

## ОПРЕДЕЛЕНИЕ ДЕФОРМАЦИЙ ГОРИЗОНТАЛЬНЫХ ЦИЛИНДРИЧЕСКИХ СТАЛЬНЫХ РЕЗЕРВУАРОВ ДЛЯ ХРАНЕНИЯ НЕФТЕПРОДУКТОВ

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В настоящее время очень важно определить, проанализировать и обработать деформацию горизонтальных и цилиндрических запасов стали, а также разработать надежное, долговечное и безопасное решение для резервуара.

Топливные резервуары содержат самые разные типы в зависимости от формы, размера и материалов, а также измеряют деформацию и емкость резервуара объемом 50 м<sup>3</sup> для хранения подземных горизонтальных цилиндров. Мониторинг деформации контейнера осуществляется с помощью геодезических измерений, что важно для измерения и распределения запаса и распределения топлива, а также отслеживания изменений, являющихся экономически значимыми. Результаты опроса были использованы для наблюдения, выборки и краткосрочных методов исследования.

**Ключевые слова:** резервуар, точка измерения, деформация, объем.

## DETERMINE DEFORMATION OF HORIZONTAL AND CYLINDRICAL STEEL STORAGE FUEL TANK

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It is very important to define, analyze, and process the deformation of horizontal and cylindrical steel reserves, and to develop a reliable, durable and secure solution for the storage tank. In this survey, the deformation of the horizontal and cylindrical steel cans is determined by volume measurement by the geodetic measurements. Fuel storage tank contain a wide variety of types depending on the shape, size, and materials, and measure the deformation and capacitance of a tank of 50m<sup>3</sup> capacity to store the underground horizontal cylinders. The stability of the storage tank is important for measuring and distribution of fuel, as well as the measurement and calculation of the fuel. The results of the survey were used for observation, sampling and short-term research methods.

**Key words:** reservoir, measurement point, deformation, volume.

## *Research of fuel tanks*

Oil and its products are stored in vertical, horizontal, droplets and in reinforced concrete containers. Oil and its products under oil and high pressure are highly volatile, fire-fighting, explosive, and electrified, so they are different. Evaporation of precious aluminum fractions of crude oil and opaque oils leads to quantitative and qualitative losses in their storage. In order to minimize these evaporation, a tank with floating and floating tanks is used [3].

Steel containers can be classified by several characteristics. These include:

Gas space in terms of working pressure:

- Low pressure (up to 2000 Pa);
- High pressure (up to 7000 Pa);
- Air pressure (heavy oil, lime storage).

By:

- Vertical cylinder;
- Horizontal cylinder;
- Drainage;
- Drifting style.

Vertical cylindrical steel basins are the most widespread and with cone and spider roofs, floats, cylindrical and spherical roofs. The most widely used vertical cylindrical steel tanks are distinguished by their size and roof structure.

Horizontal steel reservoir is a cylindrical metal basin with a sphere, spherical, cone, and cone-shaped bottom for the purpose of storage and volume control. Fuel reservoirs contain many different types, sizes, and materials. The containers and their accessories shall be made of metallic materials that are sufficiently resistant to the physical and chemical effects of the external environment, working fluids. [3]

In Mongolia, 100 % of its fuel is imported from abroad. According to the amount of imported petroleum products, NIC LLC is 17.25 %, Petrost Co. LLC 6.11 %, Magnai Trade LLC 11.64 %, Shunkhlai LLC 8.94 %, Sod Mongol Group LLC 7.18 %, Tes Petroleum Co., 6.6 % and ICOO LLC 10.14 %. Companies operating above are typically used as steel tanks (Table 1).

*Table 1*

Specifications for concrete and steel containers

| Specifications | Concrete reservoir    | Steel reservoir      |
|----------------|-----------------------|----------------------|
| Weight         |                       |                      |
| Height         | 3.1–6 m               | 12–15 m              |
| Diameter       | –                     | 22.8 /20.92/ m       |
| Volume         | 10 000 m <sup>3</sup> | 5 000 m <sup>3</sup> |
| Material cost  | 1.949.718.323 MNT     | 495.654.500 MNT      |
| Equipment cost | 188.658.250 MNT       | 18.865.825 MNT       |
| Operating term | –                     | 20–25 years          |

There are currently no cases of using concrete containers in oil and gas companies in Mongolia.

## ***2. Determine deformation of cylindrical fuel tank and horizontal steel reservoir***

Within the scope of the study, geodetic measurements were identified. The measurements were performed by Trimble R6's high-precision GPS, Faro 3D laser scanners and Trimble S3 electronic tachometer. These include:

The geodesy positioning network was established by the GPS Trimble R6 high-precision GPS map (Figure 1).

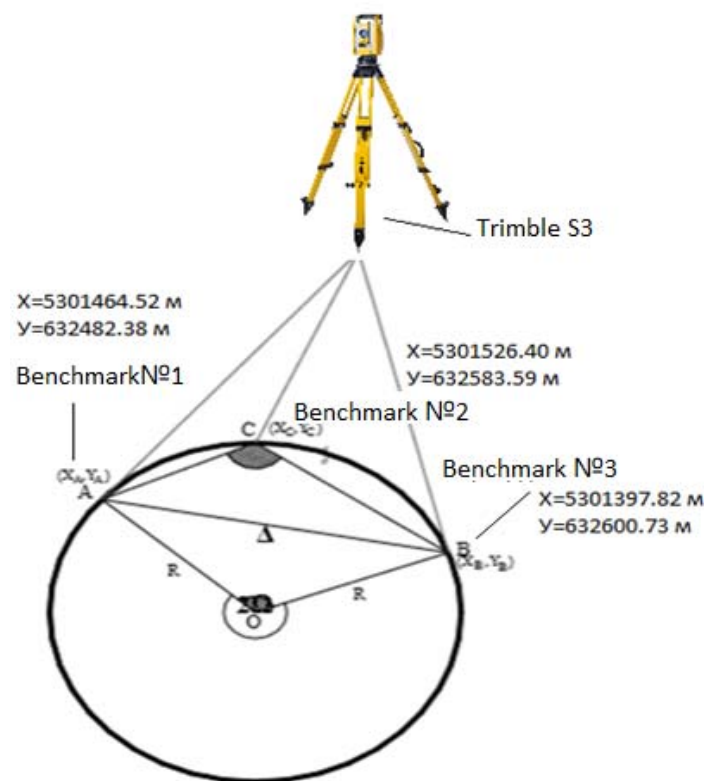


Fig. 1. Positioning scheme

When setting up an ad network, two wavelength settings are configured as follows:

- Retreat ellipsoid: WGS84
- $a = 6378137.0$  / longer half-axis /
- $f = 1 / 298.257222101$  /suction /
- Projection: Reflection of UTM 6° /48 zones /
- Level System: The Baltic Sea Height System

The stations and control points are required to determine object movement (its deformation) [1]. The monitoring points were installed during measurement (Figure 2).

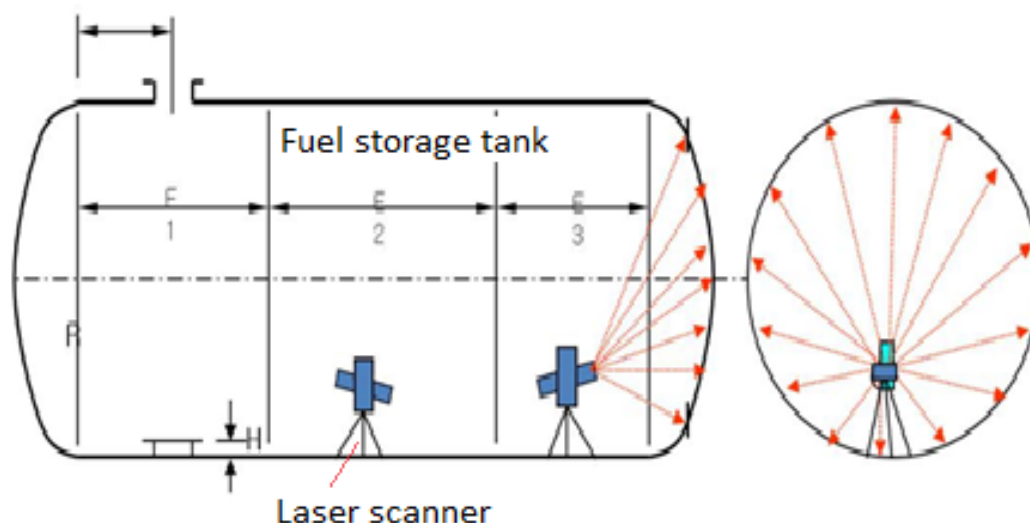


Fig. 2. Measurement of sections within the storage tank method

The trimble S3 electronic tachometer for the location of the checkpoint storage tank was measured by a 3D laser scanner and the following results were compared (Table 2).

Table 2

Results of deformation measurements on horizontal and steel storage tanks

| Station points | Control points for storage tanks | Deformation, MM          |                              |
|----------------|----------------------------------|--------------------------|------------------------------|
|                |                                  | 2018.10.30               | 2018.12.18                   |
| Stations № 1   | Control point № 1                | -10                      | -11                          |
|                | Control point № 2                | -11                      | -11                          |
|                | Control point № 3                | 60                       | 60                           |
|                | Control point № 4                | -80                      | -81.1                        |
| Stations № 2   | Control point № 1                | 50                       | 50.3                         |
|                | Control point № 2                | -15                      | -15                          |
|                | Control point № 3                | 16                       | 16.1                         |
|                | Control point № 4                | +54                      | +53.6                        |
| Stations № 3   | Control point № 1                | -45                      | -45.3                        |
|                | Control point № 2                | 4                        | 4                            |
|                | Control point № 3                | -18                      | -18                          |
|                | Control point № 4                | 52                       | 52                           |
| Stations № 4   | Control point № 1                | 40                       | 39                           |
|                | Control point № 2                | -19                      | -19                          |
|                | Control point № 3                | 20                       | 19                           |
|                | Control point № 4                | -50                      | -48.7                        |
|                | <b>Maximum value</b>             | <b>-10</b><br><b>+4</b>  | <b>-11</b><br><b>+4</b>      |
|                | <b>Minimum value</b>             | <b>+54</b><br><b>-80</b> | <b>+53.6</b><br><b>-81.1</b> |

The symbol (+) in the table deflects the wall expansibility and the minus sign (–) represents the wall groove.

Control points mark and maximum deformation of the storage tanks in Figure 3.

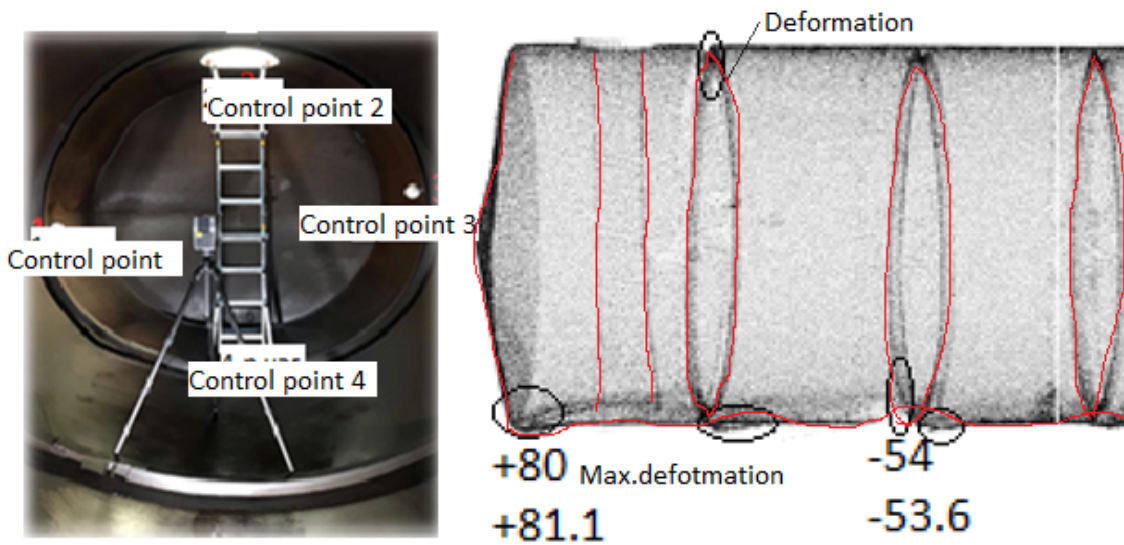


Fig. 3. Deformation of the measurement control point and storage tank

### 3. Determine capacity of the horizontal cylinder storage tank

The volume of the backup storage tank is determined by laser scanners. Laser scanner is placed with station in storage tank, picture format of  $10240 \times 4267$ , distance between points  $6.136 \text{ mm} / 10 \text{ m}$ , resolution 6x, duration of 32 minutes and measurement is made with 4 station signs.

The data obtained from the 164 000 point of measurement resulted from the Trimble Realworks program to calculate the volume of  $49,914 \text{ m}^3$  (Figure 4).



Fig. 4. The dimensions of the storage tank

Tank capacity table was performed by laser scanners.

Table 3

Table of tank capacity

| Depth | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 0     | 0       | 0.6     | 1.7     | 3.2     | 4.9     | 6.9     | 9       | 11.4    | 13.9    | 16.6    |
| 100   | 607     | 617.1   | 629.2   | 634.8   | 643.5   | 652.8   | 662.1   | 671.5   | 680.6   | 690.4   |
| 200   | 1706.6  | 1719.2  | 1731.9  | 1744.6  | 1757.3  | 1170    | 1782.8  | 1795.6  | 1808.4  | 1821.3  |
| 300   | 3100.9  | 3116.1  | 3131.3  | 3146.5  | 3161.7  | 3177    | 3192.3  | 3207.6  | 3222.9  | 3238.2  |
| 400   | 4719.4  | 4736.6  | 4753.7  | 4770.9  | 4788.1  | 4805.4  | 4822.6  | 4839.9  | 4857.1  | 4874.4  |
| 500   | 6516.7  | 6535.5  | 6554.2  | 6573    | 6591.8  | 6610.6  | 6629.5  | 6648.3  | 6667.2  | 6686.1  |
| 600   | 8459.9  | 8480    | 8500.1  | 8520.2  | 8540.3  | 8560.4  | 8580.6  | 8600.7  | 8620.9  | 8641    |
| 700   | 10523   | 10544.2 | 10565.4 | 10586.6 | 10607.7 | 10628.9 | 10650.2 | 10671.4 | 10692.6 | 10713.8 |
| 800   | 12684.4 | 12706.4 | 12728.5 | 12750.5 | 12772.6 | 12794.7 | 12816.8 | 12838.9 | 12861   | 12883.1 |
| 900   | 14925   | 14947.7 | 14970.5 | 14993.3 | 15016   | 15038.8 | 15061.6 | 15084.4 | 15107.1 | 15129.9 |
| 1000  | 17227.8 | 17251.1 | 17274.4 | 17297.7 | 17321   | 17344.3 | 17367.6 | 17391   | 17414.3 | 17437.6 |
| 1100  | 19577.2 | 19600.9 | 19624.6 | 19648.2 | 19671.9 | 19695.6 | 19719.3 | 19743   | 19766.7 | 19790.4 |
| 1200  | 21958.3 | 21982.2 | 22006.1 | 22030   | 22054   | 22077.9 | 22101.8 | 22125.7 | 22149.7 | 22173.6 |
| 1300  | 24356.7 | 24621   | 24645.1 | 24669.1 | 24693.1 | 24717.2 | 24741.2 | 24765.2 | 24789.2 | 24813.3 |
| 1400  | 26758.7 | 26782.7 | 26806.7 | 26830.7 | 26854.7 | 26878.6 | 26902.6 | 26926.6 | 26950.6 | 26974.6 |
| 1500  | 29150.2 | 29174   | 29197.9 | 29221.7 | 29245.5 | 29269.3 | 29293.1 | 29316.9 | 29340.7 | 29364.5 |
| 1600  | 31517.3 | 31540.7 | 31564.2 | 31587.7 | 31611.2 | 31634.7 | 31658.2 | 31681.7 | 31705.1 | 31728.6 |
| 1700  | 33845.3 | 33868.3 | 33891.3 | 33914.3 | 33937.4 | 33960.4 | 33983.4 | 34006.4 | 34029.4 | 34052.3 |
| 1800  | 36119   | 36141.4 | 36163.8 | 36186.2 | 36208.6 | 36231   | 36253.4 | 36275.7 | 36298.1 | 36320.4 |
| 1900  | 38322.2 | 38343.8 | 38365.4 | 38387   | 38408.6 | 38430.2 | 38451.8 | 38473.4 | 38494.9 | 38516.5 |
| 2000  | 40437   | 40457.6 | 40478.2 | 40498.8 | 40519.4 | 40540   | 40560.6 | 40581.2 | 40601.7 | 40622.3 |
| 2100  | 42443.1 | 42462.5 | 42481.9 | 42501.3 | 42520.7 | 42540.1 | 42559.5 | 42578.9 | 42598.2 | 42617.5 |
| 2200  | 44316.9 | 44334.9 | 44352.9 | 44370.8 | 44388.7 | 44406.6 | 44424.5 | 44442.4 | 44450.3 | 44478.1 |
| 2300  | 46029.5 | 46045.7 | 46061.9 | 46078   | 46094.2 | 46110.3 | 46126.4 | 46142.4 | 46158.5 | 46174.5 |
| 2400  | 47542.8 | 47556.7 | 47570.7 | 47584.6 | 47598.5 | 47612.3 | 47626.1 | 47640   | 47653.7 | 47667.5 |
| 2500  | 48800.6 | 48811.6 | 48822.6 | 48833.5 | 48844.4 | 48855.3 | 48866.1 | 48876.9 | 48887.7 | 48898.4 |
| 2600  | 49698.4 | 49704.8 | 49711.2 | 49717.5 | 49723.8 | 49729.9 | 49736.1 | 49742.1 | 49748.1 | 49754   |
| 2640  | 49895.5 | 49898.3 | 49901   | 49903.5 | 49905.9 | 49908   | 49910   | 49911.7 | 49913.2 | 49914.3 |

The volume of the storage tank is 49759.95 l or 49.780 m<sup>3</sup> in geometric method. Tank capacity table was performed by geometric method.

Table 4

Table of tank capacity

| Depth | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 0     | 0       | 0.6     | 1.7     | 3.2     | 4.9     | 6.9     | 9       | 11.4    | 13.9    | 16.6    |
| 100   | 609     | 618.1   | 627.2   | 636.4   | 645.6   | 654.9   | 664.2   | 673.5   | 682.9   | 692.3   |
| 200   | 1704.1  | 1716.7  | 1729.3  | 1742    | 1754.7  | 1767.4  | 1780.2  | 1792.9  | 1805.7  | 1818.6  |
| 300   | 3095.4  | 3110.6  | 3125.7  | 3140.9  | 3156.1  | 3171.3  | 3186.6  | 3201.8  | 3217.1  | 3232.4  |
| 400   | 4709.9  | 4727    | 4744.2  | 4761.3  | 4778.5  | 4795.6  | 4812.8  | 4830    | 4847.3  | 4864.5  |
| 500   | 6502.3  | 6521    | 6539.7  | 6558.5  | 6577.2  | 6596    | 6614.7  | 6633.5  | 6652.3  | 6671.2  |
| 600   | 8439.7  | 8459.8  | 8479.8  | 8499.8  | 8519.9  | 8539.9  | 8560    | 8580.1  | 8600.2  | 8620.3  |
| 700   | 10496.4 | 10517.5 | 10538.6 | 10559.7 | 10580.8 | 10602   | 10623.1 | 10644.3 | 10665.4 | 10686.6 |
| 800   | 12650.7 | 12672.6 | 12694.6 | 12716.6 | 12738.6 | 12760.6 | 12782.6 | 12804.6 | 12826.6 | 12848.7 |
| 900   | 14883.7 | 14906.3 | 14929   | 14951.7 | 14974.4 | 14997.1 | 15019.8 | 15042.5 | 15065.2 | 15087.9 |

*End of table 4*

| Depth | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1000  | 17178.5 | 17201.7 | 17224.9 | 17248.1 | 17271.3 | 17294.5 | 17317.8 | 17341   | 17364.2 | 17387.5 |
| 1100  | 19519.5 | 19543.1 | 19566.7 | 19590.3 | 19613.9 | 19637.5 | 19661.1 | 19684.7 | 19708.3 | 19731.9 |
| 1200  | 21891.9 | 21915.8 | 21939.6 | 21963.4 | 21987.3 | 22011.1 | 22035   | 22058.8 | 22082.7 | 22106.5 |
| 1300  | 24281.7 | 24305.7 | 24329.6 | 24353.5 | 24377.5 | 24401.4 | 24425.3 | 24449.3 | 24473.2 | 24497.2 |
| 1400  | 26674.9 | 26698.8 | 26722.7 | 26746.6 | 26770.5 | 26794.4 | 26818.3 | 26842.2 | 26866.1 | 26890   |
| 1500  | 29057.8 | 29081.5 | 29105.3 | 29129   | 29152.7 | 29176.4 | 29200.1 | 29223.9 | 29247.6 | 29271.3 |
| 1600  | 31416.3 | 31439.8 | 31463.2 | 31486.6 | 31510   | 31553.4 | 31556.8 | 31580.2 | 31603.5 | 31626.9 |
| 1700  | 33736.1 | 33759.1 | 33782   | 33805   | 33827.9 | 33850.8 | 33873.8 | 33896.7 | 33919.6 | 33942.5 |
| 1800  | 36002.1 | 36024.4 | 36046.7 | 36069   | 36091.4 | 36113.7 | 36136   | 36158.2 | 36180.5 | 36202.8 |
| 1900  | 38197.9 | 38219.4 | 38241   | 38262.5 | 38284   | 38305.5 | 38327   | 38348.5 | 38370   | 38391.5 |
| 2000  | 40305.9 | 40326.4 | 40347   | 40367.5 | 40388.1 | 40408.6 | 40429.1 | 40449.6 | 40470.1 | 40490.6 |
| 2100  | 42305.8 | 42325.2 | 42344.6 | 42363.9 | 42383.3 | 42402.6 | 42421.9 | 42441.2 | 42460.5 | 42479.8 |
| 2200  | 44174.3 | 44192.3 | 44210.2 | 44228.1 | 44245.9 | 44263.8 | 44281.7 | 44299.5 | 44317.3 | 44335.1 |
| 2300  | 45882.4 | 45898.6 | 45914.7 | 45930.8 | 45946.6 | 45963   | 45979.1 | 45995.1 | 46011.1 | 46027.1 |
| 2400  | 47392.2 | 47406.1 | 47420   | 47433.9 | 47447.8 | 47461.6 | 47475.4 | 47489.2 | 47502.9 | 47516.7 |
| 2500  | 48647.6 | 48658.6 | 48669.6 | 48680.5 | 48691.4 | 48702.2 | 48713   | 48723.8 | 48734.6 | 48745.3 |
| 2600  | 49544.1 | 49550.5 | 49556.9 | 49563.2 | 49569.5 | 49575.6 | 49581.7 | 49587.8 | 49593.8 | 49599.7 |
| 2640  | 49741   | 49743.9 | 49746.6 | 49749.1 | 49751.4 | 49753.6 | 49755.6 | 49757.3 | 49758.7 | 49759.9 |

### ***Conclusion***

The following conclusions are being made as a result of the survey. These include:

1. Determination of deformation by geodetic measurements using the selected points located on the structure and to check the technical and installation documentation of the storage tank prior to the measurement, the technicality of the surface of the tank wall or the wall of the container to be deformed, the wall thickness, the thickness of the paint wall should be checked.

2. Measuring the deformation of the receptacle, the maximum dimensions of wall expansibility 81.1 mm, -54 mm, and the minimum values are 4 mm and -10 mm.

3. The geometric method of tables was 49.780 m<sup>3</sup> and the initial volume was 0.22 m<sup>3</sup> or 220 liters of fuel less from the original volume.

4. The results of the laser scanners were 49.914 m<sup>3</sup> and the initial volume was 0.086 m<sup>3</sup> or 86 liters of fuel less.

Consequently, the deformation of the storage tank will be determined by geodetic measurements and it will be more efficient to measure the capacity of the storage tank by measuring the size of the laser scanners.

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