



Immobilized Volume Reduction in Pontoon Type Floating Roof for Petroleum Tank

*Florianópolis/SC
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External floating roof was created in 1923 for:

- **Control of evaporative emissions;**
- **Safety aspects;**

>> It is the most viable way to store oil

Design changes occurred over the years but there are still opportunities such as to reduce the immobilized volume.



Facts:

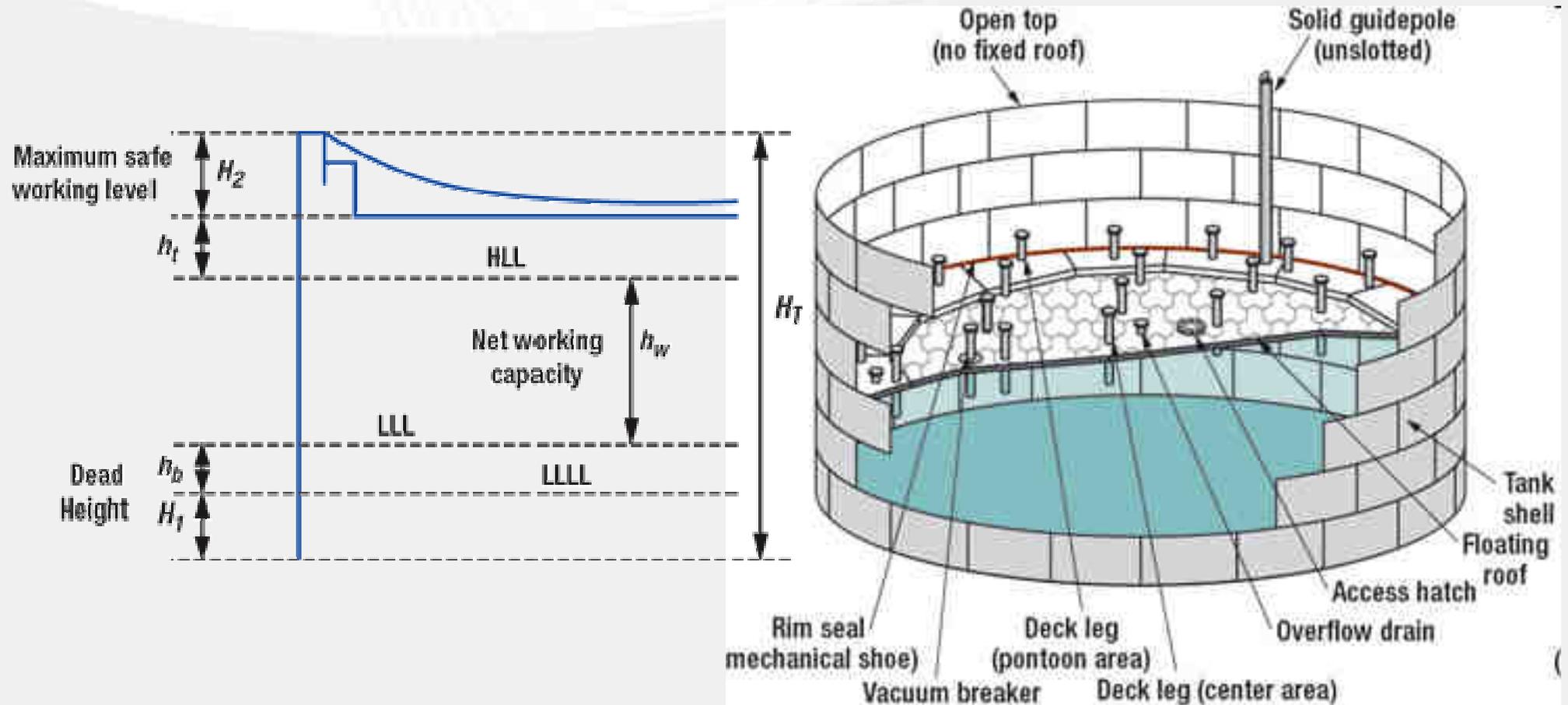
- Interferences caused by tank accessories limit the minimum fluctuation level;
- Operation with a supported roof introduces evaporative emission losses and risks of generating static electricity;

Results:

- Restricts the use of a volume which represents between 10% and 15% of total tank capacity;



Foreword



Figures source:

<http://hydrocarbonprocessing.com/Article/2598366>



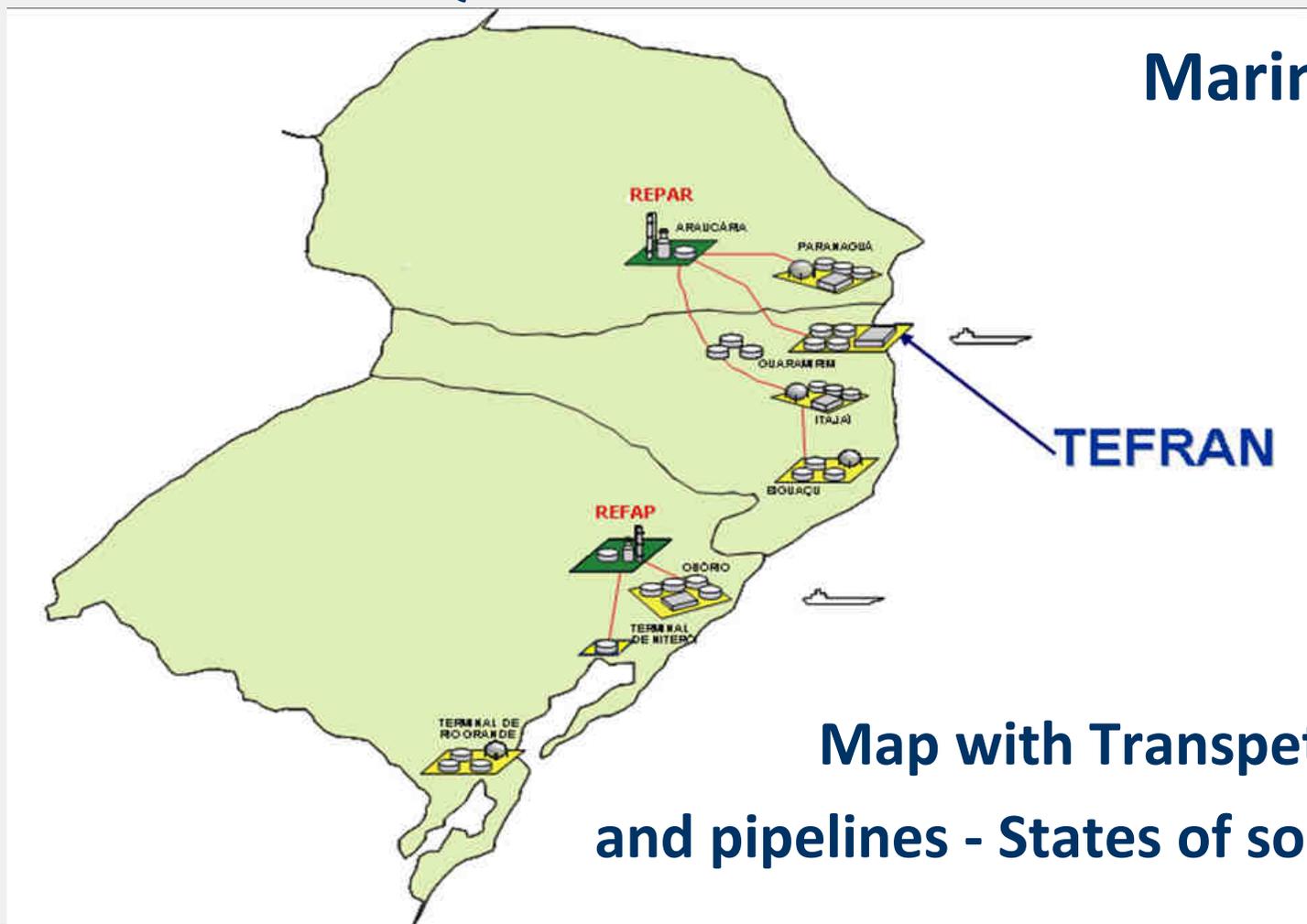
Notches have been permitted since 2007 in accordance to API-650 App. C.

At Transpetro, Osorio Marine Terminal was the first and only one to use these notches, resulting in reduction of approx. 25% of immobilized volume. Notches were made to the existing double deck floating roof during maintenance.

The need for construction a new pontoon floating roof for tank TQ-0301 created the opportunity to improve previous results.



Tank TQ-0301 is located at São Francisco do Sul Marine Terminal



Map with Transpetro terminals
and pipelines - States of southern Brazil



São Francisco do Sul Marine Terminal





Tank TQ-0301

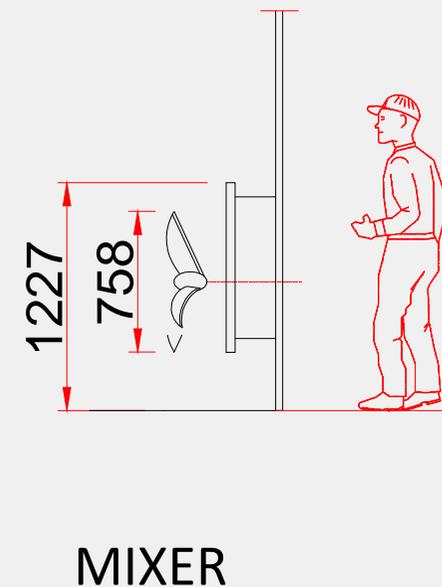
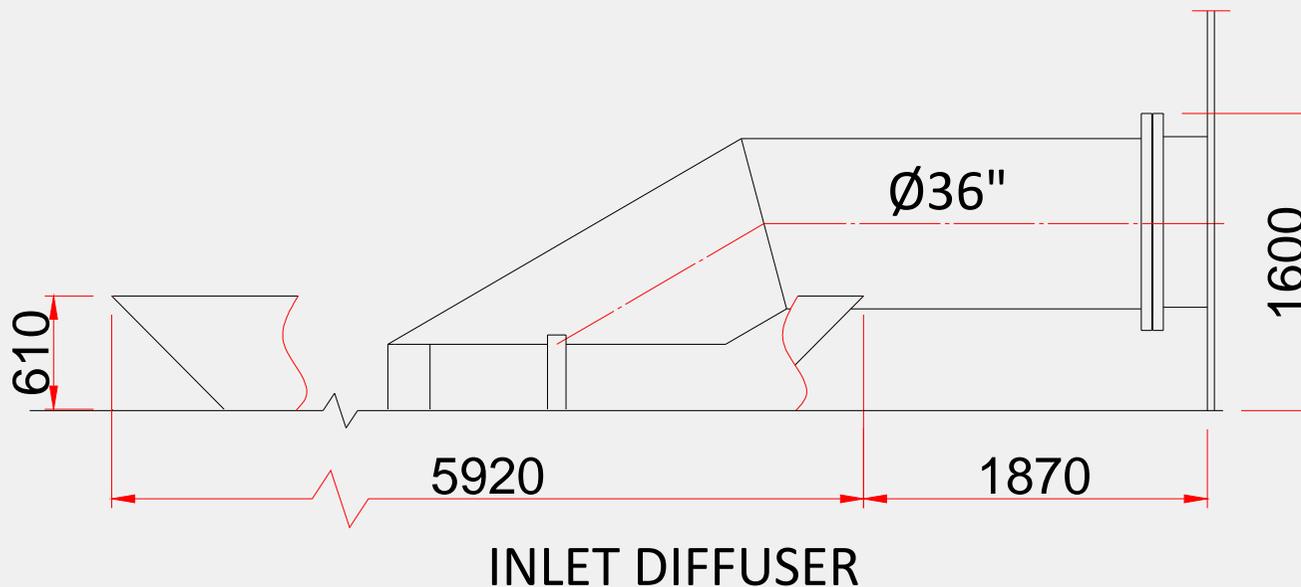
- Diameter: 86.563 m / 284 ft (“Maracanã class”)
- Height: 14.64 m / 48 ft
- Total capacity: 86,000 m³ (541,000 bbl)
- Net working capacity: 64,000 m³ (402,550 bbl)
- Immobilized volume: 11,300 m³ (71,075 bbl)
 - 13.1% total capacity
 - 17.66% net working capacity

>>At TEFTRAN, the sum of the immobilized volumes is approx. the net volume of an entire tank!



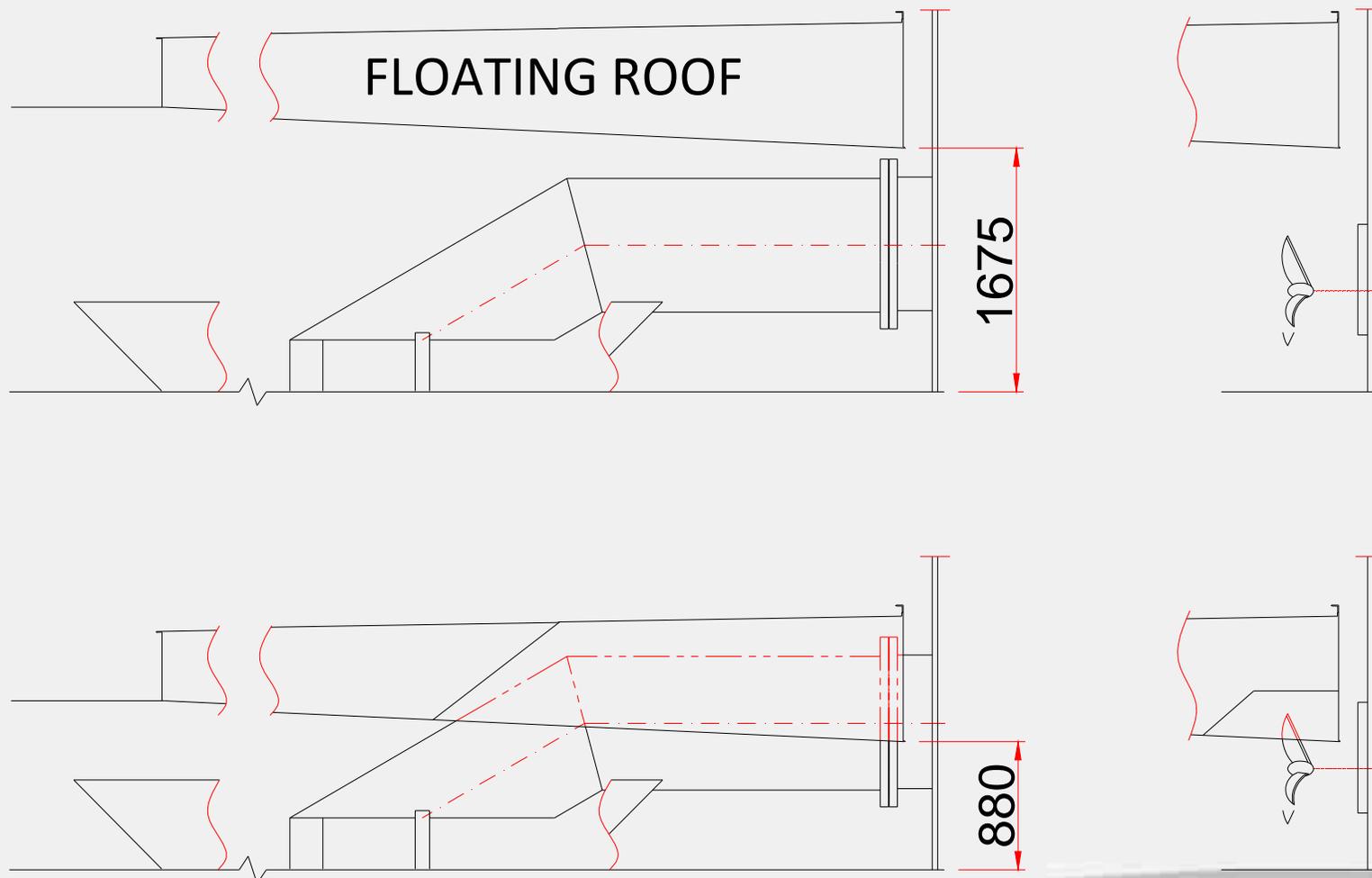
The immobilized volume of TQ-0301 are due to:

- 01 inlet/outlet diffuser according to Petrobras standard;
- 03 side entry propeller mixers;





Low-roof position with and without notches





The problem is not to carry out the notches, but to attend allowable stress according to API requirements in the severe test condition for pontoon.

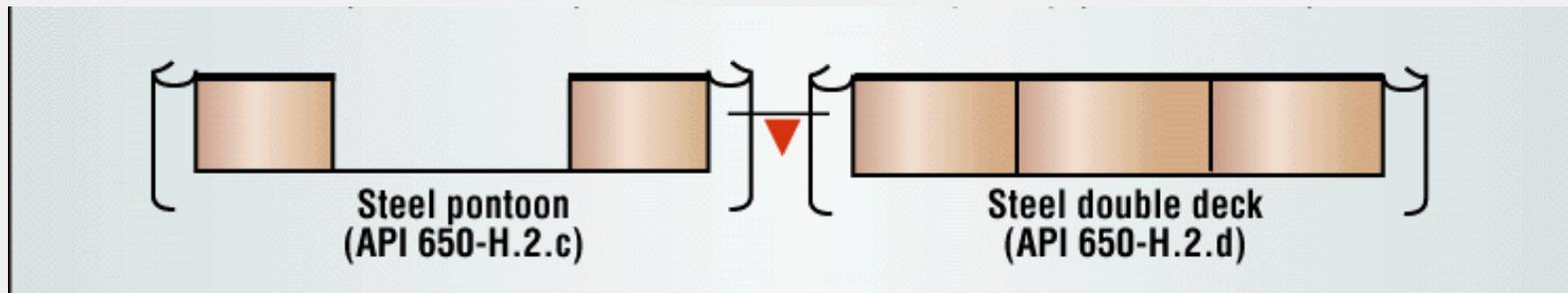


Figure source:

<http://www.ogj.com/articles/print/volume-96/issue-22>



Engineering analysis consisting of numerical method (finite elements) with:

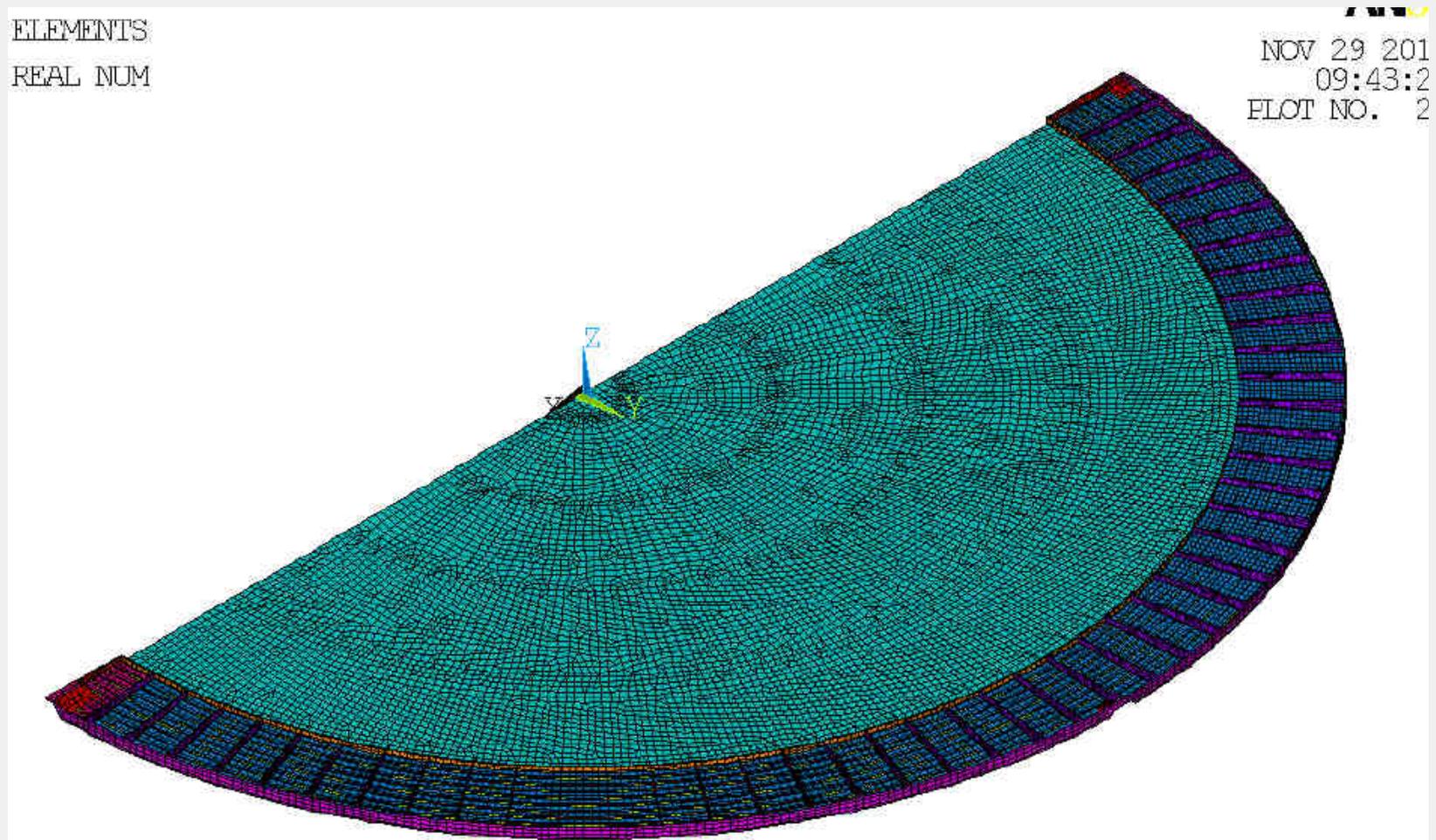
- Non linear analysis for great displacements;
- ASME criteria for stress categories and limits for equivalent stress (von Mises);

API-650 conditions with 0.7 specific gravity:

- 250 mm of rainfall in a 24-hour period;
- Single-deck and two adjacent pontoon compartments punctured;



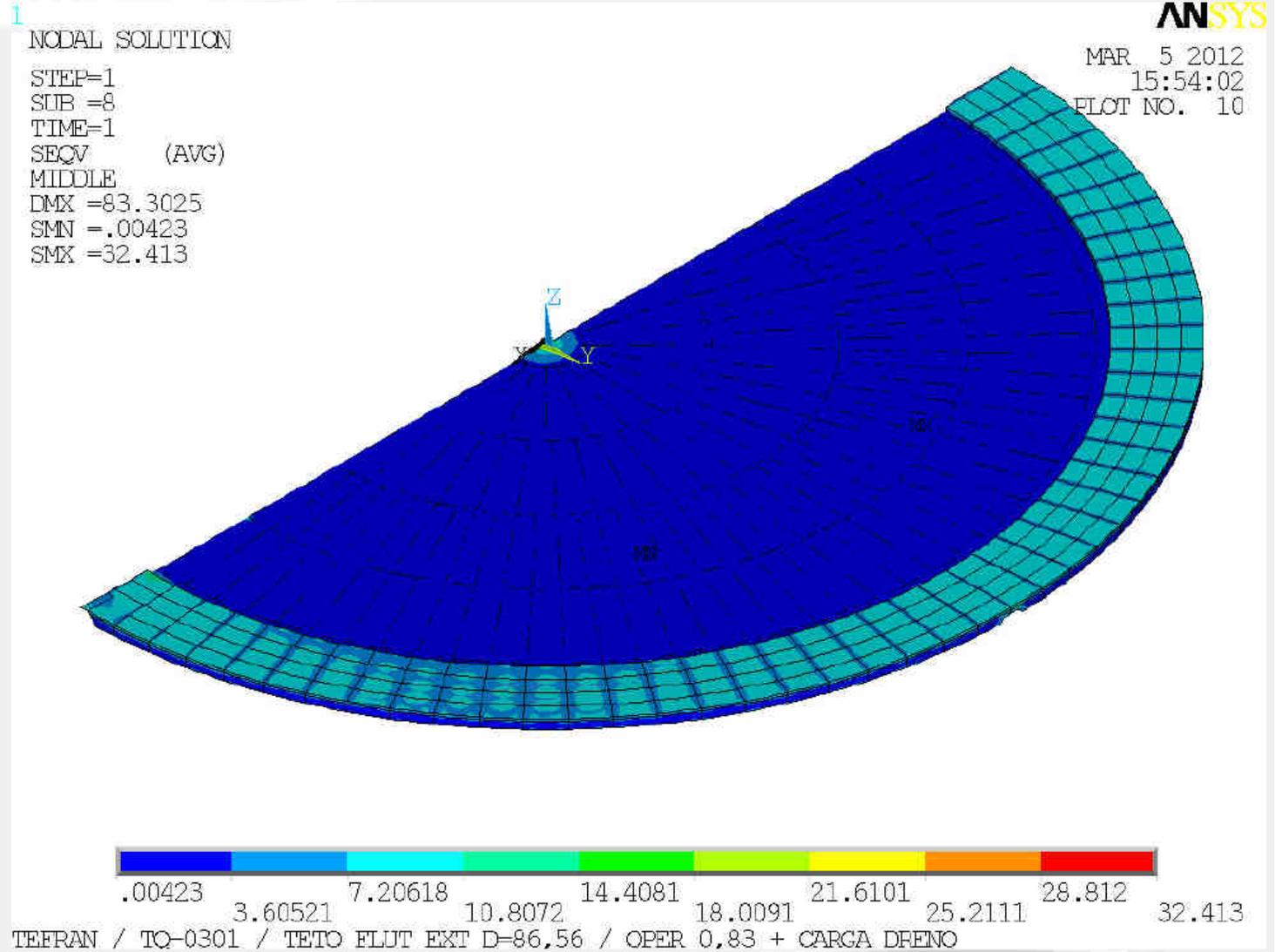
Model discretization





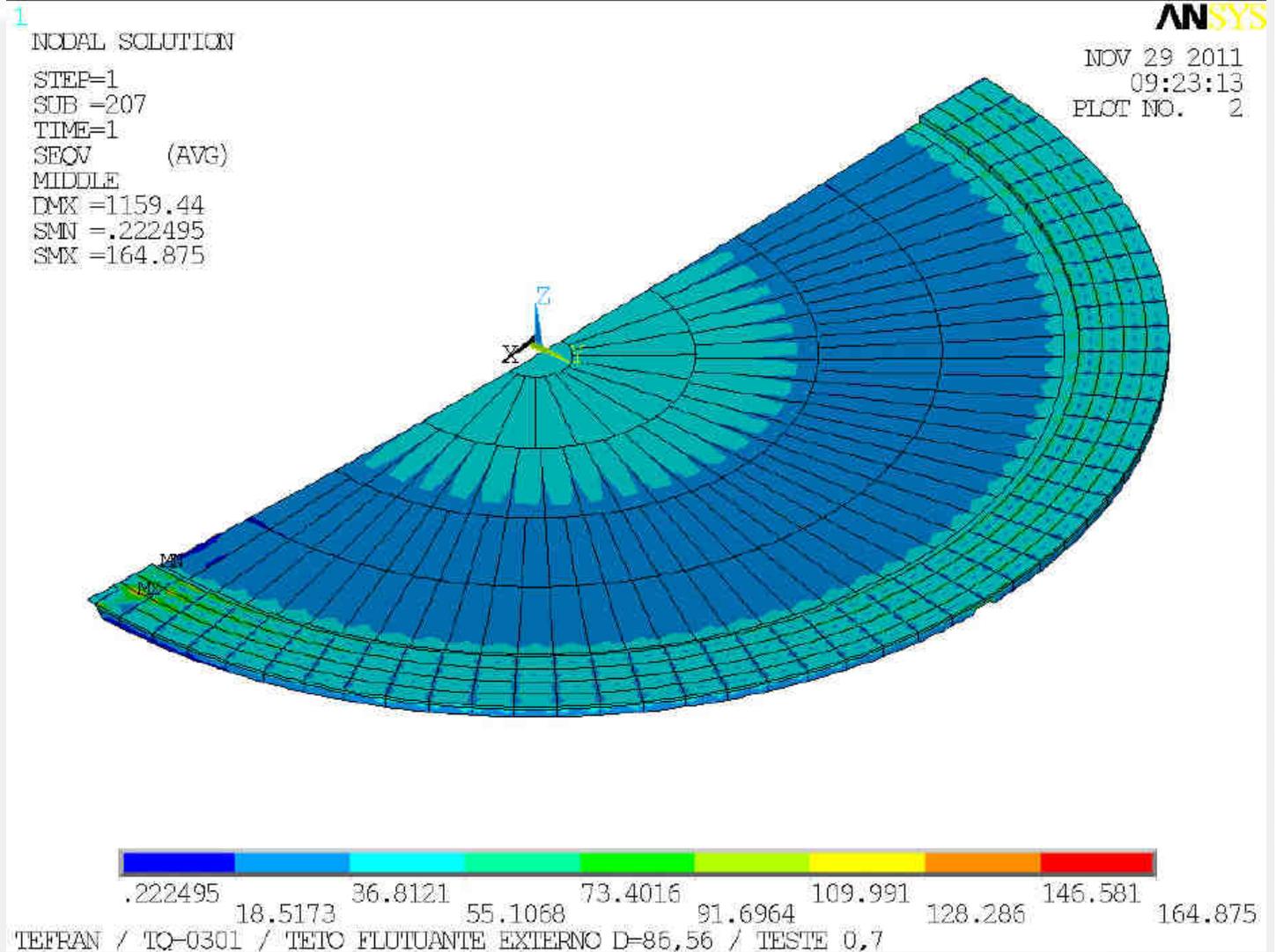
TQ-0301 case

Membrane equivalent stress in normal situation





**Membrane
equivalent
stress in most
severe
situation
(test condition)**





Construction view detailing main notch





Costs Considerations:

- Notches increase roof costs mainly due to the increase of the weight of steel to be used;
- Structural strengthening around notches represents 0.6% of weight addition;
- Strengthening structure for increasing the overall roof resistance is about 5% of weight addition;
- Total additional cost is about USD 0.4 M;



Benefits:

- Immobilized volume reduction of 40.6% (4,590 m³/ 28870 bbl), represents immediately economy USD 2.9 M (using bbl = USD 100);
- Increase of 7.17% net working capacity, representing USD 1.6 M - equivalent to construct a tank 22 m diameter (total mass 125 t and average cost USD 13 / kg);

Obs.: The unit cost was USD 13.86 by bbl reduced.



Questions

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Floating Roof for Petroleum Tank***

Thanks!

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