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GEOMETRIC INTEGRITY ASSESSMENT OF PETROLEUM STORAGE TANK USING TOTAL STATION TECHNOLOGY IN COMPLIANCE WITH API 653 STANDARDS

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Abstract

This study presents a comprehensive inspection report on a storage tank (B1) at the CNR base in Abidjan, Ivory Coast. Utilizing Total Station surveying techniques with a Kolida reflectorless total station. The investigation focused on key parameters such as base settlement, roundness (ovality), verticality, and base level assessments in compliance with API 653 standards. This study focuses on the geometric integrity assessment of petroleum storage tanks using Kolida KTS 442 reflectorless total station technology, with the objectives of : Present a comprehensive measurement workflow aligned with API 653, demonstrate how total station–derived data supports detection of deformation parameters—such as settlement, out-of-roundness, and verticality deviations and evaluate compliance with API 653 tolerance limits . The inspection methodology involved the use of a total station instrument and its assessories. Temporary control points were established within the tank premises on which Total station was set up. The circumferential level of the tank base was determined for nine(9) points at a marked interval of 2.5meters from each point. Two different set of readings were determined for check purpose. The ovality inspection was carried out by coordinating the nine (9) points marked around the circumference with 2.5m intervals and also coordinating randomly smaller intervals between the 2.5m marks for better circumference. The instrument was used to generate the coordinates of at least one point each from the five couches of the tank vertically upwards. The base level of eight points was taken round the tank B1 circumference. The difference between the highest and lowest base level reading for tank B1 was 3cm. With the mean vertical angle of the four points taken in tank B1, only one point has a high value of 00^0 02’ 46.46” which is quite different from all other values and this made the mean deflection angle to get to 00^0 01’ 41.46”. The tank B1 was found to be within allowable deviation. The verticality for four point on the tank had an excess of 1st = 0° 0' 59.42", 2nd = 0° 0' 24.28", 3rd = 0° 1' 41.48", 4th = 0° 0' 43.14" which is within the allowable standard. Total station inspection of storage tank cannot be said to be complete when there is no available initial or subsequent data of the tank under inspection which will serve as basis of comparison for any deviation. Hence it was recommend that a search be made for previous records and all inspection reports be kept safe for ease of access in case of subsequent inspection.

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Keywords: API 653, Storage Tank, Total Station, Tank Inspection, Verticality, Base settlement deviation.

1.0 INTRODUCTION

The geometric integrity of petroleum storage tanks is a critical component of operational safety, environmental stewardship, and regulatory compliance. Over time, storage tanks may undergo structural deformations—such as shell settlement, out-of-roundness, verticality deviations, and foundation distortion—stemming from ground consolidation, thermal expansion, liquid pressure, and corrosion. Such deformations reduce containment capability and elevate the risk of leaks, spills, or catastrophic failure [1].

To manage these risks, the petroleum industry relies on rigorous inspection regimes, with the American Petroleum Institute Standard 653 (API 653) serving as a cornerstone guideline for inspecting, repairing, altering, and reconstructing aboveground steel storage tanks built to API 650 standards [6]. API 653 emphasizes the need for engineering judgment when interpreting inspection data, especially where record completeness is limited, and provides guidance for settlement assessment via measurement curves and acceptability criteria (see Annex B) [5].

Modern surveying technologies—particularly the total station—offer high-precision geometric assessments that align well with API 653 requirements. Total stations enable remote measurement of distances, horizontal and vertical angles, and elevations, facilitating the creation of detailed three-dimensional profiles of the tank shell and foundation[7]. For example, inspection protocols often involve identifying multiple stations around the tank shell—typically at intervals of up to 32 ft (approximately 9.7 m)—and measuring radial lines from the shell toward the center, both on the floor and vertically along the shell, to detect deformations such as bulging and out-of-plumbness [4].

In practical field workflows, inspectors may record elevation readings manually or via total station setups—sometimes requiring multiple instrument positions—to capture a vertical series of points along the shell. These data points are then processed to produce elevation profiles, which are compared between diametrically opposed stations to reveal deviations from verticality or even settlement patterns—in line with API 653 criteria [4]. Given increasing emphasis on asset integrity, regulatory compliance, and sustainability in industrial operations, integrating total station surveying into API 653–compliant inspection protocols represents a significant advancement [2]. It enables more accurate geometric assessments, enhances safety, and supports informed decisions regarding repair, alteration, or reconstruction.

2.0 MATERIALS AND METHODS

The inspection methodology involved the use of a total station instrument, which employs electronic distance measurement (EDM) and angular measurements to precisely capture data points on the tank's surface. Utilizing a combination of laser technology and advanced software, the total station facilitated the generation of detailed elevation profiles, cross-sectional views, and three-dimensional models of the tank.

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2.1 Study Area

The study was conducted at the Canadian Natural Resources (CNR) base in Abidjan, Ivory Coast, focusing on the B1 storage tank facility. The base serves as a key operational hub for petroleum storage and handling, incorporating clustered tank installations within a secured industrial perimeter. The specific inspection location lies within a tightly arranged tank farm, where multiple above-ground welded steel tanks are positioned in close proximity. The CNR base is situated in Abidjan, the economic capital of Ivory Coast, along the country's southern Atlantic coast. The site coordinates, derived from mobile GNSS measurements and adjusted using Google Earth Pro, reference control points distributed around the tank perimeter (e.g., Points A: 582541.070 N, 388120.270 E and B: 582563.800 N, 388107.581 E). The surrounding environment consists of asphalt-surfaced service zones, operational buildings, and auxiliary infrastructure associated with petroleum logistics.



Figure 2.1 Google imagery of road network within study area (Ovu 2025)

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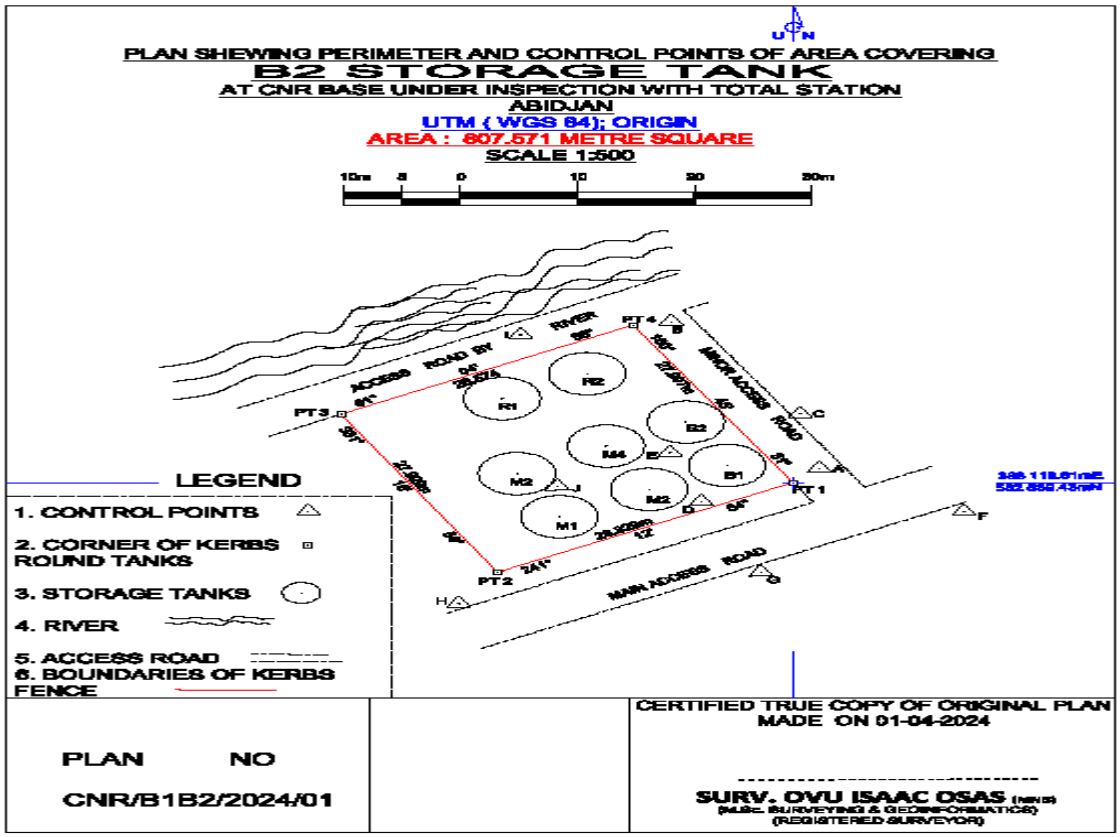

Figure 2.2 Survey Map of the study area (Ovu 2025)

2.2 Equipment Used

• Kolida KTS 442 Reflectorless Total Station

• GNSS Handheld Mobile Topographer

• 100m Steel Tape, Walkie-Talkie, Laptop

2.3 Reconnaissance survey (Recce)

During the recce, a preliminary site visit was conducted to familiarize ourselves with the tank's location, surroundings, and any potential obstacles or hazards. Searched was conducted for any existing controls around the CNR base and asked if there were any but could not be furnished with any existing control data, hence it was decided during the recce exercise to establish a low order temporary control points around the tank area where total station could be set up for observation. Ten points within and around the perimeter of the tanks were established with concrete nails thrust into the asphalt at the points. Necessary safety equipment were prepared for the operation.

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2.4 Control Establishment

Due to non-availability of existing control points and no prior information on establishment of controls on the project scope, improvised alternative use of mobile topographer Hand-hanld GNSS to pick the coordinates of two notable notable bench marks that can be located on google earth imagery was done while total station was used to take the coordinate readings of the two points. These two points were plotted on google earth pro satellite imagery with necessary adjustment before recording the coordinates of points A and B in which total station was used to extend the control coordinates to the other established points.

2.5 Tank settlement survey

The circumferential level of the tank base was determined for nine(9) points at a marked interval of 2.5meters from each point. Two different set of readings were determined at day interval for check purpose. The table 2.1 below shows the levels of each observation and their mean.

Table 2.1 Tank settlement inspection table

POINTS	1ST ELEVATION	2ND ELEVATION	DIFF. IN READING
PT 1 (Om)	1.612	1.603	0.009
PT 2 (2.5m)	1.616	1.621	0.005
PT 3 (5m)	1.618	1.607	0.011
PT 4 (7.5m)	1.605	1.596	0.009
PT 5 (10m)	1.601	1.632	0.031
PT 6 (12.5m)	1.632	1.628	0.004
PT 7 (15m)	1.624	1.598	0.026
PT 8 (17.5m)	1.598	1.606	0.008
PT 9 (20m)	1.602	1.600	0.002

2.6 Roundness (Ovality) Inspection

The ovality inspection was carried out by coordinating the nine (9) points marked around the circumference with 2.5m intervals and also coordinating randomly smaller intervals between the

2.5m marks for better circumference. This operation was carried out on the five (5) couches where the tanks were joined together with the aid of the reflectorless total station using the ray method from four (4) different control points. A Radial comparism graph was plotted for the five couches as shown in figure 2.3. A graph of radial comparison was plotted as shown in figure 2.3 while the coordinates of the circumferential points are shown on the appendix.

Table 2.2 Roundness inspection table

Tank	Point	Northing	Easting	Radius	Diameter	Circumference	Circumference Deviation
1ST couch	L118	582543.583	388114.987	3.349	6.698	21.04	0.0966
	L125	582544.73	388113.403				
	L2	582543.122	388115.288				
	L9	582540.63	388115.572				
	L16	582538.67	388114.06				
	L52	582538.31	388111.614				
2ND Couch	L119	582543.595	388114.982	3.335	6.67	20.954	0.0106
	L126	582544.725	388113.404				
	L3	582543.121	388115.292				
	L10	582540.629	388115.574				
	L17	582538.673	388114.049				
	L53	582538.312	388111.613				
3RD Couch	L120	582543.613	388114.976	3.327	6.654	20.905	0.0384
	L127	582544.713	388113.408				
	L4	582543.126	388115.282				
	L11	582540.629	388115.575				
	L18	582538.673	388114.046				
	L54	582538.311	388111.614				
4TH Couch	L121	582543.603	388114.98	3.33	6.66	20.92	0.0234
	L128	582544.723	388113.405				
	L5	582543.132	388115.269				
	L12	582540.626	388115.583				
	L19	582538.672	388114.05				
	L55	582538.315	388111.612				
5TH Couch	L122	582543.582	388114.987	3.326	6.652	20.898	0.0454
	L129	582544.718	388113.406				
	L6	582543.138	388115.258				
	L13	582540.626	388115.581				

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	L20	582538.672	388114.05				
	L56	582538.299	388111.617				
				AVERAGE RADIUS= 3.3334	**AVERAGE DIAMETER= 6.6668**	**AVERAGE CIRCUMFERENCE = 20.9434**	**CIRCUMFERENCE STANDARD DEVIATION = 0.058153**

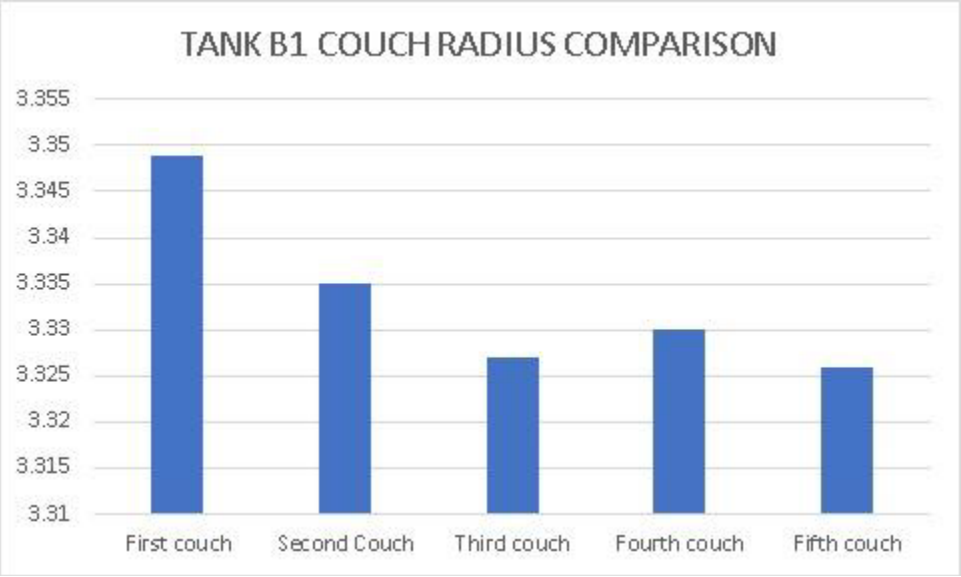

Figure 2.3 Tank B1 Radial comparison

2.7 Verticality inspection

The total station on the reflector-less mode emits a laser beam towards the tank which is the target. The instrument was used to generate the coordinates of at least one point each from the five couches of the tank vertically upwards from which we used back computation to deduce the distance from the total station to the target without needing a prism. It also measured the vertical angle from the instrument to the target. With the distance and vertical angle measurements, the vertical displacement of the target relative to a reference point was calculated. This displacement indicates whether the tank is vertically aligned or if adjustments are needed. The difference in vertical angle between the base and the top is supposed to be 00^0 00' 00" else there will be verticality error depending on the degree of deflection. The allowable deflection angle in verticality for a tank when compared to a plumb vertical line is within the range of 0.1% to 0.2% of the tank's height. Hence, the allowable deflection angle for 9m high tank is between 00^0 00' 32.4" and 00^0 01' 4.8". With the mean vertical angle of the four points taken in tank B1, only one point has a high value of 00^0 02' 46.46" as shown in table 2.3 which is quite different from all other values and this made the mean deflection angle to get to 00^0 01' 41.46", hence could be as a result of human error, the deflection angles falls within allowable vertical error.

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Table 2.3 Verticality inspection table

Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10	Column11
TANK B1 1ST READING										
stn frm	Bearing	V. Angle	Verticality	Distance	De North	De Easting	N	E	H	Station to
							582538.3	388112.9	1.276	V1
V1	116° 33' 2001"	89° 50' 50"	0° 0' 8.05"	0.002236	0.002	-0.001	582538.3	388112.9	2.115	V2
V2	279° 27' 1637"	89° 49' 24"	0° 0' 21.9"	0.006083	-0.006	0.001	582538.3	388112.9	4.088	V3
V3	96° 20' 1205"	89° 28' 53"	0° 1' 5.2"	0.018111	0.018	-0.002	582538.3	388112.9	6.089	V4
V4	101° 41' 2441"	89° 08' 37"	0° 1' 46.61"	0.029614	0.029	-0.006	582538.3	388112.9	8.07	V5
V5	280° 53' 3135"	88° 22' 59"	0° 1' 35.32"	0.026476	-0.026	0.005	582538.3	388112.9	9.008	V6
	MEAN VERTICALITY			**0° 0' 59.42"**		0.016504				
TANK B1 2ND READING										
stn frm	Bearing	Vertical Angle	Verticality	Distance	De North	De Easting	N	E	H	Station to
							582543.1	388115.3	2.044	V2
V2	153° 26' 1540"	78° 50' 20"	0° 0' 24.15"	0.006708	0.003	-0.006	582543.1	388115.3	2.078	V3
V3	158° 11' 704"	89° 50' 37"	0° 0' 19.39"	0.005385	0.002	-0.005	582543.1	388115.3	4.052	V4
V4	180° 00' 00"	87° 47' 51"	0° 0' 3.6"	0.001	0	-0.001	582543.1	388115.3	4.078	V5
V5	156° 02' 133"	89° 25' 42"	0° 1' 10.91"	0.019698	0.008	-0.018	582543.1	388115.3	6.052	V6
V6	314° 59' 3541"	87° 41' 10"	0° 0' 5.09"	0.001414	-0.001	0.001	582543.1	388115.3	6.087	V7
V7	157° 22' 1346"	89° 39' 48"	0° 0' 46.8"	0.013	0.005	-0.012	582543.1	388115.3	8.299	V8
	MEAN VERTICALITY			**0° 0' 24.28"**		0.006744				
TANK B1 3RD READING										
stn frm	Bearing	Vertical Angle	Verticality	Distance	De North	De Easting	N	E	H	Station to
							582539.8	388109.6	1.321	L60
L60	111° 48' 2837"	88° 03' 07"	0° 1' 56.32"	0.032311	0.03	-0.012	582539.8	388109.5	2.271	L61
L61	111° 48' 2837"	89° 18' 08"	0° 1' 36.93"	0.026926	0.025	-0.01	582539.8	388109.5	4.482	L62
L62	292° 37' 2195"	89° 32' 26"	0° 0' 46.8"	0.013	-0.012	0.005	582539.8	388109.5	6.103	L63
L63	110° 51' 3025"	89° 20' 08"	0° 1' 20.9"	0.022472	0.021	-0.008	582539.8	388109.5	8.041	L64
L64	111° 34' 2023"	85° 43' 41"	0° 2' 46.46"	0.046239	0.043	-0.017	582539.9	388109.5	8.66	L65

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		MEAN VERTICALITY			**0° 1' 41.48"**		0.028189			
TANK B1 4TH READING										
stn frm	Bearing	Vertical Angle	Verticality	Distance	De North	De Easting	N	E	H	Station to
							582544.8	388113.4	1.596	L124
L124	286° 30' 1786"	85° 12' 33"	0° 1' 41.38"	0.02816	-0.027	0.008	582544.7	388113.4	1.26	L125
L125	281° 18' 1098"	89° 47' 17"	0° 0' 18.36"	0.005099	-0.005	0.001	582544.7	388113.4	2.639	L126
L126	288° 26' 1540"	89° 24' 25"	0° 0' 45.54"	0.012649	-0.012	0.004	582544.7	388113.4	3.861	L127
L127	106° 41' 2476"	89° 43' 14"	0° 0' 37.59"	0.01044	0.01	-0.003	582544.7	388113.4	6.001	L128
L128	281° 18' 1098"	89° 51' 02"	0° 0' 18.36"	0.005099	-0.005	0.001	582544.7	388113.4	7.956	L129
L129	106° 41' 2476"	89° 10' 22"	0° 0' 37.59"	0.01044	0.01	-0.003	582544.7	388113.4	8.679	L130
	MEAN VERTICALITY			**0° 0' 43.14"**		0.011982				
	STANDARD DEVIATION= 0.009139182									

2.8 Bottom level inspection

The circumferential level of the tank base was determined for nine(9) points at a marked interval of 2.5meters from each point. Two different set of readings were determined for check purpose. The table below shows the levels of each observation and their mean. Table 2.4. Tank base level. A base leve inspection graph was plotted as shown in figure 2.4

Table 2.4 Bottom Level Inspection

POINTS	1ST ELEVATION	2ND ELEVATION	DIFF. IN READING
PT 1 (Om)	1.612	1.603	0.009
PT 2 (2.5m)	1.616	1.621	0.005
PT 3 (5m)	1.618	1.607	0.011
PT 4 (7.5m)	1.605	1.596	0.009
PT 5 (10m)	1.601	1.632	0.031
PT 6 (12.5m)	1.632	1.628	0.004
PT 7 (15m)	1.624	1.598	0.026
PT 8 (17.5m)	1.598	1.606	0.008
PT 9 (20m)	1.602	1.600	0.002

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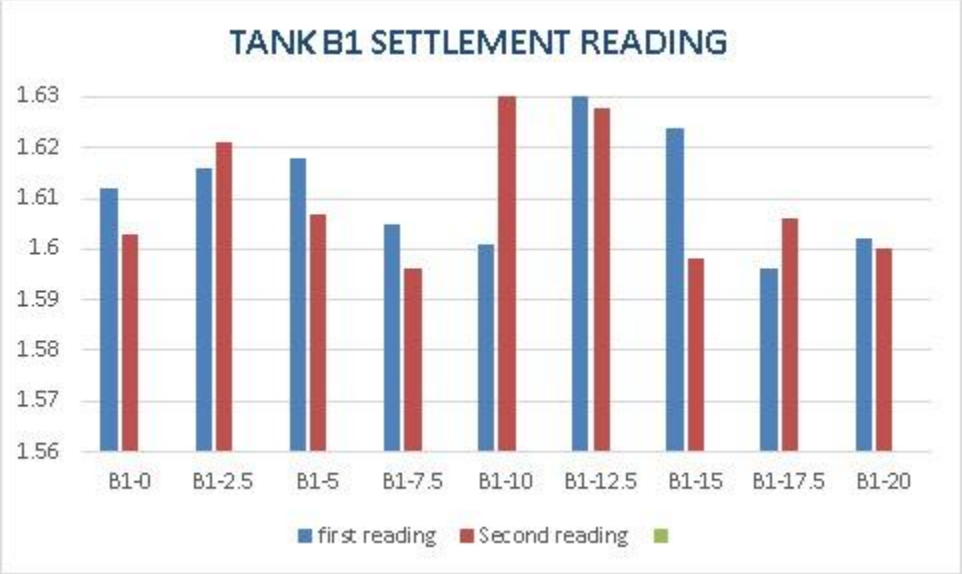

Figure 2.4. B1 base level inspection

3.0 Inspection findings

3.1 Measurements recorded

All observations were carried out using Total station to generate coordinates for the perimeter survey, the roundness, verticality and the height for the base level. The data was processed using; back computation excel spreadsheet for the vertical angles and distances, autocad for the plotting, python program to establish the center coordinate of the tank circumference since tank B1 does not have a base stud where we could locate two directly opposite stud to determine the diameter. From the measurements taken, we were able to create; a roundness inspection table, verticality inspection table and base level histogram. The coordinates and other diagrams are shown in the appendix.

3.2 Deviation from design specification

i. **Base settlement deviation:** We could not ascertain any deviation in tank's base settlement because there was available previous settlement data taken on the tank with which we can compare our data. Moreover, the tank is empty as at the time of our inspection, in order to check for any deviation in settlement, another inspection have to be carried out after a period of time when the tank would have been filled with products.

ii. **Base level deviation:** The base level of eight points was taken round the tank B1 circumference. Base level refers to the horizontal plane of the tank's foundation. The difference between the highest and lowest base level reading for tank B1 was 3cm. This deviation was supposed to be compared with the base level data as at the time of installation or any previous inspection. Since there is no previous base level data, we cannot ascertain the original base level of the tank.

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iii. **Ovality deviation:** We carried out ovality inspection on the five couches of tank B1 except for the where there was cluster of tanks so the total station was set up in a position very close to tank B1 whereby only the first couch could be sighted. Ovality measures the deviation of the tank's circumference from a perfect circle. There was no previous inspection report to determine the ovality of B1 as at the time of installation hence no basis for comparison but when we plotted the circumferential points, we can say the ovality is permissible.

iv. **Verticality deviation:** Verticality refers to the alignment of the tank's walls relative to the vertical axis. The difference in vertical angle between the base and the top is supposed to be 00^0 00' 00" else there will be verticality error depending on the degree of deflection. The allowable deflection angle in verticality for a tank when compared to a plumb vertical line is within the range of 0.1% to 0.2% of the tank's height. Hence, the allowable deflection angle for 9m high tank is between 00^0 00' 32.4" and 00^0 01' 4.8". With the mean vertical angle of the four points taken in tank B1, only one point has a high value of 00^0 02' 46.46" which is quite different from all other values and this made the mean deflection angle to get to 00^0 01' 41.46", hence could be as a result of human error, the deflection angles falls within allowable vertical error.

3.3 Any defect or anomalies detected

From our inspection carried out on tank B1, we would say there was no noticeable defect or anomalies detected when compared to general specification but it would have been more productive if there was previous inspection data to compare with.

3.4 Summary of findings

This report presented the findings and recommendations resulting from a comprehensive total station inspection focusing on the base level, ovality, and verticality aspects of the API 653 storage tank. The inspection aimed to assess the structural integrity and dimensional stability of the tank, crucial for ensuring safe and efficient operations. The tank B1 was found to be within allowable deviation. The verticality for four point on the tank had an excess of 1st = 0° 0' 59.42", 2nd = 0° 0' 24.28", 3rd = 0° 1' 41.48", 4th = 0° 0' 43.14" which is within the allowable standard.

4.0 Conclusion/Recommendation

Total station inspection is a critical process in ensuring the integrity and safety of storage tanks. It involves measuring various parameters which was carried out in our inspection such as base settlement, base level, ovality, and verticality to ensure compliance with design specifications. However, deviations from these specifications can occur, posing potential risks to the structural integrity of the tank and the safety of its surroundings depending on the level of deviation.

Total station inspection of storage tank cannot be said to be complete when there is no available initial or subsequent data of the tank under inspection which will serve as basis of comparison for any deviation. Hence we recommend that a search be made for previous records and subsequently all inspection reports be kept safe for ease of access in case of subsequent inspection.

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Appendix

Control points coordinates

CONTROL COORDINATES			
	Column1	**Column2**	**Column3**
STN	N	E	Z
A	582541.07	388120.27	1.5
B	582563.8	388107.581	1.053
C	582549.506	388118.612	1.422
D	582535.902	388110.156	1.628
E	582543.505	388107.487	1.621
F	582534.358	388132.63	1.737
G	582524.948	388115.262	1.727
H	582520.104	388089.403	1.655
I	582561.747	388094.711	1.043
J	582538.274	388097.872	1.567

Ovality inspection coordinates

OVALITY INSPECTION FOR TANK B1 1ST COUCH			
	Column1	**Column2**	**Column3**
STN	N	E	Z
L118	582543.583	388114.987	1.062
L125	582544.73	388113.403	1.26
L2	582543.122	388115.288	1.057
L9	582540.63	388115.572	1.325
L16	582538.67	388114.06	1.378
L52	582538.31	388111.614	1.375
B2R48	582544.018	388114.587	0.653
B2R49	582543.143	388115.285	0.693
B2R50	582542.847	388115.438	0.704
B2R51	582542.319	388115.616	0.72
B2R52	582541.768	388115.712	0.732
B2R53	582541.364	388115.712	0.738
B2R54	582540.826	388115.621	0.743
B2R55	582540.443	388115.515	0.744
B2R56	581540.17	388115.4	0.744
B2R57	582539.858	388115.244	0.742
B2R58	582539.523	388115.02	1.139
B2R59	582539.203	388114.734	1.136
B2R60	582538.8	388114.245	1.129
B2R61	582538.466	388113.63	1.12
B2R62	582538.276	388112.95	1.109

B2R63	582538.233	388112.238	1.097

OVALITY INSPECTION FOR TANK B1 2ND COUCH			
	Column1	**Column2**	**Column3**
L119	582543.595	388114.982	3.028
L126	582544.725	388113.404	2.639
L3	582543.121	388115.292	2.798
L10	582540.629	388115.574	2.806
L17	582538.673	388114.049	2.452
L53	582538.312	388111.613	2.592
B2R64	582538.239	388112.237	2.269
B2R65	582538.286	388113.023	2.239
B2R66	582538.585	388113.87	2.209
B2R67	582538.972	388114.461	2.19
B2R68	582539.238	388114.761	2.181
B2R69	582539.432	388114.936	2.177
B2R70	582539.809	388115.207	2.171
B2R71	582540.074	388115.36	2.168
B2R72	582540.369	388115.488	2.167
B2R73	582540.977	388115.658	2.169
B2R74	582541.357	388115.697	2.173
B2R75	582542.041	388115.672	2.185
B2R76	582543.038	388115.349	2.213
B2R77	582543.63	388114.953	2.237
B2R78	582544.145	388114.432	2.264

OVALITY INSPECTION FOR TANK B1 3RD COUCH			
	Column1	**Column2**	**Column3**
L120	582543.613	388114.976	4.677
L127	582544.713	388113.408	3.861
L4	582543.126	388115.282	4.228
L11	582540.629	388115.575	4.428
L18	582538.673	388114.046	4.199
L54	582538.311	388111.614	4.733
B2R79	582544.148	388114.439	4.93
B2R80	582542.485	388115.563	4.636
B2R81	582541.503	388115.695	4.549
B2R82	582540.559	388115.547	4.514
B2R83	582539.77	388115.19	4.529

B2R84	582539.214	388114.724	4.578
B2R85	582538.736	388114.136	4.655
B2R86	582538.396	388113.427	4.759
B2R87	582538.376	388113.37	4.771

OVALITY INSPECTION FOR TANK B1 4TH COUCH			
	Column1	**Column2**	**Column3**
L121	582543.603	388114.98	6.328
L128	582544.723	388113.405	6.001
L5	582543.132	388115.269	6.188
L12	582540.626	388115.583	6.403
L19	582538.672	388114.05	6.198
L55	582538.315	388111.612	6.479
B2R88	582538.244	388112.411	6.391
B2R89	582538.392	388113.391	6.169
B2R90	582538.931	388114.415	5.959
B2R91	582539.211	388114.735	5.902
B2R92	582539.87	388115.268	5.824
B2R93	582540.18	388115.427	6.271
B2R94	582540.974	388115.66	6.285
B2R95	582541.659	388115.685	6.348
B2R96	582542.279	388115.609	6.433
B2R97	582543.129	388115.282	6.61
B2R98	582543.525	388115.04	6.715
B2R99	582544.077	388114.519	6.905

OVALITY INSPECTION FOR TANK B1 5TH COUCH			
	Column1	**Column2**	**Column3**
L122	582543.582	388114.987	8.086
L129	582544.718	388113.406	7.956
L6	582543.138	388115.258	8.434
L13	582540.626	388115.581	8.215
L20	582538.672	388114.05	8.058
L56	582538.299	388111.617	7.966
B2R100	582544.243	388114.303	8.301
B2R101	582543.406	388115.113	7.948
B2R102	582542.797	388115.435	8.265
B2R103	582541.978	388115.67	8.062

B2R104	582541.273	588115.698	7.954
B2R105	582540.563	388115.569	7.906
B2R106	582539.973	388115.316	7.926
B2R107	582539.367	388114.896	8.006
B2R108	582539.004	388114.525	8.1
B2R109	582538.553	388113.79	8.312
B2R110	582538.424	388113.438	7.95
B2R111	582538.234	388112.379	8.28

Verticality inspection coordinates

VERTICALITY INSPECTION ON TANK B1 1ST READING			
	Column1	**Column2**	**Column3**
STN	N	E	Z
V1	582538.278	388112.948	1.276
V2	582538.28	388112.947	2.115
V3	582538.274	388112.948	4.088
V4	582538.292	388112.946	6.089
V5	582538.321	388112.94	8.07
V6	582538.295	388112.945	9.008

VERTICALITY INSPECTION ON TANK B1 2ND READING			
	Column1	**Column2**	**Column3**
STN	N	E	Z
V1	582543.057	388115.32	0.661
V2	582543.058	388115.317	2.044
V3	582543.061	388115.311	2.078
V4	582543.063	388115.306	4.052
V5	582543.063	388115.305	4.078
V6	582543.071	388115.287	6.052
V7	582543.07	388115.288	6.087
V8	582543.075	388115.276	8.299
V8	582543.079	388115.266	8.901

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VERTICALITY INSPECTION ON TANK B1 3RD READING			
	Column1	**Column2**	**Column3**
STN	N	E	Z
L58	582539.623	388109.567	1.601
L60	582539.761	388109.55	1.321
L61	582539.791	388109.538	2.271
L62	582539.816	388109.528	4.482
L63	582539.804	388109.533	6.103
L64	582539.825	388109.525	8.041
L65	582539.868	388109.508	8.66

VERTICALITY INSPECTION ON TANK B1 4TH READING			
	Column1	**Column2**	**Column3**
STN	N	E	Z
L124	582544.757	388113.395	1.596
L125	582544.73	388113.403	1.26
L126	582544.725	388113.404	2.639
L127	582544.713	388113.408	3.861
L128	582544.723	388113.405	6.001
L129	582544.718	388113.406	7.956
L130	582544.728	388113.403	8.679

Base level reading

TANK SETTLEMENT FOR B1 READING 1				
	Column1	**Column2**	**Column3**	**Column4**
STN	N	E	Z	CHG
L1	582543.092	388115.348	1.612	B1 0
L8	582540.63	388115.572	1.616	B1 2.5
L15	582538.664	388114.085	1.618	B1 5
L51	582538.314	388111.613	1.605	B1 7.5
L58	582539.623	388109.567	1.601	B1 10
L141	582541.966	388109.016	1.632	B1 12.5
L142	582544.28	388110.325	1.624	B1 15
L124	582544.757	388113.395	1.596	B1 18.2
L117	582543.754	388114.924	1.602	B1 20

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TANK SETTLEMENT READING 2				
	Column1	**Column2**	**Column3**	**Column4**
CL-0	582543.065	388115.335	1.603	B1-0
2.5	582540.657	388115.548	1.621	B1-2.5
L76	582538.68	388114.062	1.607	B1-5
GL-3	582538.304	388111.614	1.596	B1-7.5
EL-5	582542.069	388109.038	1.632	B1-10
EL-6	582544.278	388110.307	1.628	B1-12.5
CL-6	582544.191	388110.241	1.598	B1-15
CL-7	582544.9	388112.603	1.606	B1-17.5
CL-8	582543.775	388114.829	1.6	B1-20

Perimeter survey data

PERIMETER SURVEY DATA			
	Column1	**Column2**	**Column3**
STN	N	E	Z
L43	582538.852	388118.052	2.353
L44	582563.281	388104.376	1.129
L150	582524.97	388092.785	1.652
L145	582549.464	388079.365	1.157

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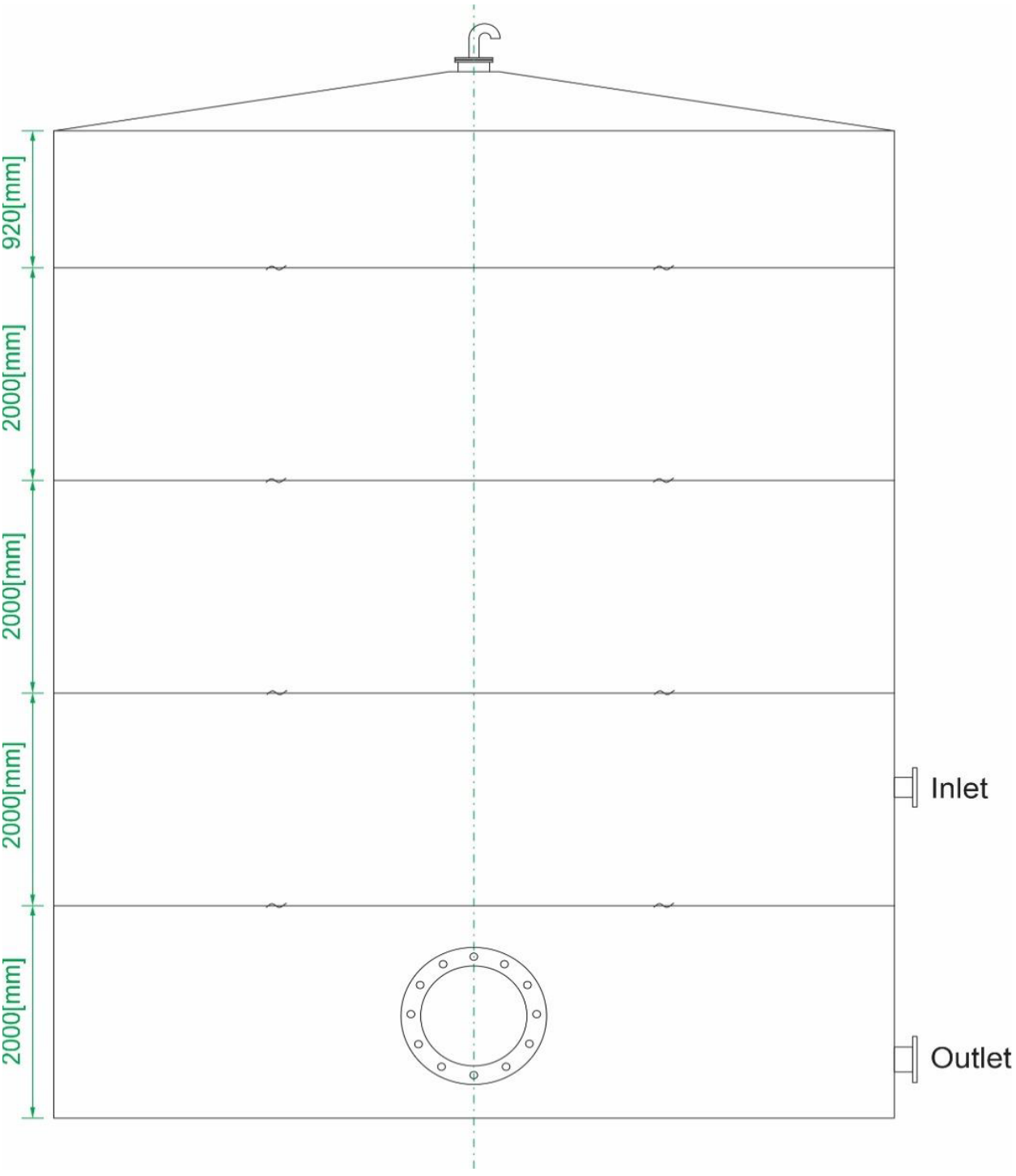
Tank plan and profile



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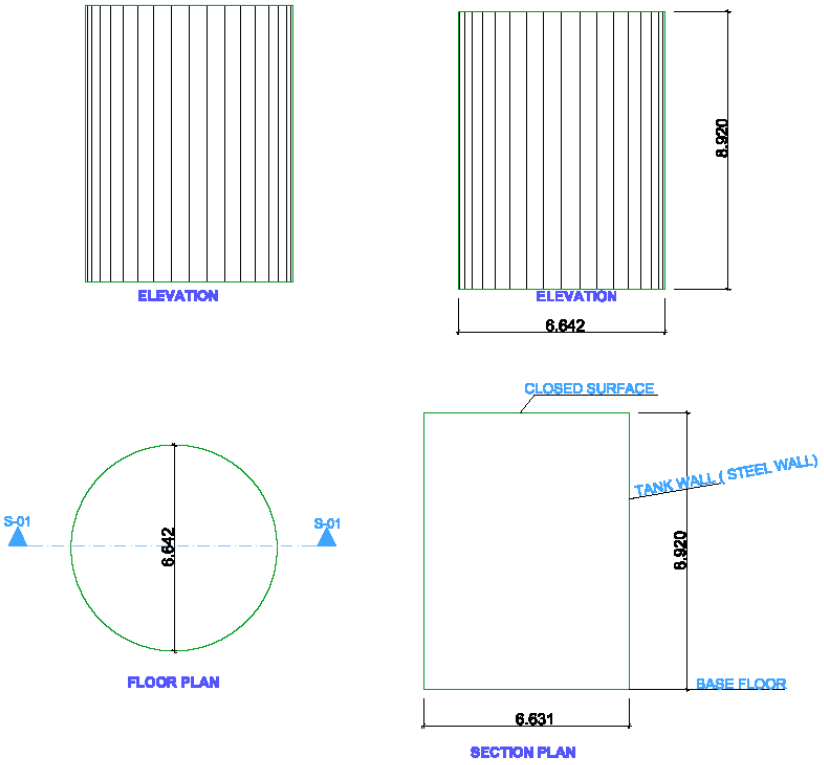

Tank plan and profile

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