Large Scale 3D Laser Scanning

3D Laser Technology

Medium or large-scale 3D laser scans provide accurate measurements and 3D models of structures. This has many uses including measurement of distortions or settlement; provision of 'as built' dimensions; volumetric measurement and checking the fit of items such as replacement pipe spools and nozzles.

External Laser Scan of a Tank

The scanner is used both internally and externally for surveys of tanks and vessels. Internal scans are best for insulated vessels and those obscured by piping and ironwork. Internal scanning also has the benefit of capturing elements such as a tank floor whereas external scanning can be carried out with the vessel in service.

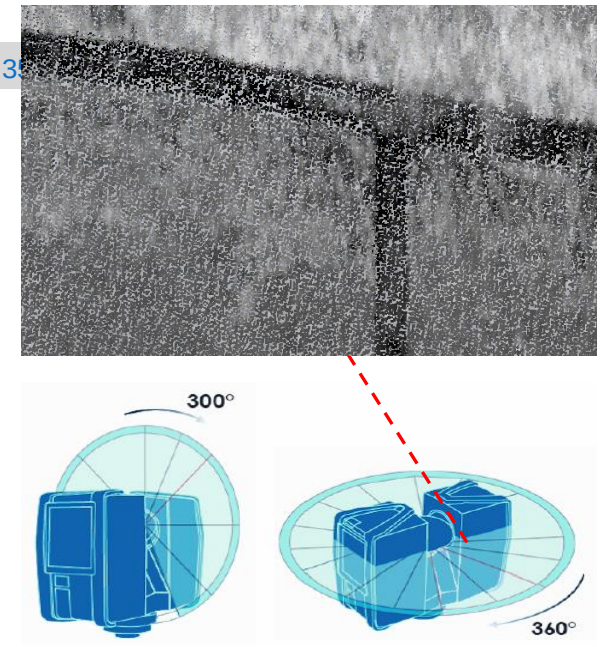
Although the scanner range extends to 120m, we typically carry out multiple scans such that any one scan is limited to 25m maximum. This maintains a relatively high resolution (6-25mm) reduces shadowing by fixtures and minimises errors due to a low incidence angle.

Measurement accuracy depends on the scanner ranging error and registration accuracy for multiple scans. This is typically better than ±5mm with level measurement to within 0.015°.

The laser beam is directed in the vertical plane by a rotating mirror as the scanner rotates slowly in the horizontal plane. The scanner records over the full 360° horizontally but the vertical scan is limited to ±150° from the vertical.

Tens of millions of distance measurement points are recorded with their corresponding mirror and rotation angles. These polar values are translated to Cartesian (X-Y-Z) coordinates by the scanner software. The measurement points may be as close as 6mm apart with a high-resolution scan and generally no more than 25mm at ranges up to 25m.

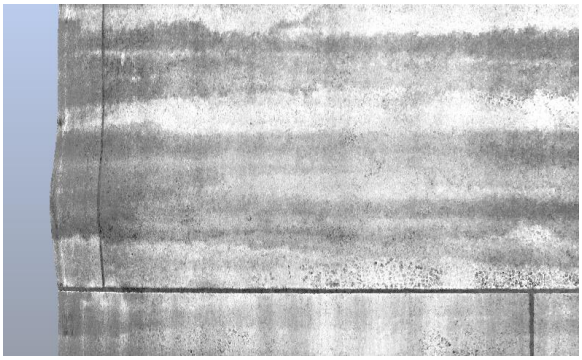
Scanner Operation and Point Cloud Coordinates



Each scan produces a "point cloud" which is a three dimensional dataset of the scanner's environment. Scan times range from 10 to 40 minutes depending on the scan resolution needed.

The laser scan is independent of light levels and returns a greyscale image based on the reflected laser intensity. Where there is good light, a built in camera can record colour pictures for a true colour rendition of the scan image.

3D Point Cloud Showing a Bulged Area



Depending on the application, the scanner is mounted on a tripod or telescopic mast. It can be inverted if the access is from the top nozzle of a vertical vessel for example. In such cases, a remote connection to a laptop computer is used. The scanner is battery powered but 110V power may be needed if a large number of scans are carried out.

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Recorded scans are combined to produce a 3D model of the item scanned. This is often converted to a 3D mesh for additional processing. A powerful feature is the ability to compare the scan data (actual measurements) with a reference model to identify bulges, dents, floor ripples and so forth. The scan images also provide a good visual record of the item scanned.

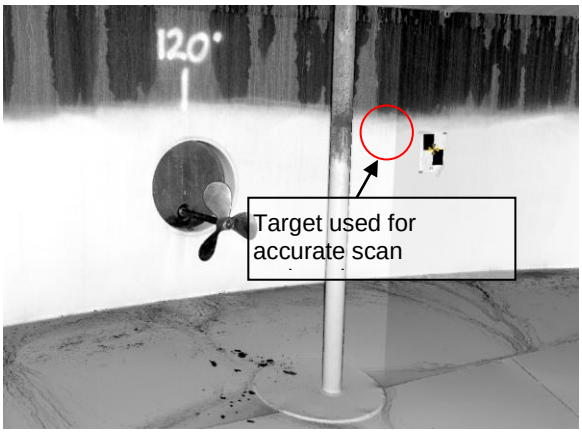
Scan Conditions

External scans require reasonably calm conditions with no precipitation, dust, steam or mist to diffuse the laser beam. Bright, direct sunlight may cause difficulties with some scans. Internal scans are generally sheltered but require preparation for entry and surface cleaning if there are heavy deposits. It is also important to remove internal or external clutter that can obstruct the scans.

Processing of Scan Data

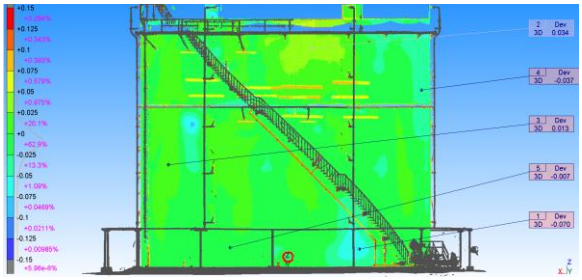
The scan files are filtered and combined to produce a point cloud image of the structure. This may be explored in detail and selected images captured to show specific features surface condition. The software can measure as-built dimensions; out of roundness and other distortions as well as measurement of floor slope, settlement and volume.

Screen Shot from a Tank Internal Scan

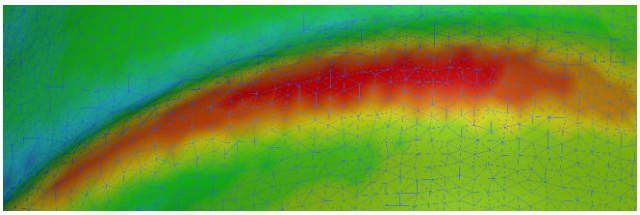


Deviations from the nominal dimensions are measured by comparing a geometric model, such as a cylinder to the point cloud or 3D mesh as shown.

Shell Deviations – Colour Range ±150mm

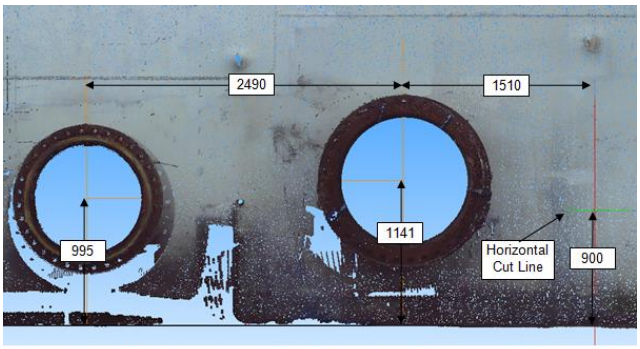


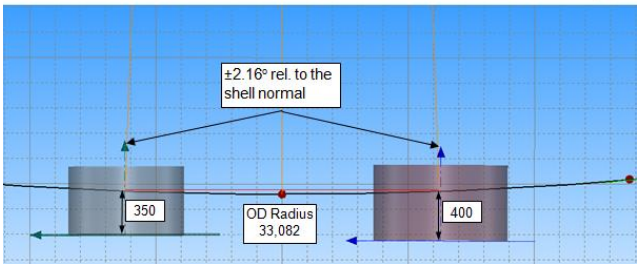
3D Mesh Showing Bulging in a Vertical Drum



Measurements such as diameter by elevation and sector as well as edge settlement are taken from sectional views. If required, the mesh may be exported as either a 3D model or spreadsheet for finite element analysis.

As-built Tank Nozzle Dimensions





Applications for 3D Laser Scanning

The scanner is a general purpose surveying instrument suitable for a wide range of applications:

- Tank surveys including measurement of settlement; dents; floor ripples and slope; volume and bund volume.
- Settlement and other measurements to API-653, EEMUA-159 or as required.
- Coke drum scans to measure bulging, bending and lean.
- Comparison of new and old nozzles and pipe spools to check the fit before installation.
- Production of as-built dimensions for replacement or refurbishment projects.
- Volumetric measurement of product stockpiles.

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