Foreign experience in assurance management in constructing and exploiting of oil storage constructions

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Abstract

The article is devoted to modern technology of assurance management in construction and operation of oil storage constructions in accordance with international quality standards "6 sigma management". It is suggested to use this system for domestic oil output and refining companies to reduce oil losses. The substantiation of economic feasibility of the introduction of this system in the industry is described.

Key words: *assurance management, evaporation, hydrostatic testing, health safety and enviroment, oil losses, oil storage contructions, reduction losses.*

The Problem

Today lagging behind in terms of technology and civilization, there are some countries with its oil and gas reserves in the world. It must be mentioned that these countries can not benefit from these resources effectively. Therefore, some countries which have technological power and these underdeveloped countries are competing with each other to create artificial terror in order to share oil and gas reserves by abuse of the concept of peace. As it is commonly known that managing any contruction and exploiting oil storage construction requires use of technical internationally accepted standarts, we suggest to consider the productive expirience of designing companies that construct oil storages in Saudi Arabia.

An important task in the operation of tanks is to maintain the quality and quantity of the product. This requires maximum sealing of the draining process, loading and storaging. The main share of losses from evaporation during the entire path of the oil from the field to refinery factories, directly at factories accounts for storage (oil industry quantitative irrecoverable losses are as follows: loss in the oil output industry – 4.0 %; refineries – 3.5 % in the transport and storage of oil and oil products tanks and oil pipelines – 2.0 %. Total 9.5 %).

All loss of oil and petroleum products are classified into the following types: quantitative losses; qualitative and quantitative losses in which there is a quantitative loss with simultaneous deterioration of the quality of petroleum products, – evaporation losses; quality loss when the deteriorating quality of oil at a constant amount – losses unacceptable confusion.

Furthermore, two other groups of hydrocarbons loss should be identified such as natural loss and irretrievable losses in case of accidents.

According to the "Rules of natural attrition ..." natural losses are resulting from the imperfections of the existing funds and technology acceptance, storage, release and transport of products. This allowed only a reduction in the amount while maintaining the quality within the specified requirements. Natural losses may also be due to changes in physical and chemical properties of oil, or the influence of meteorological factors.

Losses caused by violations of the requirements of standards, specifications, rules of technical operation, refered to as emergency storage or excessive losses. For emergency losses we take losses caused by natural: natural disasters, or the influence of foreign powers.

Petroleum products, depending on their physical-chemical properties, resulting in their natural loss, divided into eight groups (Table 1). The calendar year is divided into two periods: autumn-winter (from October 1 to March 31, inclusive), and the spring and summer (from April 1 to September 30, inclusive).

Reducing regulatory and excessive loss of oil still remains one of the "eternal" problems of transport and storage. At expert estimation it could be 1.5 % of the oil produced. Losses from evaporation during loading of petroleum and petroleum products in the tank in the UK are estimated at 0.4–0.6 %, reaching 120,000 tons per year. Available regeneration vapor stations by cooling,

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Table 1 – Losses of oil products and crude oil [1]

Source loss	Losses, %
In tanks, including those:	64.8
from “large breaths”	54.0
blow out	4.6
from the gas trap	0.9
during cleaning	5.3
at pumping stations	2.3
with sewage effluent	7.5
In pipelines, including those:	23.5
on leakage	22.3
from crashes	1.2

condensation or adsorption are ineffective. The US has a similar setup to allow the recycling of 95 %, but they are effective only at high turnover tanks and hydrocarbon concentration in the vapor mixture of more than 35 %. It is necessary to carry out various measures to reduce losses effectively. Even official data show that the losses are very large.

From measurements it was found that GOR of oil decreases 2.5–3.0 times after passing reservoirs incompareson with the value that was input in tanks.

The greatest loss of oil from the evaporation are observed in fixed roof tanks. Their amount is typically about 0.14 % of the stored volume, but in some cases can be increased by 1.50 times. When the movement of oil by pipeline such gas enters the gas phase, forming a tube, and falling into the tank is lost to atmosphere through a breathing valve.

Brief literature review

Problems of calculating losses from evaporation petroleum products in terrestrial tanks are under investigation because of their high importance. Many foreign and domestic scientists payed attention to solving these problems, such as: Hrudz V.Ya. [3], Kryzhanivskiy Ye.I. [4], Kozlov A.V., Kondrat R.M., Mysliuk M.A., Sementsov G.N. [5], Serediuk M.D., DoroshenkoYu.I. [8].

Purpose

The purpose of article is to introduce assurance management standards in the construction and operation of storage facilities for cruid oil and petroleum products to reduce their losses and improve the environmental safety of storage.

The Results

Oil evaporation reduction. Researches have found some methods to reduce evaporation in variables studies. Studying the impact of the different variables present in the evaporation of the product in a tank centered on calculating losses by evaporation with different configurations of tanks in different places. Researchers used a mathematical model using emission factors published by the US Environmental Protection Agency "Organic Liquid Storage Tanks." Then they checked the result of this theoretical model by measuring the energy balance of the tanks themselves.

The most important variables were:
ambient temperature;
wind speed;
tank type;
type of seal;
stored product;
paint color.

Tank volume also affects evaporation, but to simplify the study, and since it is obvious that it will directly correlate with evaporation volumes, it was held constant.

Location effect. Studying location's effects, or the effect of the average ambient temperature, solar irradiance, and wind speed in the various cities where the tanks are installed, required tank type and volume be held constant. The tank studied in each setting is an external floating roof tank, 80 m in diameter and 17 m high, with the walls painted white, containing RVP 10 gasoline, with a mechanical primary seal and no secondary seal.

Evaporation reduction. The Huelva example uses a mechanical shoe seal without a secondary seal, resulting in losses of 31,703 kg/year, 81 % of which were caused by seal type. Installing a product-mounted seal with a secondary seal reduced total loss by 76 %, to 7,601 kg/year.

Having improved seal efficiency, proposals focused next on reducing losses caused by the floating roof's legs (52 %). Installing leg socks (polyurethane covers) closed the gap between the leg and the roof, reducing losses an additional 52 %, to 3,663 kg/year (Fig. 1). Applying similar covers to the tank's tube guide reduced evaporation losses still further.

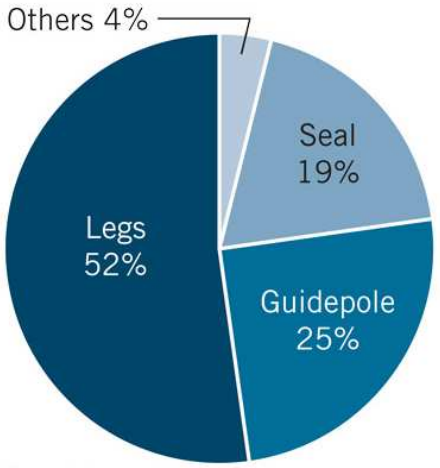


Figure 1 – Structural reducing losses [2]

Applying these three measures reduced total evaporative losses by 95 %, from 31,703 kg/year to 1,742 kg/year (Table 2).

Designation of oil storage construction should be made by qualifed designing companies. And this designations is controled by consulting engineer companies in the world. Every countries in the world now are flowing this profesional methods and third party inspections.

Table 2 – Successive solutions and reduction achieved

	Loss, kg/year	Reduction, %
Mechanical seal without secondary	31.703	–
Solution 1, product-mounted seal with secondary	7.601	76
Solution 2, leg socks	3.633	52
Solution 3, guide-pole sleeve	1.742	52

To assure the management the following necessary standarts need to be in the technical date package of the oil storage construction manufacturing plans.

In light of the introduction of the modern concept of sustainable development, the decision problems of compliance with international quality standards during construction and operation of oil and gas industry objects become particularly important.

The leading oil-producing countries has significant experience in the implementation of these standards, which will be beneficial for domestic companies.

Designing of any store tanks should contain the following:

health safety and environment, (Consulting engineering responsibility);

shop manufacturing control, (Cutting sheet metal, Sand blasting and Painting);

procedure for welding, (Consulting engineering responsibility);

procedure for post welding treatment, (Consulting engineering responsibility);

field erection control, (Consulting engineering responsibility);

method statement for internal and external coatings, (Consulting engineering responsibility);

hydrostatic testing, (Consulting engineering responsibility);

capacity and static control, (Consulting engineering responsibility).

Let’s consider each component.

Health safety and enviroment (HSE)

HSE matters can be managed effectively only when they are considered a line responsibility. Therefore the management is a combined effort by all people involved within the scope of the work. For ensuring that the work is carried out in a safe manner, constructor will make sure that the safety regulations are strictly followed by all of its personnel and the necessary instructions will be given to each one. The instructions and reports currently used in our company are enclosed for reference. HSE Supervisor and Site Manager will have the authority and responsibility to ensure safe working practices and to correct unsafe conditions and unsafe acts, this will be done by regular controlling of the safety precautions and by holding weekly safety meetings.

Health. On the construction site the HSE Supervisor and the Site Manager will ensure that at least one person is qualified.Also, all construction chiefs and supervisors will be trained to treat first aid cases specifically related to the health hazardous tasks.

Maintaining hygiene standards in the residential areas is the joint responsibility of the Camp Boss and those that use the facilities.The paramedic and the HSE Supervisor will conduct regular inspections to ensure that the hygiene standards are maintained.

Maintaining occupational health standards is the joint responsibility of the supervisors and their subordinates. HSE Supervisor will conduct a monthly inspection to ensure that the standards are maintained. During the activity all staff must be aware of the ERP for that activity. In the event of an injury during this task the HSE Supervisor shall ensure that first aid treatment is available for the activity.

Accident Investigation and Follow-Up. The HSE Supervisor will ensure that in addition all requirements of the Employer's safety regulations are met. The learning points of all accidents and reported near-misses shall be discussed in all safety meetings in an effort to prevent recurrence of similar accidents.

Safety Meetings. During the project execution the following safety meetings will be held (Table 3).

Table 3 – Frequency of safety meetings HSE [1]

Frequency	Chaired and attended by	Called by
Once a month	Project Manager	Office based senior project staff
Once a week	Site Manager	Site based senior project staff
Once a month	Site Manager	Site based staff
Twice a month	Foreman	Subordinates

All the above-mentioned meetings shall be minuted by the HSE Supervisor. The HSE Supervisor shall generate the agendas for the safety meetings.

Fundamental safety rules applicable to each employee and instructions to the personel are below. Be sure to take sufficient rest before commencing work:

do not drink any alcohol during working hours, including meal times. No alcoholic drinks, narcotics or similar substances are to be taken to the work site, or remain on the work site. Any personnel under the influence of alcoholic, narcotics or similar substances will not be permitted to enter or remain on the refinery site;

promptly report to the Supervisors concerned when one's physical condition is unsatisfactory;

regardless of severity, report to the Supervisors immediately when any injuries are sustained, materials or equipment damaged;

wear safe working clothes which have been properly repaired and washed. Do not work with bare foot, but wear proper shoes or safety shoes if available;

always wear a safety belt when working at any level where there is a danger of falling unless fully protected by scaffolds, handrails and toe boards;

use other safety protective equipment such as gloves, aprons, boots, goggles, respirators, etc., when required;

do not remove any safety devices from machines or attempt to operate machines without such as devices;

do not operate any machines, cranes, trucks, or other equipment without a proper licence and authorisation;

do not operate any vehicles at speeds exceeding the designated limit;

always use ladders, stairways or other access ways when going up or down scaffolds, towers and pipe racks, etc;

do not throw or drop any tools or materials from height;

do not stand or sit under any loads being hoisted by crane, forklift, etc;

do not work directly under other personnel working above;

do not smoke or use an open fire except in the designated areas;

advise fellow workers if any imminent safety hazard is discovered;

reports to the Supervisors for remedial action if any unsafe acts of other work groups or unsafe conditions are observed;

observe safety directives pointed out and/or made by Supervisors, safety committee members, and the Employer;

keep working places, water closets, and waiting rooms clean and neat;

do not urinate or defecate except in the designated areas.

Shop manufacturing and control

Constructor will make sure that receiving inspection of every material be done before storing them to warehouse. After receiving the material, the first major of the parts to manufatured shall be determined and planed to be cut in according to the drawing requrements. Dimensional inspection shall be performed prior to be sent to blasting operation. After sand blasting surface profile and salt contamination test should be performed for a good adhesion before primer painting operations. Paint thickness shall be conducted then the parts need to be presented to consulting engineer company before trasnfered to erection field.

Procedure for welding

The procedures and specifications which stated below need to be followed in order to get required weldments (Table 4).

Required foundation and grade works shall be supplied by the Contractor, unless otherwise specified in the Contract. The Contractor shall check level tolerances and contour before starting work, and shall notify the Employer of any deficiency discovered that might affect the quality of the finished work.

Tanks and their structural attachments shall be welded by the shielded metal-arc, gas metal-arc, gas tungsten-arc, oxyfuel, flux-cored arc, submerged-arc, electroslag, or electrogas process using suitable equipment. Use of the oxyfuel, electroslag, or electrogas process shall be by agreement between the Consultant and the Contractor.

Table 4 – Procedures and specifications [2]

Specifications	Procedures
Specification M09	Steel Tanks
General Specification`	Description of Project and Works
	Project Execution
	Weld Visual Examination Procedure
	Procedure for Radiographic Examination
	Procedure for Ultrasonic Examination
	Procedure for Liquid Penetrant Examination
	Procedure for Magnetic Particle Examination
	Procedure for Repairing Weld Damages Water Storage Steel Tanks
	Procedure for Hydrostatic Test of Water Storage Steel Tanks
	Procedure for Vacuum Box Test
	Inspection and Test Plan for Tank Erection
	Health, Safety and Environmental Plan

No welding of any kind shall be performed when the surfaces to be welded are wet from rain, snow, or ice; when rain or snow is falling on such surfaces; or during periods of high winds unless the welder and the work are properly shielded. Also, preheat shall be applied when metal temperature is below the temperature requirements.

All welding shall be free from coarse ripples, grooves, overlaps, abrupt ridges, and valleys that interfere with interpretation of non destructive examination (NDE) results.

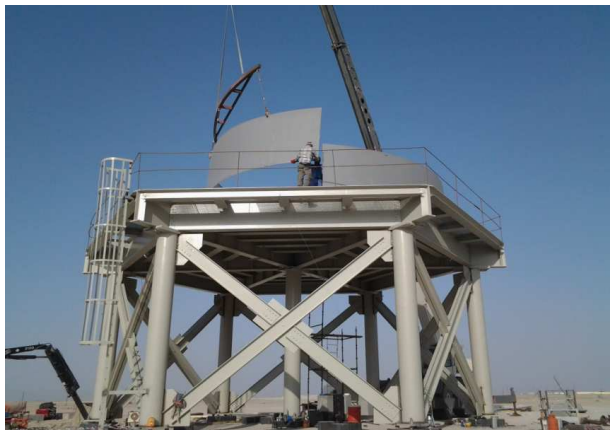


Figure 2 – General view of storage constructing process made in Saudi Arabia

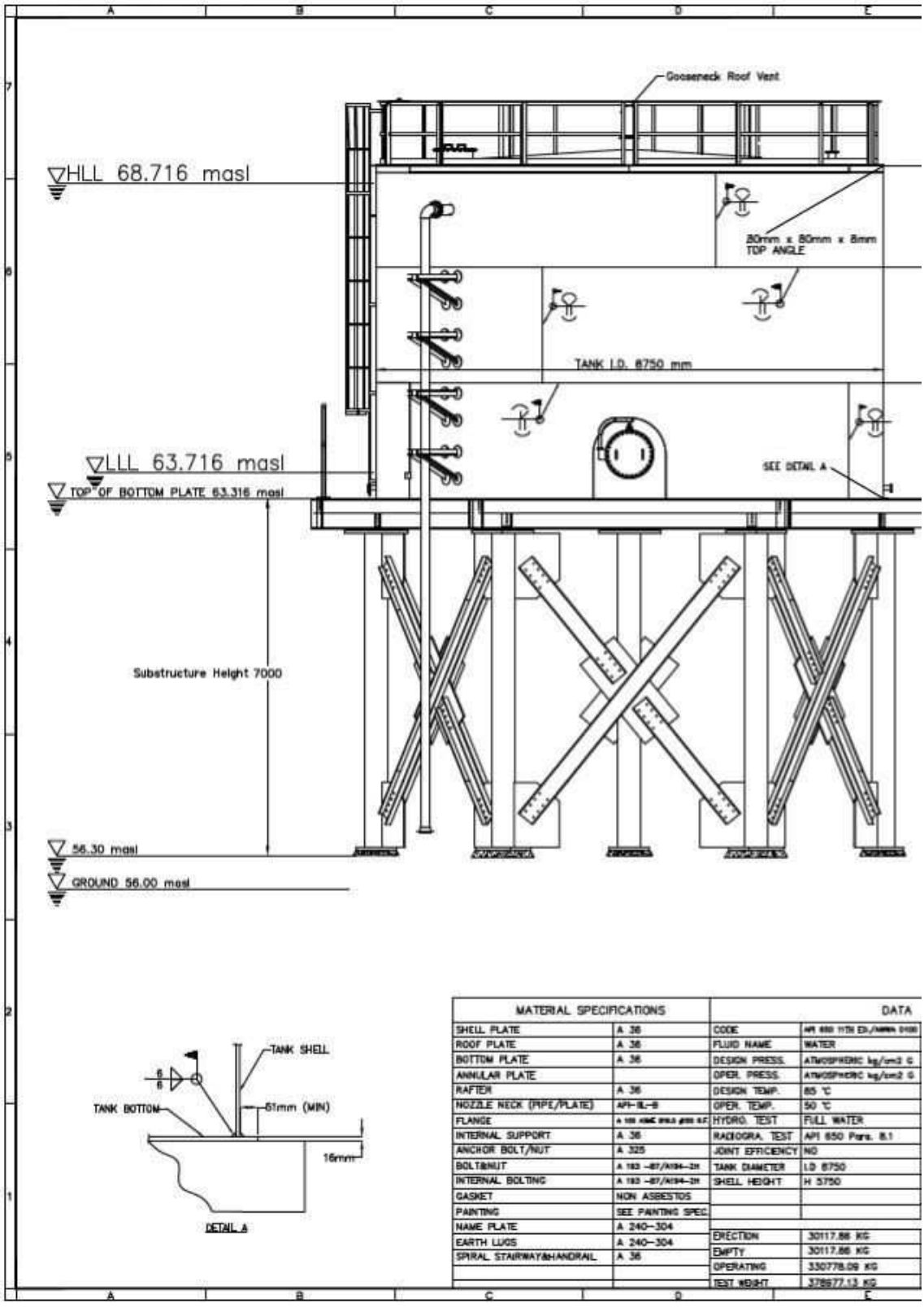
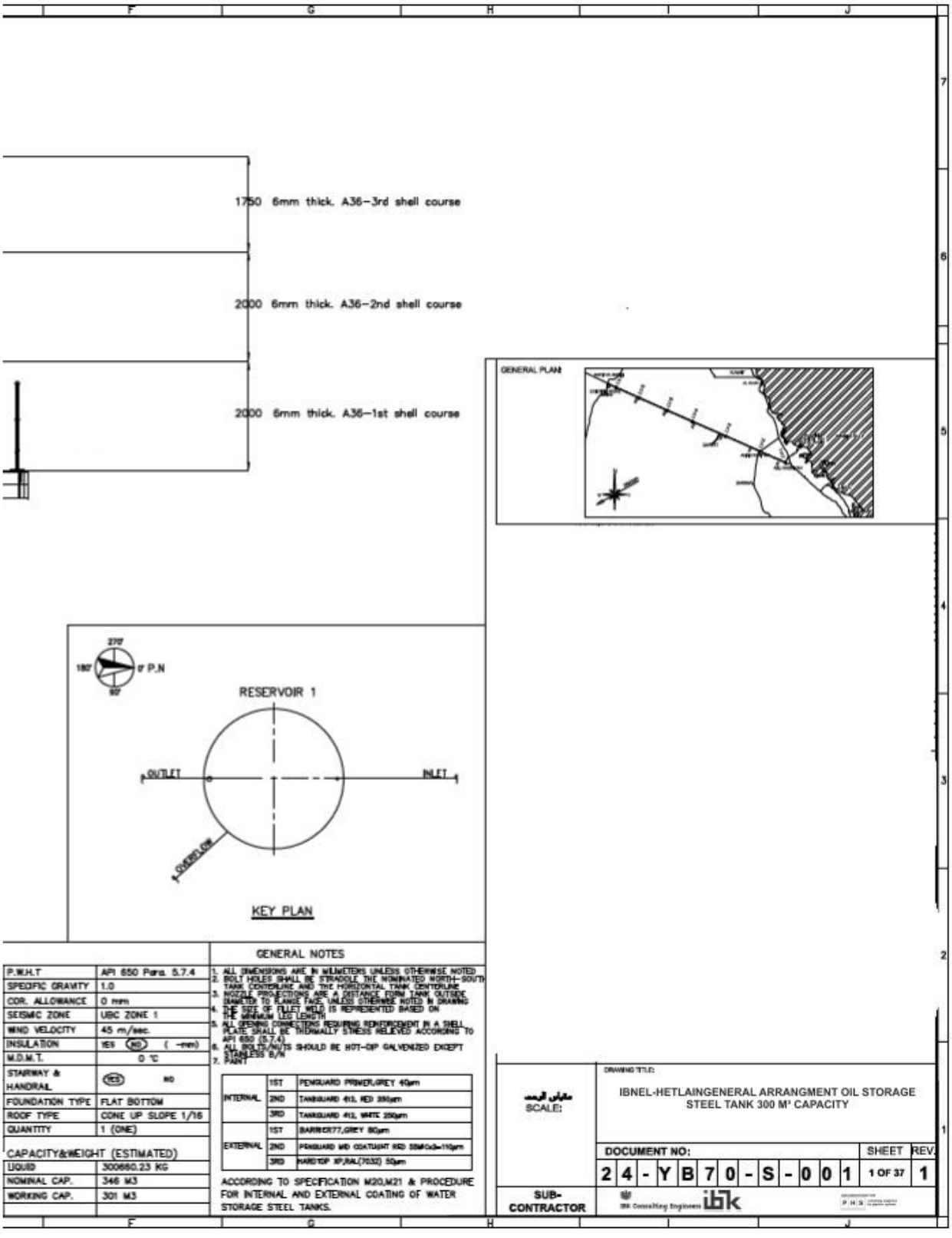


Figure 3 – General arrangement potable oil storage still tank 300 m^3 capacity


1750 6mm thick. A36-3rd shell course
2000 6mm thick. A36-2nd shell course
2000 6mm thick. A36-1st shell course
GENERAL PLAN
RESERVOIR 1
OUTLET
INLET
KEY PLAN
GENERAL NOTES
1. ALL DIMENSIONS ARE IN MILIMETERS UNLESS OTHERWISE NOTED
2. BOLT HOLES SHALL BE STRADDLE THE NOMINATED NORTH-SOUTH TANK CENTERLINE AND THE HORIZONTAL TANK CENTERLINE
3. NOZZLE PROJECTIONS ARE A DISTANCE FORM TANK OUTSIDE DIAMETER TO FLANGE FACE, UNLESS OTHERWISE NOTED IN DRAWING
4. THE SIZE OF FILLET WELD IS REPRESENTED BASED ON THE MINIMUM LEG LENGTH
5. ALL OPENING CONNECTIONS REQUIRING REINFORCEMENT IN A SHELL PLATE SHALL BE THERMALLY STRESS RELIEVED ACCORDING TO API 650 (5.7.4)
6. ALL BOLTS/NUTS SHOULD BE HOT-DIP GALVENIZED EXCEPT STAINLESS B/N
7. PAINT
INTERNAL 1ST PENGUARD PRIMER,GREY 40µm
2ND TANKGUARD 412, RED 250µm
3RD TANKGUARD 412, WHITE 250µm
EXTERNAL 1ST BARRIER77,GREY 80µm
2ND PENGUARD MID COATLIGHT RED 50MICR=110µm
3RD HARDTOP XP,RAL(7032) 50µm
ACCORDING TO SPECIFICATION M20,M21 & PROCEDURE FOR INTERNAL AND EXTERNAL COATING OF WATER STORAGE STEEL TANKS.
P.W.H.T API 650 Para. 5.7.4
SPECIFIC GRAVITY 1.0
COR. ALLOWANCE 0 mm
SEISMIC ZONE UBC ZONE 1
WIND VELOCITY 45 m/sec.
INSULATION YES (NO) (-mm)
M.D.M.T. 0 °C
STAIRWAY & HANDRAIL (YES) NO
FOUNDATION TYPE FLAT BOTTOM
ROOF TYPE CONE UP SLOPE 1/16
QUANTITY 1 (ONE)
CAPACITY&WEIGHT (ESTIMATED)
LIQUID 300660.23 KG
NOMINAL CAP. 346 M3
WORKING CAP. 301 M3
SCALE:
DRAWING TITLE:
IBNEL-HETLAINGENERAL ARRANGMENT OIL STORAGE STEEL TANK 300 M³ CAPACITY
DOCUMENT NO: 24-YB70-S-001
SHEET 1 OF 37
REV. 1
SUB-CONTRACTOR

When such joints are welded by the submerged-arc process, the tack welds shall be thoroughly cleaned of all welding slag but need not be removed if they are sound and are thoroughly fused into the subsequently applied weld beads.

Whether tack welds are removed or left in place, they shall be made using a fillet-weld or butt-weld procedure qualified in accordance with Section IX of the American Society of Mechanical Engineering (ASME) Code.

Procedure for post welding treatment

Scope. Post weld heat treatment (PWHT) shall be prequalified provided that it shall be approved by the Consultant and the following conditions shall be met. PWHT shall be conducted in accordance with the following stress-relief heat treatment.

Where required by the contract documents, welded assemblies shall be stress relieved by heat treating. Final machining after stress relieving shall be considered when needed to maintain dimensional tolerances.

Requirements. The stress-relief treatment shall conform to the following requirements:

the temperature of heating surface will not exceed 315°C at the time the welded assembly is placed in it;

above 315°C, the rate of heating shall not be more than 204°C per hour divided by the maximum metal thickness of the thicker part, in inches, but in no case more than 204°C per hour. Above 315°C, the rate of heating in °C/hr shall not exceed 5600 divided by the maximum metal thickness, in millimeters, but not more than 218°C/hr. During the heating period, variations in temperature throughout the portion of the part being heated shall be no greater than 140°C within any 15 ft [5 m] interval of length. The rates of heating and cooling need not be less than 55°C per hour. However, in all cases, consideration of closed chambers and complex structures may indicate reduced rates of heating and cooling to avoid structural damage due to excessive thermal gradients;

after a maximum temperature of 600°C is reached on quenched and tempered steels, or a mean temperature range between 600°C and 650°C is reached on other steels, the temperature of the assembly shall be held within the specified limits for a time. When the specified stress relief is for dimensional stability, the holding time shall be not less than specified on the basis of the thicker part thickness. During the holding period there shall be no difference greater than 65°C between the highest and lowest temperature throughout the portion of the assembly being heated.

Documentation, reports, records heat treatment:

PWHT Instruction Sheet is used for PWHT where needed. The record will be kept for 3 months;

record the WPS / PQR number that was utilized to weld for field welds;

Heat Treatment Temperature Range – record the temperature range specified for PWHT from the Welding Technique Sheet;

Set Point Temperature – the set point temperature should be the mean temperature of the heat treatment temperature range and should be maintained as close as possible for the length of the holding time. For PWHT equipment that has programmable controls, this set point temperature should be programmed into the controller;

Holding Time – record the holding time based on the nominal thickness and the values listed on the Welding Technique Sheet;

Heating Rate above 315 ºC – record the heat-up rate from Paragraph 5.12 of the PWHT Procedure;

Cooling Rate above 315 ºC – record the cool-down rate from Paragraph 5.12 of the PWHT Procedure;

Special Instructions – list any special instructions, e.g. width of band to be heated, what temperature to remove insulation, which equipment to use.

Field erection control

Tank erection method. Site clearance for tank erection shall be obtained before preparation for tank erection. Equipments and tools to be used for erection shall meet the requirements of project specifications pertaining to HSE and calibration. There shall be well defined areas for site offices, stores, storage areas for prefabricated items and raw materials.

All fittings, valves, plates, etc., shall be properly laid out on wooden supports clear of the soil. Special care shall be taken that damage does not occur to joint faces of valves and flanges or to beveled ends of fittings. The following documents, with approved for construction/implementation status, shall be available at erection site office for references:

tank drawings;

AMS (applicable method statements);

WPS (welding prosess sysytem);

calibration records for equipments and instruments;

consumable certificates;

ITP (inspection test plans);

safety instructions relevant to tank erection.

Sequence of operation. The erection methods employed for the construction of tank will be conventional method and progressive assembly method. Sequence adopted for both methods will be detailed in the following narrative. Bottom plate assembly is more or less the same in both methods except the shell to bottom plate welding:

installation bottom plate assembly;

installation of shell plate;

installation of curb angle;

checking of alignment.

Dimentional tolerances. The purpose of the tolerances given produce a tank of acceptable appearance. Measurements shall be taken prior to the hydrostatic water test. Unless waived or modified by the contractor or established separately by agreement between the Contractor and the Manufacturer, the following tolerances must be applied:

plumbness;

roundness;

local deviations;

shell manholes;

circularity of the shell plate.

Method statement for internal and external coatings

One of the existing means of reducing losses is the color of the outer surface of the tank reflective paints Table 2. If the temperature of the oil in the tanks is above the daily average ambient temperature then reduce losses from evaporation from the oil tank color reflective paint is virtually nonexistent. The most effective in reducing the losses of oil from evaporation is white paint. In addition, the preservation of white paint on the tank (nitro, enamel) reaches 3–4 years, and aluminum – 1.5–2.0 years (Table 5).

Purpose. The main purpose of this Method Statement is to describe how the internal and external surfaces of the steel tanks will be prepared and coated according to the specifications and requirements project.

Scope. Method Statement covers the guidelines for surface preparation, coating, touch-up/repair and inspection & testing of internal and external surfaces of the steel water storage tanks.

Surface Preparation. The tank bottom, shell and roof plates as well as the structural steels, internal pipes and fittings will be prefabricated before the tank erection. The prefabrication includes plate rolling, shotblasting, non-solvent based shop primer coating (if decided) and external protective coating according to the place of use of material. Storage, handling, mixing, thinning and application of paint/coating materials and the type of application equipment shall be in accordance with Manufacturer recommendations. Mixing shall be carried out by high-speed shakers or rotary mixers with flat blades and a speed control.

Table 5 – Dependence of oil losses from evaporation in vertical steel tanks on the type of coloring surface [7]

Type of paint	Loss from the tank, part of the unit	Loss reduction depended on the type of paint,%
Black or red (new unpainted tank)	1.00	0
White	0.46	54
Aluminum old paint after 2–3 years of operation	0.82	18
Aluminum paint after 0.5–1.0 years of operation	0.63	37
Aluminum new paint before 0.5 year of operation	0.56	44

Wet Film Thickness. The wet film thickness comb shall be applied on an area that allows both end tabs to be in contact with the substrate.

Test Record. The following information will be recorded on the Daily Reports for Examination of Surface Preparation and Protective Coating :

air and substrate temperatures;
relative humidity;
ambient conditions;
painting/coating materials;
painting/coating progress;
painting/coating film thickness measure wfts,dfts;
surface profile;
surface cleanliness standard;
visual inspection;
paint material batch numbers;
any relevant comment;
item description/drawing number;
report number.

The results of adhesion tests shall be recorded. Data sheets for all coating, calibration certificate for all inspection and test equipment certificates shall be held within the Quality Department.

Wet Film Thickness. The wet film thickness comb shall be applied on an area that allows both end tabs to be in contact with the substrate.

Dry Film Thickness. Dry film thickness gauges shall be used per manufacturer's recommendations.

Adhesion Test. Each coat of a system and the complete system shall be visually inspected for adhesion and surface imperfections. If upon visual inspection loss of adhesion is suspected or found in a paint system, an adhesion test shall be carried out. Test plates shall be adhesion tested for each paint / coating system. A cross cut test or pull off test shall be used to check the adhesion of primer to substrate or inter coat.

Other requirements. All blasting, painting and coating activities shall be carried out in accordance with Manufacturer's Material Safety Data Sheets (MSDS) and product data sheets.Copies of MSDSs' and product data sheets shall be available at all locations where blasting and painting/coating activities are carried out. Manufacturer's safety precautions for their products shall be considered part of this procedure. In case of conflict, the most stringent recommendations shall apply.

Hydrostatic testing

General. After completion of the erection and NDTs, the tanks shall be subjected: to hydrotest per AWWA – D100. The following requirements shall apply:

water shall be clean and clear;
water pH shall be between 6 and 9;
water temperature shall be below 38 °C;
the tank shall be filled to the design level.

Exposure time shall be minimum 24 hours without evidence of leakage. Hydrostatic test shall be conducted and witnessed by Consultant. Consultant shall have the right to reject any equipment or parts, which do not conform to this specification.

Storage tanks placed on clay, silty or sandy subsoil should be filled in four stages.

The duration of, and the interval between, the various stages depends on the subsoil conditions and the settlement behaviour during hydrostatic testing. Soil data and settlement and stability calculations shall be available before the tank is tested. For carbon steel tanks, the tank metal temperature during hydrostatic testing shall not be colder than the design metal

temperature, as long as the water is prevented from freezing.

The settlement behaviour during and after hydrostatic testing shall be monitored. Hydrostatic test of the tank shall be conducted before permanent external piping is connected to the tank. After completion of the hydro-test, only non-structural small attachments may be welded to the tank.

Capacity and statick control

Water Filling Rate. When settlement measurements are specified by the Contractor, the maximum filling rates shall be as follows (Table 6).

Table 6 – Water Filling Rate For Hydrostatic Test

Buttom course thickness	Tank portion	Maximum filling rate
Less than 22 mm (7/8 in.)	Top course	300 mm / h (12 in. / h)
	Below top course	460 mm / h (18 in. / h)
22 mm (7/8 in.) and thiker	Top third of tank	230 mm / h (9 in. / h)
	Middle third of tank	300 mm / h (12 in. / h)
	Bottom third of tank	460 mm / h (18 in. / h)

Filling may continue while elevation measurements are being made as long as the change in water elevation for a set of readings does not exceed 300 mm.

Elevation Readings. Contractor shall make shell elevation measurements in accordance with the following:

shell elevation measurements shall be made at equally-spaced intervals around the tank circumference not exceeding 0.8 m (32 ft). The minimum number of shell measurement points shall be eight;

observed elevations shall be referred to a permanent benchmark. The level instrument shall be set up at least 1.5 times tank diameter away from the tank when tank elevation readings are taken.

Six sets of settlement readings are required:

before start of the hydrostatic test;

with tank filled to 1/4 test height (±600 mm);

with tank filled to 1/2 test height (±600 mm);

with tank filled to 3/4 test height (±600 mm);

at least 24 hours after the tank has been filled to the maximum test height;

after tank has been emptied of test water.

If settlement measurements are specified by the Contractor, any differential settlement greater than 13 mm per 10 m of circumference or a uniform settlement over 50 mm shall be reported to the Employer and Consultant for evaluation. Internal bottom elevation measurements shall be made before and after hydrostatic testing. Measurements shall be made at maximum intervals of 3 m measured on diametrical lines across the tank. The diametrical lines shall be spaced at equal angles, with a maximum separation measured at the tank circumference of 10 m. A minimum of four diametrical lines shall be used.

All elevation measurements shall be included in the Contractor's Post-Construction Document Package.

Emptying of the Tank After Hydrostatic Test. Before the test water is pumped or drained from the tank, adequate measures shall be taken to avoid a vacuum condition inside the tank. Special care should be taken if the test water is drained by gravity.

Conclusions

The proposed system of assurance management provides an opportunity to significantly reduce the losses of firm-customer as at the stage of tank construction and in the course of their operation by reducing both the natural and excess losses of petroleum products. This can lead to decrease in the cost of storing oil and oil products, and as a result – to decrease in prices for the final consumers of the oil products.

References

[1] Manual of Petroleum Measurement Standards, Chapter 19.2, Evaporative Loss from Floating-Roof Tanks 2011, *American Petroleum Institute*, 320 p.

[2] Manual of Petroleum Measurement Standards, Chapter 19.1, Evaporative Loss from Fixed-Roof Tanks 2011, *American Petroleum Institute*, 286 p.

[3] Hrudz, VYa, Hrudz, YaV, Kostiv, VV, Mykhalkiv, VB, Tarayevskyy, OS & Tymkiv, DF 2012, *Technical diagnostics of pipeline systems: monograph*, Lileya-NV, Ivano-Frankivsk, 512 p. (in Ukrainian).

[4] Kryzhanivskyy, YeI, Goncharuk, MI, Hrudz, VYa, Kozlov, AV, Kondrat, RM, Myslyuk, MA, Razumnyy, YaT, Rybchych, II & Fyk, IM 2006, *State energy security: high-performance technology production, supply and use of natural gas: monograph*, Interpress LTD, Kyiv, 282 p. (in Ukrainian).

[5] Sementsov, GN, Dranchuk, MN, Hutak, AV, Kohuch, JR, Kohutiak, MI & Kurovets, YaV 2010, *Basics of monitoring of oil and gas industry objects: teaching guidelines*, Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, 808 p. (in Ukrainian).

[6] Fadyeyeva, IG 2012, *System synergy principles of management of corporate structure of oil and gas companies: monograph*, Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, 459 p. (in Ukrainian).

[7] http://www.gazovikneft.ru/articles/poteri/

[8] Doroshenko, YuI & Luta, NV 2012, 'Overview of modern methods of calculating of the loss of oil from evaporation during storage in ground tanks', *Scientific Bulletin of Ivano-Frankivsk National Technical University of Oil and Gas*, no. 3, pp. 81–90. (in Ukrainian).

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Зарубіжний досвід управління забезпеченням якості у будівництві та експлуатації споруд для зберігання нафти

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Стаття присвячена сучасним технологіям будівництва та експлуатації споруд для зберігання нафти відповідно до системи якості міжнародних стандартів «6 sigma management». З метою зниження втрат нафтопродуктів під час зберігання обґрунтовано доцільність використання системи забезпечення якості для вітчизняних нафтовидобувних і нафтопереробних компаній. Наведено обґрунтування економічної доцільності впровадження даної системи на підприємствах нафтогазового комплексу.

Ключові слова: *безпека здоров'я і навколишнього середовища, будівництво нафтосховищ, випаровування, втрати нафти, гідростатичне випробування, зниження втрат, управління забезпеченням якості.*