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| GP 04-08-01 | Tank Foundations | March 2005 |
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# Tank Foundations

## GP 04-08-01

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### Scope

[I] This Global Practice (GP) covers the design and construction of foundations for atmospheric storage tanks, refrigerated storage tanks, and carbon steel tanks in sulfuric acid service.

[I] An asterisk (\*) indicates that additional information is required. If a job is contracted, this information is furnished in the Job Specification.

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## 1. Required References

- 1) [I] This Section lists the Practice that is referenced and assumed to be a part of this document. Unless otherwise specified herein, use the latest edition.
- 2) \* [I] Local codes and standards may be substituted for the ones referenced herein provided the following provisions are met:
  - a) The resultant design meets the safety and serviceability criteria attained through this practice.
  - b) Substitution is accepted by the authorities where the facility is to be located and by the Owner's Engineer.

### 1.1. Global Practices–ExxonMobil Engineering Practices

|                             |                                |
|-----------------------------|--------------------------------|
| <a href="#">GP 04-01-03</a> | Design Loads for Structures    |
| <a href="#">GP 04-09-01</a> | Site Preparation and Earthwork |

## 2. Additional References

- 1) \* [I] The following Practices and Standards shall be used with this Practice as applicable.
- 2) \* [I] Local codes and standards may be substituted for the ones referenced herein provided the following provisions are met:
  - a) The resultant design meets the safety and serviceability criteria attained through this GP.
  - b) Substitution is accepted by the authorities where the facility is to be located and by the Owner's Engineer.

### 2.1. Global Practices–ExxonMobil Engineering Practices

|                             |                                                         |
|-----------------------------|---------------------------------------------------------|
| <a href="#">GP 04-01-01</a> | Concrete Design and Construction                        |
| <a href="#">GP 04-06-01</a> | Reinforced Concrete Foundations, Anchor Bolts and Grout |
| <a href="#">GP 04-07-01</a> | Piles and Sheet Piling                                  |
| <a href="#">GP 09-06-01</a> | Refrigerated Storage Tanks                              |
| <a href="#">GP 19-05-01</a> | Cathodic Protection                                     |

### 2.2. AASHTO–American Association of State Highway Transportation Officials

|             |                                                                                                                          |
|-------------|--------------------------------------------------------------------------------------------------------------------------|
| AASHTO T166 | Standard Method of Test for Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens |
|-------------|--------------------------------------------------------------------------------------------------------------------------|

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## 2.3. ACI–American Concrete Institute

|              |                                                                                              |
|--------------|----------------------------------------------------------------------------------------------|
| ACI 318/318R | Building Code Requirements for Structural Concrete (ACI 318-02) and Commentary (ACI 318R-02) |
|--------------|----------------------------------------------------------------------------------------------|

## 2.4. API–American Petroleum Institute

|                     |                                                                                              |
|---------------------|----------------------------------------------------------------------------------------------|
| API STD 650         | Welded Steel Tanks for Oil Storage                                                           |
| API STD 650, App. B | Recommendations for Design and Construction of Foundations for Aboveground Oil Storage Tanks |
| API STD 650, App. E | Seismic Design of Storage Tanks                                                              |
| API STD 650, App. I | Undertank Leak Detection and Subgrade Protection                                             |

## 2.5. ASTM–American Society for Testing and Materials

|                   |                                                                                                                                                            |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM B 418        | Standard Specification for Cast and Wrought Galvanic Zinc Anodes                                                                                           |
| ASTM C 192/C 192M | Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory                                                                          |
| ASTM D 448        | Standard Classification for Sizes of Aggregate for Road and Bridge Construction                                                                            |
| ASTM D 693        | Standard Specification for Crushed Aggregate for Macadam Pavements                                                                                         |
| ASTM D 1556       | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method                                                                  |
| ASTM D 1557       | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2,700 kN-m/m <sup>3</sup> )) |
| ASTM D 2167       | Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method                                                             |
| ASTM D 2922       | Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)                                                   |
| ASTM D 2937       | Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method                                                                             |

## 3. General

- 1) [R] Earth subgrade preparation, placement of fill, and compaction requirements shall be per [GP 04-09-01](#).
- 2) [R] Where concrete ringwalls are provided under the shell, they shall be designed in accordance with API STD 650, Appendix B, and ACI 318/318R, taking into consideration predicted settlements.

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## 4. Pad Construction for Atmospheric Storage Tanks

- 1) [O], [R] Pad construction shall be per Figure 1, Figure 2, or Figure 3. If flush type nozzles are used, there shall be a minimum 2 in. (50 mm) clearance beneath the flange of the nozzle.
- 2) \* [I] Predicted settlement to be used in establishing foundation pad height will be specified.
- 3) [R] Pads equipped with a ringwall are required for the following conditions:
  - a) Tanks larger than 120 ft (36.5 m) in diameter
  - b) Tanks higher than 48 ft (14.6 m) with diameters of 100 ft (30 m) or larger
  - c) When a cohesionless soil will be used as general fill, the minimum size tank requiring a ringwall will be specified.
- 4) [R] Acceptable materials for stone ringwall construction, below the top 4 in. (100 mm) zone of graded crushed stone or crushed gravel, include any crushed stone or crushed gravel size numbers 2, 24, 3, 357, 4 or 467 (ASTM D 448) that meets the requirements of ASTM D 693 for crushed aggregate. Proposals to use other gradations or materials shall be approved by the Owner's Engineer. Crushed slag shall not be used.
- 5) [R] A reinforced concrete ringwall is acceptable, provided a tank shell settlement of 2 in. (50 mm) or less is expected and details in Figure 3 are applied. If site-specific experience has demonstrated satisfactory performance of concrete ringwalls for larger shell settlements, then the use of concrete in lieu of crushed stone can be considered in these cases as well.
- 6) [O], [R] The average elevation of finished pads, measured at the tank shell, shall be within a tolerance of 1 in. (25 mm) of that shown on the construction drawings.
- 7) [O], [R] Tank pad elevation differences, measured at the shell, shall not exceed any of the following:
  - a) 1:720 in any distance of 30 ft (10 m) or more.
  - b) 1 in. (25 mm) between the highest and lowest elevation points.

To achieve these tolerances, it may be helpful to either choke surface voids in a crushed stone ringwall with fine aggregate of gradation Size No. 10 (ASTM D 448), or excavate a portion of the crushed stone and place a layer of unreinforced or fiber-reinforced mortar having maximum dimensions of 1 ft (300 mm) wide by 2 in. (50 mm) thick.
- 8) [O], [R] Deviations from the specified slope of the pad within the tank shell shall not exceed 1:720 in a horizontal distance of 30 ft (10 m) or more.
- 9) [O] Apex-down cone bottom tanks shall have a drain pipe installed to remove rainwater during construction. The pipe shall empty into a water drawoff manhole, rainwater sump, or other location as specified. The inlet to the drain shall be per API STD 650.
- 10) [O], [E] Bottom leak detection facility: All new tank pads shall be equipped with a bottom leak detection facility consisting of a synthetic membrane, a collection sump, and a drain pipe, and specified in accordance with API STD 650, Appendix I.
  - a) The requirement for a leak detection system may be waived if the tank contains clean water, a product not fluid at ambient temperature, or if the temperature of the tank is sufficiently high to jeopardize the integrity of the membrane.

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