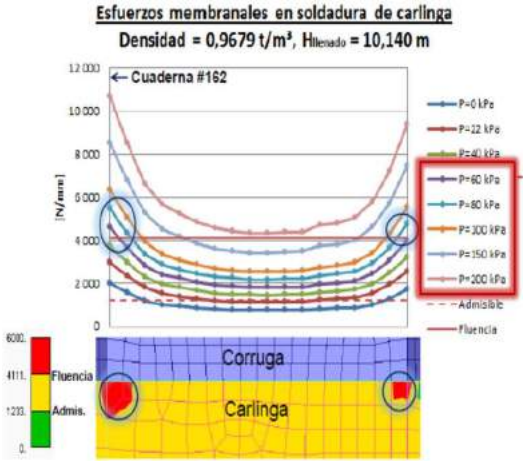


The bulkhead buckling modes were determined, and further analysed and compared.
Considering the welding sizes and material, the strength of the welding seams was evaluated.



Based on the above described calculations, the welding stresses corresponding to different structural members under various loading conditions were compared.

The start of yielding points for the relevant parts of the welding seams were determined for the different structural members and loading conditions.



The conclusion of this investigation was a realistic and solid probable failure mechanism.