

	<p>نگهداشت و افزایش تولید میدان نفتی بینک</p> <p>سطح الارض و ابنیه تحت الارض</p> <p>عمومی و مشترک</p>								
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طرح نگهداشت و افزایش تولید ۲۷ مخزن

SPECIFICATION FOR STORAGE TANK FOUNDATION

نگهداشت و افزایش تولید میدان نفتی بینک


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IFC: Issued For Comment
IFA: Issued For Approval
AFD: Approved For Design
AFC: Approved For Construction
AFP: Approved For Purchase
AFQ: Approved For Quotation
IFI: Issued For Information
AB-R: As-Built for CLIENT Review
AB-A: As-Built –Approved

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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields CLIENT (NISOC)
PROJECT:	Binak Oilfield Development – General Facilities
EPD/EPC CONTRACTOR(GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR(GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

2.0 SCOPE

This Specification covers the minimum requirements for construction of foundations for Storage Tanks.

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The Construction Contractor shall furnish all materials, tools, equipment, utilities, facilities, and etc. He shall perform all labor and services necessary for the proper execution and completion of foundation for storage tanks, all as shown on the drawings, as specified herein and/or reasonably implied thereby to carry out the apparent intent of the work. The Construction Contractor shall follow the Specification for site preparation and earthwork in all stages of foundations' execution and completion.

Compliance with this Specification does not relieve the Construction Contractor from his own responsibilities and guarantees nor from any further contract obligations.

Material and workmanship not conforming to the design drawings and specifications may be rejected at any time when such defects are found.

This Specification includes:

- Excavation as required, supply and installation of all fill material, gravel and asphaltic concrete for tank foundations
- Disposal of surplus excavated material
- Application of weed killer to the subgrade


3.0 NORMATIVE REFERENCES

3.1 LOCAL CODES AND STANDARDS

- INBC Part 9 Iranian National Building Code, Part 9 (4th edition)
- IPS-C-CE-112 Construction Standard for Earthworks
- IPS-C-CE-120 Construction Standard for Foundations
- IPS-E-CE-120 Engineering Standard for Foundations
- IPS-E-CE-130 Engineering Standard for Piles

3.2 INTERNATIONAL CODES AND STANDARDS

- ACI-318M Building Code Requirements for Structural Concrete and Commentary
- AASHTO- M226 Standard Specification for Viscosity Graded Asphalt
- ASTM – C33-95 Standard Specification for Concrete Aggregates
- ASTM – C131 Test method for resistance to degradation of small Size coarse aggregates by abrasion and impact in The Los Angeles machine
- ASTM – C150 Specification for Portland cement
- ASTM – D5-95 Test Methods for Penetration of Bituminous Content

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- ASTM-D242-95 Standard Specification for Mineral Filler for Bituminous Paving Mixtures
- ASTM-D692 Standard Specifications for Bituminous Paving Mixtures
- ASTM-D698-91 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
- ASTM-D1073-94 Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
- ASTM-D1557-9 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM-D1559-89 The Method for Resistance To Plastic Flow of Bituminous Mixtures Using Marshal Apparatus
- ASTM-D2027-76 Standard Specification for Cutback Asphalt (Medium Curing Type)
- ASTM-2028-76 Standard Specification for Cutback Asphalt (Rapid-Curing Type)
- ASTM-D3282 Standard practice for classification of soils and soil
- API 650 Standard for Welded Steel Tanks for Oil Storage

3.3 THE PROJECT DOCUMENTS

- BK-GNRL-PEDCO-000-CV-SP-0004 Specification for Earth Work
- BK-GNRL-PEDCO-000-ST-SP-0001 Specification for Concrete Works

3.4 ENVIRONMENTAL DATA


Refer to "Process Basis of Design; Doc. No. BK-GNRL-PEDCO-000-PR-DB-0001".

3.5 ORDER OF PRECEDENCE

In case of any conflict between the contents of this document or any discrepancy between this document and other project documents or reference standards, this issue must be reported to the CLIENT. The final decision in this situation will be made by CLIENT.

4.0 DESIGN

Tanks shall be supported on tank pad foundations except tanks in process and / or utilities areas, which may be supported on concrete foundations or concrete ring walls.
For tanks which require anchor bolt with internal diameter ≥ 5 m, concrete ring wall shall be considered. Concrete mat foundations shall be used when tank internal diameter is < 5 m.

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. Tank pad foundation design for all storage tanks shall take into account the following:

- The height of the tank pad foundation above the highest level of the bunded area floor shall be a minimum of 0.60 m plus the total predicted settlement of the tank over 30 years and designed following soil investigation data.
- At the top of the foundation, the diameter of the foundation shall be minimum $D + 3$ m (with D = the nominal tank diameter for single shell tank and $D + 4$ m with D = diameter corresponding to the outer shell for double shell tanks, if any).
- External slope of the tank pad shall be 2 (horizontal) for 1 (vertical). The top of the shoulder shall have a slope of 1:10 from the steel shell (or outer shell) of the tank.
- Top of the tank pad foundation shall be sloped in accordance with the data of the tank manufacturer.

All hydrocarbon tank pads (excluding water tanks and sulphur tank) shall be provided with a leak detection system consisting of a HDPE continuous membrane, which shall be installed extending beyond the area of the tank bottom plate. A drain sump fabricated from HDPE shall be installed below the tank sump as an integral part of the membrane. A 100 mm diameter PVC or HDPE pipe sleeve complete with 25 mm diameter internal PVC telltale drain pipe shall be routed from the sump to the leak detection pit located on the periphery of the tank pad. A Geotextile filter cloth membrane shall be installed below the HDPE membrane.

The tank pad shall consist of a foundation ring (i.e. the shoulder and the zone under the tank shell for a distance of 1 m on the inside of the tank from the inner shell of tank) of crushed rock or similar granular material (or a concrete ring beam for tanks with a diameter between 3 and 5 m), under the tank shell. The tank pad body foundation inside the foundation ring shall be well-compacted granular material.

A minimum 50 mm thick sand bitumen mix layer shall be applied to the top of the tank pad to the extent of the tank external radius of the base plate +100 mm. For Sulphur tank, this layer shall be replaced by an oily sand layer, 50 mm thick. Before installation of these layers, tank pad foundations shall be primed and coated.

External to the tank diameter (or outer shell for double containment tank) +100 mm, top and side slope of the tank pad foundation shall be covered with a 100 mm thickness of reinforced concrete with one layer of wire mesh. This layer shall be deleted when a concrete ring wall or full concrete foundation is considered.

5.0 CONSTRUCTION OF TANK PADS

5.1 GENERAL

Material for tank pads shall consist of gravel, or the approved excavated material and/or other material approved by the Engineer subject to the gradation given below and shall be free of rock, trash, lumber or other debris.

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5.2 EXCAVATION

The soil shall be excavated down to the level indicated on the design drawings. The slope at edges of the cut shall be 1 (horizontal) for 2 (vertical).

Where the bulk or local excavation will extend below the ground water table, measures shall be taken to lower the ground water table to at least 0.5 m below the excavation level.

Ground water lowering shall be carried out in accordance with Project Specification Document No: BK-GNRAL-PEDCO-000-CV-SP-0004 "Specification for Earth work". The excavated material shall be stored apart on site for material, which may be reused, or sent to an approved dump area for unusable material.

5.3 STOCKPILING & DISPOSAL OF MATERIAL

Excavated material which is approved for backfill shall be stockpiled at a location adjacent to the construction site to be selected by the Construction Contractor and approved by the Engineer. No stockpiling of topsoil and unapproved material is allowed on the construction site. All surplus backfill material and unapproved materials shall be transported off the construction site immediately to a location, which will be selected by the Engineer.

5.4 COMPACTION OF THE BOTTOM OF EXCAVATION

The surface of excavation shall be properly compacted prior to the start of filling operation.

Method of filling and control of compaction and elevation shall be in accordance with paragraphs 5.7. through 5.10.


5.5 MATERIAL FOR TANK PADS

5.5.1. Crushed Rock or Granular Material

Material for the tank pads shall be well-graded granular material with a fine content (passing # 200 sieve) not exceeding 10% by weight.

The grading requirement shall be within the following limits:

Sieve Designation	% By Weight Passing
3 Inch	100
2"	95 -100
1"	75 - 95
3/8"	40 -75
No. 4	30 - 60
No. 10	20 - 45
No. 40	15 -30
No. 200	0 - 10

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The natural gravel or crushed stone when specified for the ring under the tank periphery shall not contain any fine and shall be in accordance with the requirements of API Standard 650. The gravel size shall be within 10mm minimum, to 25mm maximum. The compaction shall be attained by applying a 6 ton roller several times over the ring to achieve adequate stability and strength compatible with the tank base coarse material. Remove topsoil and natural soils to the required depth.

Before placing fill, check the surface for soft spots and water pockets. Remove and replace with compacted approved material.

The crushed rock shall have the following characteristics:

sieve: 10 / 38 mm

The sieve envelope shall be as follows:

%of elements passing through mesh	Min	Max
38mm	80	100
28mm	60	90
20mm	30	70
14mm	10	30
10mm	5	15



5.5.2. Sand Bitumen

The Sand Bitumen top layer shall be of a consistency material with following specifications:

1) Sand

Sand shall be fine sand in accordance with the ASTM D 3282 group A3.

2) Binder

Bitumen grade 60 / 70.

3) Oily Sand

- Sand

Sand shall be fine sand in accordance with the ASTM D 3282 group A3.

- Binder

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Fuel oil; percentage of binder (in volume) shall be 3: 1 to 5: 1 (Sand: Oil).

Mixing shall be cold mix type.

5.5.3. Prime Coating

Cut back MC 70 or MC 250.

5.5.4. HDPE Sheet

HDPE sheet shall have a 2 mm thickness.

5.5.5. Leak Detection Pipes

GRP, PVC or HDPE pipes.

5.5.6. Geotextile Filter Cloth Membrane

Geotextile shall have a size distribution of pore openings such that the mean filtration opening O90 is between 100 and 300 microns. (For hydrocarbon storage tanks)





5.6 APPROVAL OF MATERIALS

All materials to be used in the construction shall be supplied by EPC CONTRACTOR.

EPC CONTRACTOR shall supply all characteristics of materials before use for approval by CLIENT.

This shall include the following items (not to be considered as limitative).

- Granular material
 - Lithology - location of borrow pits
 - Sieve analysis
 - Atterberg limits
 - Water content
 - Optimum moisture content
 - Salt content
 - Los Angeles coefficient
 - Organic matter content
- Sand bitumen mix
 - Gradation of sand
 - Types of bitumen or binder
 - Composition of sand bitumen mix
 - Results of Marshall Tests
- Characteristics of prime coating. (For hydrocarbon storage tanks)
- Characteristics of HDPE (High Density Poly Ethylene) sheet. (For hydrocarbon storage tanks)

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- Characteristics of geotextile filter cloth membrane. (For hydrocarbon storage tanks)

5.7 FILLING

The tank foundation ring shall be made of granular material in accordance with paragraph 5.5. Granular material for tank pad body, above HDPE membrane and inside foundation ring wall shall a fine to coarse sand. (For hydrocarbon storage tanks)

These materials shall be placed in layers not thicker than 150 mm after compaction, with each layer being watered to bring it to its optimum moisture content and then compacted before the next layer is placed.

The moistening agent shall be fresh desalinated water. The spreading of the water shall be carried out using a suitable sprinkler system. The chlorides content of water shall be a maximum of 0.3%.

5.8 METHOD FOR PLACING THE FILL MATERIAL

The compaction shall be performed with suitable rollers: heavy pneumatic tired roller compactor or heavy vibrating compactor.

The equipment used: type, quality, number... must receive the previous approval from CLIENT.

The number of passes shall be determined after trial tests, in agreement with CLIENT.

The compaction operation shall start from the external boundary of the portion to be treated towards the center, along the radial direction of the slope of the pad.

5.9 COMPACTION CONTROL

The degree of compaction and density for earthwork shall be determined and controlled in accordance with the requirement of ASTM D1557 and earthworks Specification. It shall be the responsibility of the Construction Contractor and the Laboratory to perform the necessary tests to ensure that a properly compacted fill is obtained. A minimum 24 hours advance notice shall be given to the Engineer to supervise the testing.

The degree of compaction and density shall be carried for each layer prior to approval of next layer.

5.10 CONTROLS

Control checks shall be carried out at the following frequency:

5.10.1. On the Fill Material

- sieve analysis
- moisture content
- Atterberg limits (for each 500 m³ of material)
- salt content

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- sand equivalent

5.10.2. Compaction Controls

Density measurements shall be performed on site by nuclear density gauge or by the rubber balloon method or any other relevant method adapted to the nature of the soil and described in international codes (ASTM) and approved by CLIENT.

CLIENT shall approve the type of equipment.

These tests shall be carried out on the graded tank foundation and for each layer of compacted soil after compaction on the basis of one test per 500 m² (with a minimum value of 3 tests) at locations defined by CLIENT.

In addition to density measurements:

- Plate loading tests shall be performed on the graded (excavated) tank foundation base before the placement of the first fill layer and on the fill layers with the following procedure based on the plate diameter.
 - for plate 300 mm diameter : tests every two (2) spread layers
 - for plate 450 mm diameter : tests every three (3) spread layers
 - for plate 600 mm diameter (and more) : tests every four (4) spread layers

On the excavated tank base, and on each tested layers, two (2) plate loading tests shall be performed with pressure varying from 0.0 to 0.3 MN/m² (in one single stage) for small tanks (tanks with diameter ≤ 30 m) and four (4) plate loading tests for large tanks (tanks with diameter > 30 m).

CLIENT shall indicate the location of these plate loading tests, which shall cover the entire surface of the layer.

5.10.3. Results:

- Density measurements

The value of 95% of MDD (Maximum Dry Density - Modified Proctor) according to ASTM D 1557 shall be obtained for all measures at the graded tank foundation level and in the tank pad foundation.


- Plate loading tests

The elastic module of soil shall be:

> 30 MN/m² for the graded excavated tank foundation base and internal filling.

> 50 MN/m² for the tank pad foundation ring (but > 70 MN/m² for the final layer at top)

For the design, the following formula shall be used:

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$$E = \frac{1.5Q \times B}{2s} \times (1 - u^2)$$

With:

E: elastic modulus (MN/m²)

s: settlement (m)

B: plate diameter (m)

u: Poisson's coefficient = 0.3

Q: stress under the plate (MN/m²)

5.10.4. Elevation and Thickness Controls

The fill area shall be controlled on a grid of 10 x 10 m.

- The maximum acceptable variation of thickness in relation to the prescribed thickness shall be: ± 50 mm (for each layer).
- The maximum acceptable variation of levels in relation to the finished prescribed levels shall be: ± 13 mm at the base of the surfacing layers (sand bitumen and sand / bituminous / cement).
- Where a concrete ring wall is provided under the shell, the top of the ring wall shall be within ± 3 mm in any 10 m of the circumference and within ± 6 mm in the total circumference measured from the average elevation.

5.10.5. Sand Surfacing



The surface of the tank foundation ring in crushed rock shall be closed with fine sand in order to obtain a smooth surface before installation of geotextile and HDPE membrane. Sand in accordance with paragraph 5.5.2. May be used for this purpose. Compaction shall be with a light or medium compactor.


5.10.6. Prime Coating

Before sand bitumen or oily sand and concrete covering surfacing is done, the top surface and the slope of the tank pad shall be sealed with cut back to be applied on slightly wet areas.

Cut back in accordance with paragraph 5.5. shall be spread at a rate of 1.5 to 2.0 kg/m².

The quantity shall be defined in relation with the possibility of absorption of the material of the tank pad for 8 hours duration.

The prime coat shall penetrate 1 to 2 cm into the compacted fill. The pouring equipment shall be equipped with a device allowing for uniform covering of sealer on an adjustable width and

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with a proportioning pump allowing for a constant pressure pouring of the seal.

Overproofing of the sealing coat shall be avoided on longitudinal joints. Traffic shall be forbidden on the sealing coat during drying period. In areas where over pouring of prime coat occurred, the excess shall be broomed or raked away and surface properly leveled.

5.10.7. Surfacing of the tank pad foundation

5.10.7.1. Material

Surfacing material shall be sand bitumen or oily sand and concrete covering. It shall be laid on compacted primed fill. The surfacing material shall cover the tank foundation to 1.5 m outside of the tank pad foundation.

5.10.7.2. Sand Bitumen or Oily Sand

Sand bitumen or oily sand in accordance with paragraph 5.5. shall be compacted using a light or medium weight roller.

5.10.7.3. Concrete Surfacing

Outside sand bitumen (or oily sand) the top and side slopes of the tank pad foundations shall be covered with a 100 mm thickness of reinforced concrete with one layer of wire mesh on a geotextile layer. Concrete and wire mesh shall be in accordance with the project

“Specification for Concrete Work” Doc No: BK-GNRAL-PEDCO-000-ST-SP-0001, geotextile shall be in accordance with paragraph 5.5.4.

5.10.7.4. Control of Thickness for Surfacing

The surfacing thickness shall be controlled:

- with a metallic rod while spreading is done and before compaction
- on the border of the layer just spread and compacted
- with core sampling.


The required tolerances are as follows:

- theoretical thickness :
5 cm for the sand bitumen or oily sand.
- absolute minimum thickness :
4 cm for the sand bitumen or oily sand
- maximum thickness :
5.5 cm for the sand bitumen or oily sand

Finally, the mean thickness obtained by dividing the fabricated tonnage by the surfaced area shall permit to verify if the thickness is close to ± 10 % of the theoretical one.

5.10.8. Leak detection pipes

Leak detection pipes shall be placed in accordance with the drawing. They shall project from the external face of the tank pad foundations for a minimum of 100 mm.

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5.10.9. Concrete works

All concrete works shall be in accordance with the “Specification for Concrete Work Doc. No: BK-GNRAL-PEDCO-000-ST-SP-0001”.

5.11 TOLERANCE

Tolerances shall be in accordance with API 650 Chapter 7.5.5.

5.12 CATHODIC PROTECTION

For cathodic protection system requirements (if any), refers to “Specification for Cathodic Protection System Doc. No: BK-GNRAL-PEDCO-000-EL-SP-0016”.

5.13 PROTECTION DURING CONSTRUCTION

For the construction of the tank, the side of the tank foundation shall be protected with a 2 m wide embankment. A geotextile membrane or polyethylene sheet shall be placed between the tank

foundation and this embankment. This embankment (Including the geotextile or polyethylene sheet) shall be removed after the water test at the end of the construction.

This embankment shall be made of material extracted during the excavation. No heavy compaction is required.

6.0 TANK DIKES

6.1 GENERAL HYDROCARBON TANKS

These tanks shall be enclosed in a bounded area with separate compartments if required.

In case, the tanks dike areas are to backfilled or cut, the corresponding earthworks shall be in accordance with “Specification for Earth work, Document No: BK-GNRAL-PEDCO-000-CV-SP-0004”.

The finished level of the tank dike shall be provided with a minimum slope of 1% going down from the tank pad foundation to the bund wall base.

The dike floor shall be covered by a concrete paving with a thickness of 100 mm. For paving Please refer to “Specification for Road & Paving , Document No: BK-GNRAL-PEDCO-000-CV-SP-0002”

6.2 DOUBLE-SHELL TANKS

No dikes are to be provided for the double shell tanks, if any. A general slope shall be considered for the surface water drainage.

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6.3 WATER TANKS

No dikes to be provided for water tanks. A general slope shall be considered for the surface water drainage.

7.0 BUNDWALLS

7.1 DESCRIPTION

Bund walls shall be constructed with side slopes of 2 (horizontal) for 1 (vertical). The height of the bund walls shall be determined from the volume of liquid to be retained plus a free board of 0.3 m after allowing for total long term settlement (over 30 years).

The minimum width at the top of bund walls shall be 0.6 m. The final arrangement of bund walls is to be finalized during the detail engineering phase.

No bund walls shall be considered for double shell tanks if any and water tanks. Preferably, no pipe shall penetrate the bund wall. Such penetration should be unavoidable, construction details

shall be developed to ensure that the wall remains leak proof and they shall be submitted to the CLIENT for approval. In the utilities area, concrete walls shall replace bund walls.

7.2 CONSTRUCTION

Sloping ground shall be graded to provide a good key. The overburden shall be removed down to approved formation level, to effect a good key. The grade below the bund walls shall be scarified to a depth of 150 - 300 mm, moisture conditioned and compacted to an average density of not less than 95% of the maximum dry density (MDD), with no individual test result less than 90% of MDD, as per ASTM D 1557 (Modified Proctor).

Bund walls shall be made with natural soil (sandy gravels) but shall not contain more than 2% of organic matter or any other detrimental elements.

Fill in bund walls shall be deposited in layers not exceeding 200 mm loose depth, moisture conditioned and compacted to an average density of not less than 90% of MDD, with no individual test result less than 85% of MDD, as per ASTM D1557 (Modified Proctor).

Compaction tests for bunds shall not be less than one set of 3 No. field density tests per 100 meter length of bund or per 200 m³ of soil.

Bund walls shall be constructed oversize (minimum 0.5 m) and trimmed to the profiles shown on drawings following compaction.

Any openings formed or left for pipelines or other purposes shall be terraced at 200 mm vertical intervals. Each terrace shall be 600 mm wide with 30° slope between terraces.

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Compacted material adjoining such openings shall be adequately protected against ingress of water, and the openings shall be filled and thoroughly compacted to the same consistency as the remainder of the bund.

Bund walls shall be covered with a filter cloth membrane. A 100 mm thickness of reinforced concrete with one layer of wire mesh shall be applied to the sides and top of the bund walls.

Concrete shall be in accordance with Project Doc. No.: "BK-GNRAL-PEDCO-000-ST-SP-0001 ,Specification for Concrete Work".

Concrete layer (100 mm thick) and joints shall be in accordance with "Specification for Road & Paving , Doc. No: BK-GNRAL-PEDCO-000-CV-SP-0002"

On the external side of the bund walls, one line of weepholes shall be provided. They shall be 25 mm inside diameter PVC pipes approximately 500 mm long at 1 (Vertical) for 10 (horizontal) slope. They shall be located 100 mm above the base of bund walls at 3 m maximum centers.

Bund walls shall be properly shaped to the required elevations. The elevation of any point and the line of any edge or center of the bund walls shall conform to that shown on the drawings within the tolerances stated below.

Tolerances from True Level	Tolerances from True Line
+ 75 mm	+ 75 mm
- 0	- 75 mm

8.0 TANK ANCHORAGE

When a tank is required to be anchored according to Appendix E&F (API 650), or when a tank is anchored for any other reason, the following minimum requirements shall be met.

Anchorage shall be provided to resist each of the uplift load cases listed in Table 5-21a & 5-21b(API 650). The load per anchor shall be:


Where: $t_b = U/N$

t_b = load per anchor,

U = net uplift load per table 5-21a & 5-21b

N = number of anchors

When mechanical anchorage is required, at least six anchors shall be provided.

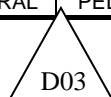
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The spacing between anchors shall not exceed 3 m (10 ft).

Allowable stresses for anchor bolts shall be in accordance with Table 5-21a & 5-21b for each load case. The allowable stress shall apply to the net (root) area of the anchor bolt.

For more information of tank anchorage please refer to API 650 (Clause 5.12).

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APPENDIX 1

HYDROCARBON TANK TYPICAL FOUNDATIONS

