



Ivor Wildin
Director, WTS

API 653: TANK INSPECTION CODE: TANK LIFTING AS AN OPTION TO REPAIR





Introduction

General



Annex B of API 653 lays out prescriptive limits to bottom settlement, planar tilt and differential settlement. If the settlement is found to be outside the stated limits what options do we have to correct it?

OPTIONS FOR LIFTING TANKS

1. AIR BAGS
2. CLIMBING JACKS
3. HYDRAULIC JACKING



Are the most common forms of lifting storage tanks however both Option 2 & 3 require the welding on of lifting frames or pad eye to connect the jacks to. If a tank has leaked and washed out the basecourse then it would not be prudent to weld in the vicinity.

AIR BAG LIFTING

Within the past five - ten years the environmental impact on the operation of petro-chemical product storage tanks containing hydrocarbon or other dangerous goods, constructed to standards such as API 650, has taken on critical implications for refineries, distribution centres and other storers of Dangerous Goods.

Pollution of the supporting foundation and possible widespread effects on ground water has resulted in moves to require the installation of secondary containment. That is not to say, necessarily, a tank with two steel bottoms, but alternative means of reducing the failure probability to an acceptable public or statutory level. Compliance with statutory codes such as Dangerous Goods Regulations 2010 and AS 1940 dictate that ‘impervious’ secondary containment is now required throughout the bunded area.

In the USA, Europe, and other western countries it has long been required to also place a secondary containment liner or double bottom under storage tanks.

The ongoing quest by engineers is to establish corrosion trends in tanks through inspection by various means however the underfloor has always provided a challenge to ascertain a clear evaluation of deterioration hence, assurance of the integrity of the primary containment.

Clearly, increased inspection of the tank bottom has merit and visual examination of the bottom from inside the tank can be supplemented by ultrasonic methods, acoustic leak detection and magnetic flux scanning.

Tank lifting now offers a very cost-effective method for underfloor inspection, combined with the opportunity to undertake repairs to the bottom and underside painting, together with improvements and repairs to the Bit-sand surface of the tank pad.

An impervious membrane can also be installed with a leak detection trough formed around the tank edge so rendering the tank compliant and extending its useful life.







In fact, tank lifting using discrete airbags offers the most cost-effective method for lifting tanks off their foundations. When compared with the more conventional system of hydraulic jacking, the airbag method results in some very distinct advantages, apart from a most significant reduction in cost.

It is not necessary to weld any attachments to the shell or dig deep pits beneath the annular plate. Site preparation is an absolute minimum, and only requires excavations extending 400mm, under the tank shell by 800mm wide and 30mm deep, at a number of discrete locations. In the case of smaller tanks, say up to 46M (150 feet) diameter, the annular plate can be well clear of the pad within six hours of the lifting crew arriving at site.

Summary

The application of the airbag method for lifting bulk liquid storage tanks has been described, together with some of the background theory and experimental measurements that have been made to develop a safe and very economical means of raising tanks so that their bottom underside can be examined or foundation pad repaired or complete secondary containment inserted under the tank.

NDT methods are always a ‘compromise’ and address the evaluation of a defect but not the ‘root cause’ or seek to remediate the cause, this can lead to defects caused by foundation debris continuing to manifest themselves in the corrosion of repaired plates on a floor.

Other considerations are those causing settlement problems in storage tanks where the ground bearing capacities have not resisted the forces applied by the tank. Planar tilt and differential settlement render the tank unusable if this exceeds the limitations in Appendix B of API 653. The lifting of the tank either partially or wholly to insert a ring beam (FIG 1) is required to remediate the settlement.

WORLDWIDE TANK SERVICES



Size Limits?

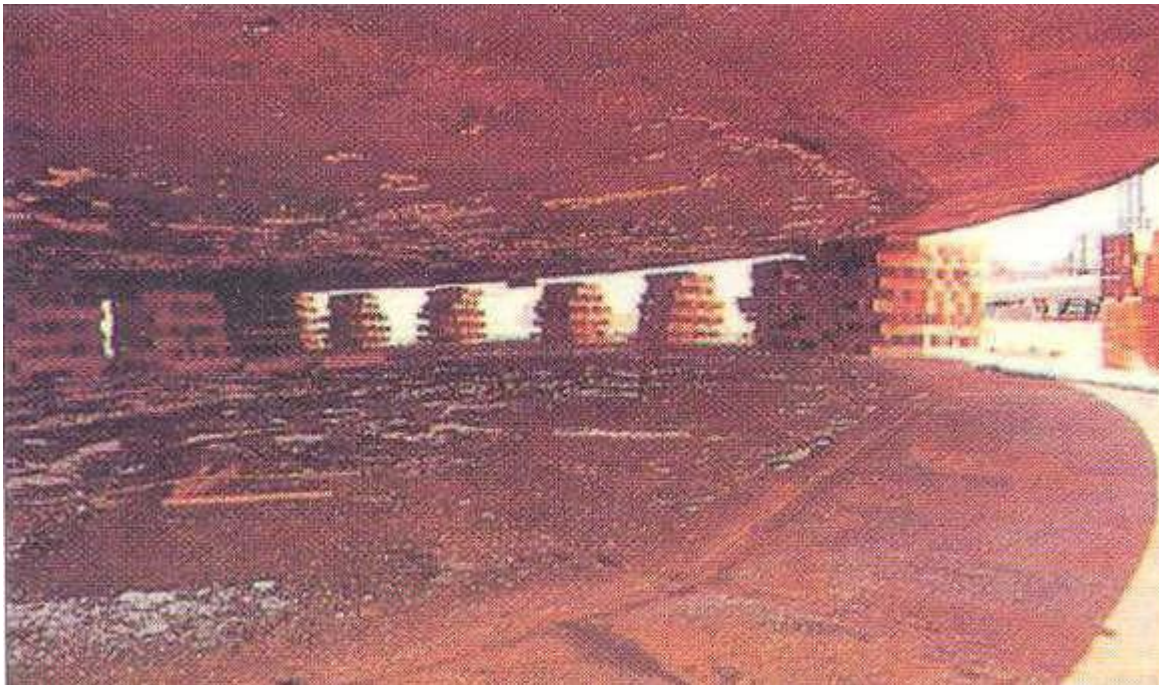


53 X 19M
SRC Singapore

Other touches we can do:



This tank had leaked twice at SRC Singapore and the floor was to be replaced. After lifting it was found that the MFL Scan was in error and there was only two holes in the floor due to stones the rest of the floor had the heat numbers still visible in perfect condition!



25M X 15M
SRC Singapore

The finishing touches.....



HMAS Stirling WA



**FLOOR CHANGE
AUSTRALIAN LUBRICATION MANUFACTURERS
FREMANTLE, WESTERN AUSTRALIA
A JOINT CALTEX/BP FACILITY**

Tank 21 at ALMC had suffered planar tilt outside the limits stated in API 653 Appendix B. The tank was built in 1938 and had leaked through external floor corrosion.

The job was to correct the differential settlement, install a secondary containment liner under the tank and change the floor in the tank.



The tank was lifted from the ground using airbags inserted under the tank



As the tank rises pushed up by the airbags the height gain is consolidated by inserting timber gluts under the tank. The number and support and lifting positions is dictated by a computer program which ensures the stability of the tank and that the compressive loads do not exceed the bottom strake buckling (API 650) of the tank.





The lifting continues around the tank until the whole periphery of the tank is supported on the cribs of timber





As the tank rises the airbags are placed on cribs of timber which then allows the tank to be lifted increasingly higher. The height gain is constantly consolidated by inserting further timber gluts on the support cribs. The tank always remains LEVEL +/- 6 inches side to side minimising any stresses imposed in the lifting.

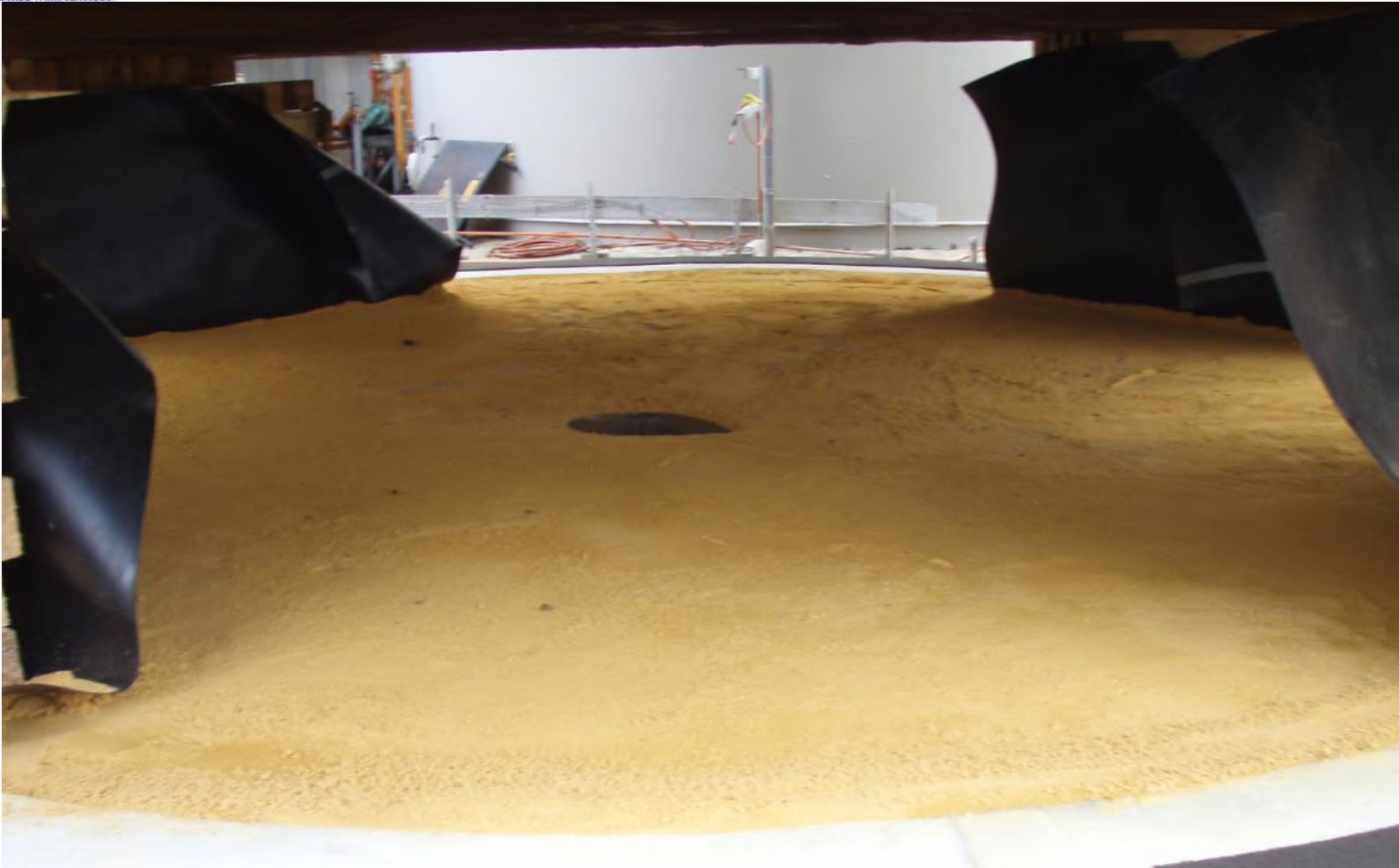




Upon attaining access height under the tank the lifting cribs are removed and the basecourse foundation cap is taken out. This particular tank dihedral of the floor was changed from Cone-Up to 1:120 Cone Down....hence further excavation was required. The concrete ring beam was not level which accounted for the tank differential settlement.



Formwork was laid out to pour the increase in height of the ringbeam and level the tank



After filling of the basecourse it was now time to place in the secondary containment. A drain pipe was incorporated in the basecourse to allow draining in the event of a release under the tank.









Geotextile and pea gravel is added to ensure free drainage in the secondary containment sump



Formwork is added to the sump to ensure the correct dihedral of the resulting fill of the basecourse. The basecourse is now ready for final fill and compaction. The new floor will also be laid on the basecourse







The new sump is added to the floor and welded into place





Lifting cribs are re-inserted around the tank and the tank is lowered

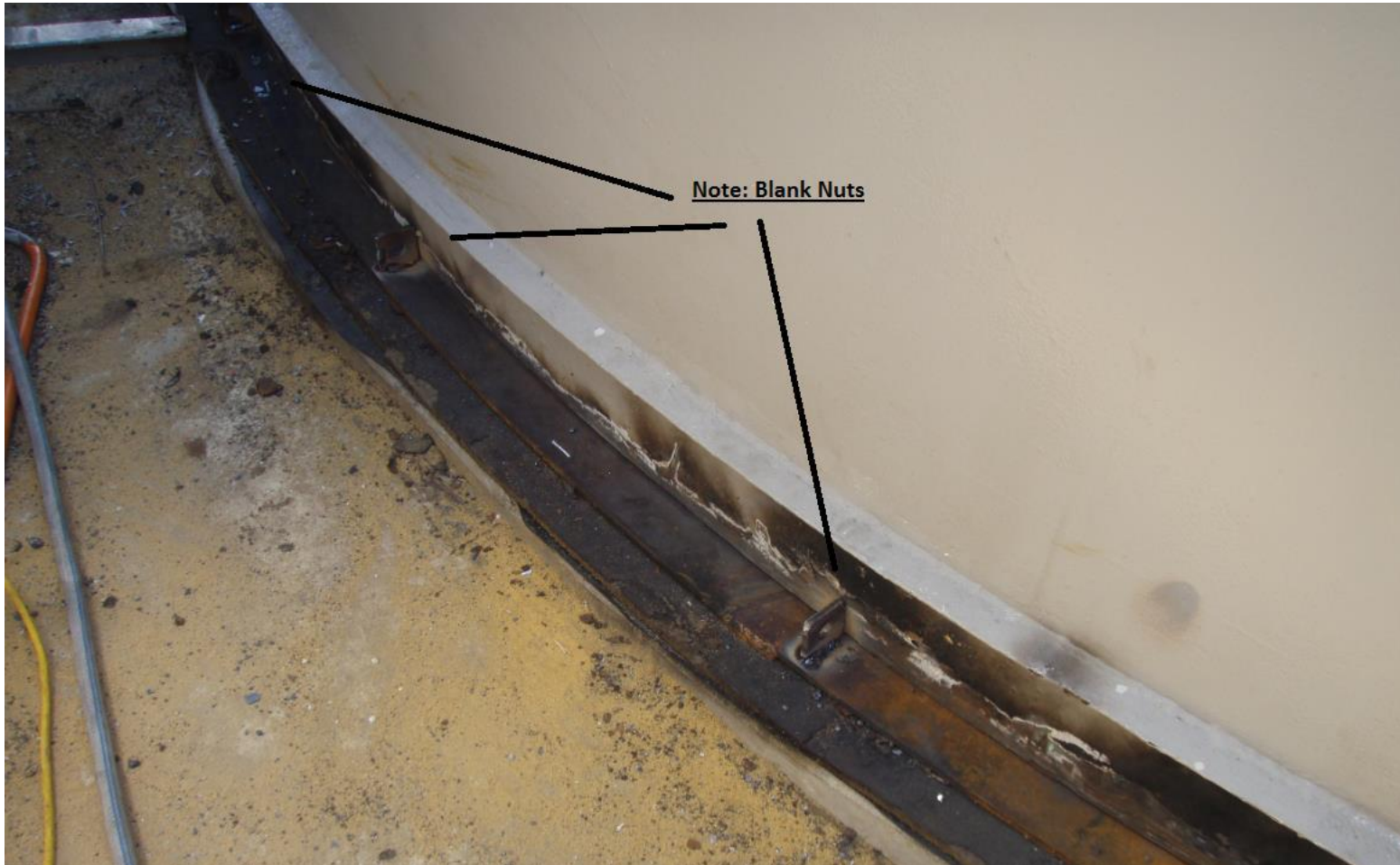




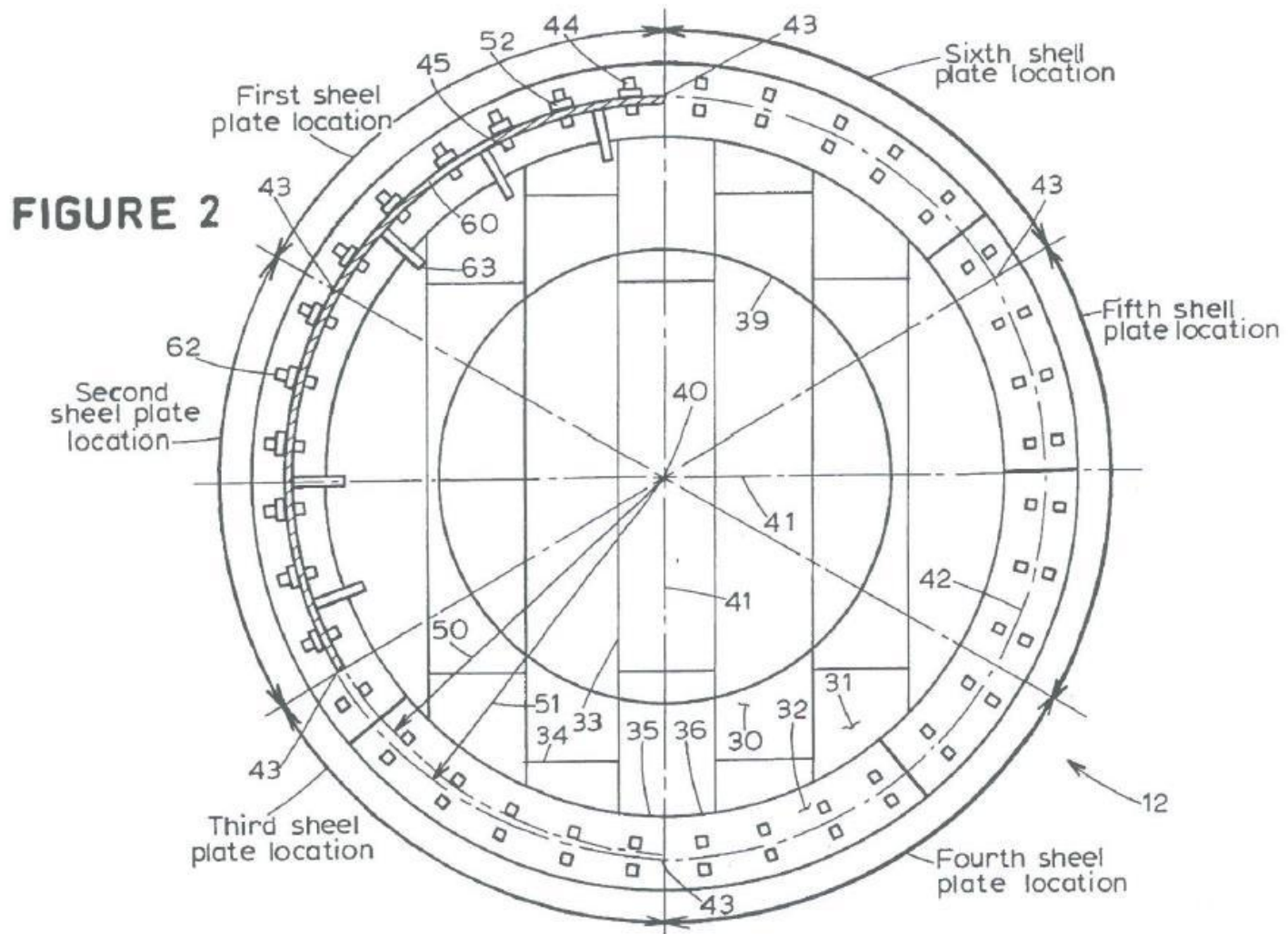
The tank remains at 6 inches above the new floor to allow the cutting out of the old floor

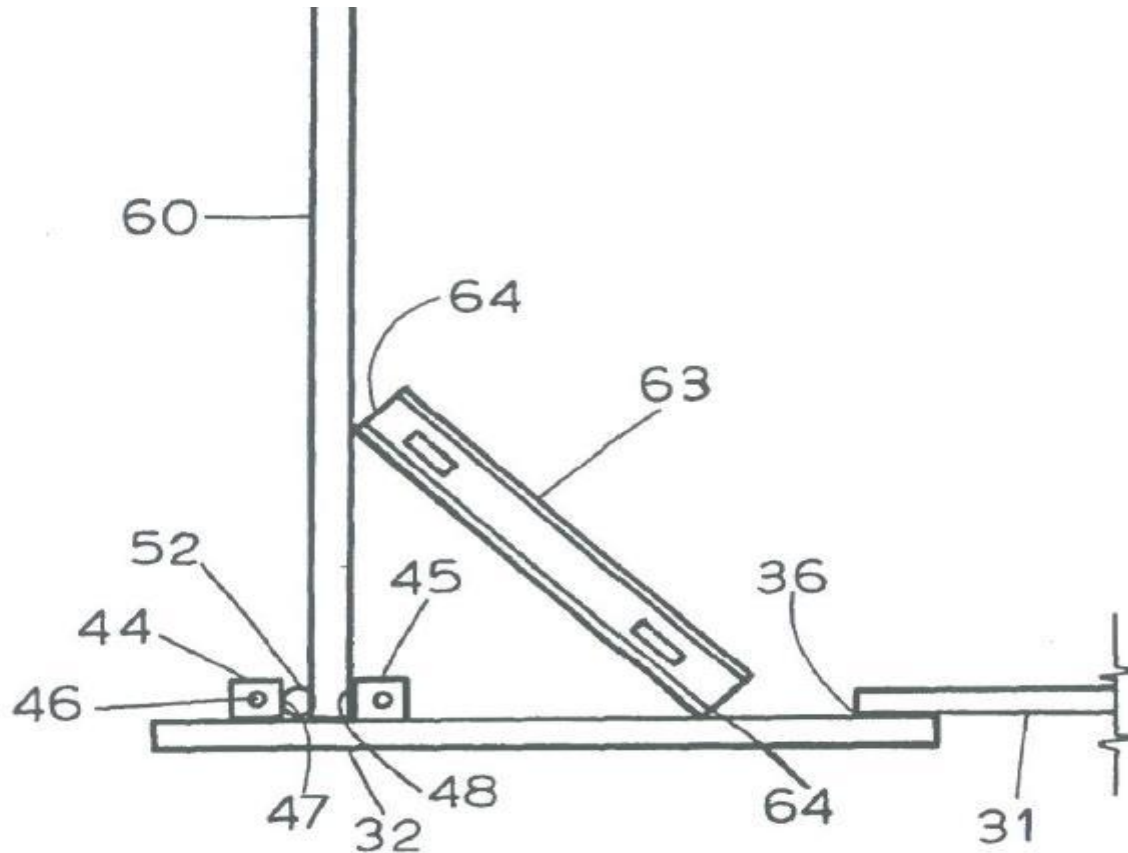


The old floor is cut out and pulled out from under the tank. Sidewalls are cut above the HAZ and the sketch plates released from the tank. The tank is differentially lowered setting the sidewall onto blank nuts to ensure the roundness of the tank is maintained.









The setting of Blank Nuts (44 - 46) allow us to ensure that the tank wall is on the scribe line and can be adjusted by the insertion of the carrot pins (taper wedges - 52) ensuring the tank remains 'round'.

The tank can now be welded in the normal way and the floor welded internally.

The tank will then be boxed up and hydrostatically tested and certificated to API 653



WORLDWIDE TANK SERVICES
SPECIALIST INSPECTION LIFTING AND RELOCATION
OF BULK STORAGE TANKS
1, FORBES ROAD MANDURAH WESTERN AUSTRALIA
TEL. (61) 8 9535 8176 MOB 0439 913313

<p align="center">MAJOR BULK TANK INSPECTION CATEGORY 5 & 6 ABOVEGROUND TANK FINAL INSPECTION AND FIELD REPORT AFTER MAJOR REPAIR</p>		
Tank No. ALMC T21		Unit/Location: North Fremantle Lube Plant
Facility/Business Unit: Australasian Lubrication Manufacturing Company Swan Street North Fremantle Western Australia		Original build standard and no API/BS/Other API 653 Plate attached to tank YES/ NO
Date(s) of Inspection: Final Inspection conducted on 13 th December 2012 after levelling of tank, new floor bottom plates and installation of secondary containment liner / leak detection.		Inspection Type: External / Internal Internal – External Inspection, NDT conducted on new floor welds, 100% Magnetic Particle Inspection of Annular Fillet Welds Internal/External and 100% Vacuum Box Testing of floor inter-plate welds
Bulk Tank Data Sheet attached YES/ NO See MDR File	Design Pressure Atmospheric	Product Stored: Base Oil
Overall Roof Condition from visual inspection : Good		NDT: See MDR File
Overall Shell Condition from visual inspection: Good		NDT: See MDR File
NDT inspection by: Are NDT Reports Attached: YES / NO See MDR File		(Company) Marine Inspection Services P/L
NDT test date: December 2012 – See MDR Report		Statutory Inspection to AS 1940 – API 653 4 th Edition Addendum 2
<p>Comment on overall tank condition :</p> <p>Tank 21 is in good condition, compliant with AS 1940 and API 653 and considered fit for service.</p> <p>Tank 21 was refurbished after being identified with a lean exceeding the confines of Annex B of API 653. The refurbishment included the lifting of the tank off its base to 1.8M, recapping and levelling the concrete ring beam. Installation of a HDPE 1.5mm secondary containment Liner with leak detection piping, filling and compaction of basecourse foundation over liner, installation of a new floor bottom plate 8mm W.T – reversing the cone of the floor from the original cone up to a cone down 1:120 slope to a central sump with water drain piping.</p> <p>Extensive NDT was conducted on the repairs in keeping with the confines of both API 653 and API 650 including a full hydrostatic test of the tank as per the requirements of API 650 with a hold time exceeding 24hrs on 12th – 13th December 2012 – No leakage or settlement was observed.</p> <p>Are other tank repairs required? No</p> <p>Out-of-service maintenance required? No</p>		

Tank Inspection Completed by an Approved Tank Inspector:

Name: Ivor P Wildin

Signed: _____

API 653 Reg. Inspector Name: Ivor P Wildin
API Registration Number Reg Inspector 1246
Inspection Closeout Date:



IVOR WILDIN
API 653 REG. INSPECTOR
NUMBER 1246

Tank rated at :- **FIT FOR SERVICE** / NOT FIT FOR SERVICE