

### 1.13.9. OVERALL INSPECTION AND INTEGRITY ASSESSMENT OF OIL AND OIL PRODUCTS STORAGE TANKS

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Steel tanks are widely used by oil & gas producing and transporting petrochemical companies and refineries for storage of oil and oil products. More than 2 thousand tanks having capacity from 100 up to 50 thousand m<sup>3</sup> are being operated in Russia. Most of them were constructed mid 70th and beginning of the 80th of the last century and by now have come to the end of their design lifetime limited by 20 years. Operators perform inspection and repair of tanks on a regular basis and the issues of integrity assessment of these hazardous industrial facilities have crucial importance for them with a view of well-founded repair scope and time.

These challenging problems are solved based on results of tanks inspection, which as per the ruling document issued by Rostekhnadzor has to be performed not less than once every 4–5 years. Tank inspection is divided into partial, performed with no requirement for tank discharge, and the full one which needs tank decommissioning, cleaning and degassing.

A considerable number of defects of storage tank structure are detected based on results of inspection which are impermissible as per the existing regulations, however not bringing the structure to the limiting condition.

Storage tank is a complex unit consisting of separate structures: wall, bottom, roof, floating roof, foundation, pipelines, auxiliary structures, attachments etc., which differ considerably both in respect of design as well as defects which may occur. Therefore, in order to assess integrity of a tank it is necessary first of all to examine each structure separately considering the defects found and tank operation conditions and after that interaction of the structures. Herewith it is necessary to consider product properties, loading

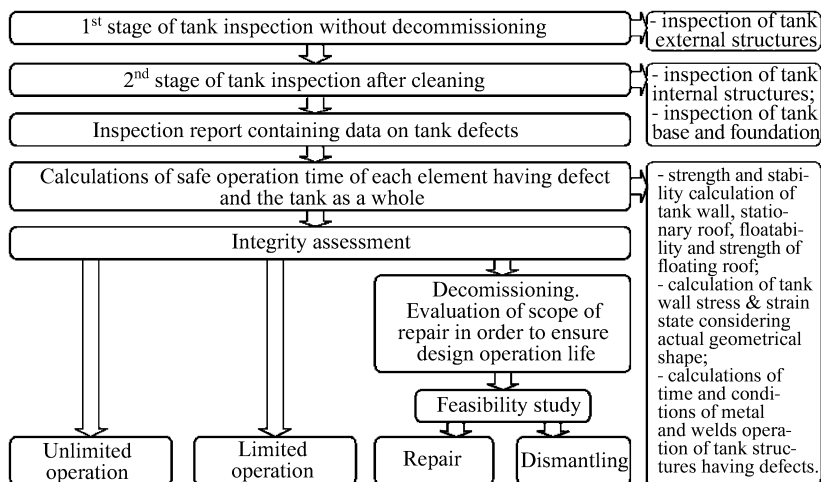


Fig. 1. Tank integrity assessment procedure

cycles, filling level, wind and snow loads, environmental corrosiveness etc. It is evident that storage tank integrity assessment have to be performed consisting of several stages. At each of the stage the calculation and analysis of individual elements and structures have to be performed and after that the storage tank have to be considered as a whole. Tank integrity assessment procedure is shown on fig. 1.

Within the period of 2003 – 2007 CJSC at “VNIIST-Diagnostika” has developed and introduced technique of vertical storage tanks (VST) integrity assessment and a number of calculation methods, considering the above factors as well as presence of the following defects:

- dents, bulging;
- vertical deviations of wall elements;
- angularity of wall welds;
- sagging of tank bottom;
- uneven snow load on the roof;
- base metal defects, weld defects and others.

VST wall simulation and stress-deformed state calculations are performed in accordance with the developed method using ANSYS. The method includes procedure of creation of finite element grid, procedure of selection of its spacing, procedure of assessment of accuracy of the results received and some other constituents. The software considers geometrical parameters of VST wall, plate thickness variation depending on its height, mechanical properties of wall plates steel, as well as operation loads.

The technique developed for tank integrity assessment and the method of stress-deformed state calculation of its structures allow for assessment of severity of defects, detected during inspection depending on actual tank operation conditions.

The proposed techniques can be used during development of feasibility study of repair expediency depending on after repair tank operation. Therefore operator shall obtain instrument allowing to take well-founded decision based on inspection data and integrity assessment considering tank farm utilization, financial and technical feasibility to continue operation of VST without repair, to perform maintenance or overhaul repair or dismantle the tank.

Based on results of calculations performed by CJSC “VNIIST-Diagnostika” in 2007–2008 operation of about 40 tanks had been extended and the scope of repair work of 60 tanks considerably reduced.