TANK SUPPORT DESIGNS
SPREADSHEET USER INSTRUCTIONS

- Designs are provided for International Building Code (IBC) 2003 and 2009 Editions. You must determine which code is applicable in the area where the tank will be installed.

NOTES:
- There is now a “RUN CALCULATIONS” button that MUST be hit to execute a visual basic program. This was done to eliminate a problem with circular calculations.
- You MUST enable macros to allow this calculate button to work. At the top of the spreadsheet, you will see

  ![Security Warning: Macros have been disabled.](options.png)

  Click on “Options” and choose “Enable this content”

Fireguard saddle and foundation designs
See the “Foundation Input” tab on the spreadsheets for the difference between a “Pier” and a “Footing.” Choose the spreadsheet for IBC 2003 or 2009 as applicable to the location where the tank will be installed.

Rectangular tanks foundation designs
Designs for each “Mapped Spectral Acceleration” are provided on separate spreadsheets. “Mapped Spectral Acceleration” is a term used in the IBC 2003. This factor is only needed for earthquake (seismic) designs.

UL 142 tanks saddle and foundation designs
See the “Foundation Input” tab on the spreadsheets for the difference between a “Pier” and a “Footing.” Choose the spreadsheet for IBC 2003 or 2009 as applicable to the location where the tank will be installed.

UL 142 vertical tank design
A separate computer program to design vertical tanks on legs and skirts is available for purchase through STI. This program has the added benefit in that you will be able to apply a UL Listing label to these tanks. They are designed using ASCE 7-05, WRC-107, AISC 8th Edition, API-620 11th Edition, and Pressure Vessel Design Manual by Dennis Moss 2nd Edition. Contact Dana Schmidt at dschmidt@steeltank.com for more information.

NOTES FOR ALL SPREADSHEETS
1. All designs based on "trial and error" approach - input the design of a proposed tank and then see if it works. If no "ERROR STATEMENTS" are displayed the design passes.
2. Tank design must be completed prior to designing supports. Minimum shell and head thicknesses and other requirements shall be per the applicable code.
3. The design is valid for atmospheric tanks without corrosion allowance only.
4. Saddle inputs must be completed and checked for validity before Foundation inputs can be completed and checked for validity. The Saddles can be designed without designing Foundations.
5. Tank head depth is assumed to be 0.625" for flat flanged heads. This is the distance from the outside of the head to the end of the radius portion of the head created by flanging the head. It can be set to zero as a minimum if desired.
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6. The saddle location, "A" is the distance from the end of the outer tank to the center of the saddle. It cannot exceed the diameter of the tank divided by 4, nor can it be less than the width of the saddle wear plate divided by 2.
7. The saddle contact angle is the total angle of the saddle itself. This cannot be less than 120° nor more than 168°.
8. The saddle width is the total width of the saddle above the base plate. The saddle height is the distance from the center of the tank to the bottom of the base plate of the saddle.
9. The base plate thickness is the thickness of the bottom base plate.
10. The wear plate thickness is the thickness of the wear plate attached to the tank between the saddle and the tank.
11. The web plate thickness is the thickness of the back, vertical, curve cut plate that extends between the base plate and the wear plate.
12. The rib plate thickness is the thickness of the vertical ribs that are attached to the web plate and extend between the base plate and the wear plate. It is the same thickness as the web plate.
13. There is a rib plate at each of the outer edges of the web plate. In addition, Saddle Variables E1 and RS designate how many internal ribs must be added and their spacing respectively.
14. Saddle variable L specifies the minimum length the saddle wear plate must be for this design.
15. The "Additional Loads" are loads other than the weight of the tank shell and contents. This would include loads imposed by platforms and equipment. If the loads are not centered on the tank, then multiply the load by 2 for maximum load per saddle.
16. The Yield Strength of the shell and saddle material is dependent upon the grade of material being used. For A36 material this would be 36000. The shell and saddle may be of different material.
17. The Modulus of Elasticity of the shell and saddle material is dependent upon whether it is carbon steel or stainless steel. For carbon steel it is usually set at 29,000,000.
18. The Wind Speed is obtained either from the customer or taken from ASCE7-05, or ASCE7-10 Code, as applicable, or from local codes. This value ranges from 70 to 130.
19. The Exposure is determined by the area surrounding the tank. Exposure D is the worst case.
20. Exposure B has terrain with buildings, forest or surface irregularities, covering at least 20% of the ground level area extending 1 mile or more from the site Exposure C has terrain which is flat and generally open, extending one-half mile or more from the site in any full quadrant. Exposure D represents the most severe exposure in areas with basic wind speeds of 80 miles per hour or greater and has terrain which is flat and unobstructed facing large bodies of water over one mile or more in width relative to any quadrant of the building site. Exposure D extends inland from the shoreline 1/4 mile.
21. The Seismic values are obtained from the customer, taken from ASCE7-05, or ASCE7-10 Code, as applicable, from local codes or determined by some other method. The Mapped Spectral Acceleration values are to be given by the customer or determined from ASCE7-02 based on the installation location of the tank.
22. The wind calculation variables Ce, Cq, qs, Iw, and Pw are based upon ASCE7-05, or ASCE7-10 Code, as applicable. The remainder of the values are from the Pressure Vessel Design Manual.
23. The seismic calculation variables are based upon ASCE7-05, or ASCE7-10 Code, as applicable, or the Pressure Vessel Design Manual.
24. Check the "Validation Statements" for any conditions that exceed the limits. Review the notes attached to the particular statement for suggestions on correcting the condition.
25. All welds shall be continuous with 3/16" minimum leg size.

Foundations
1. All designs based on "trial and error" approach - input the design of a proposed tank and then see if it works. If no "ERROR STATEMENTS" are displayed the design passes.
2. Saddle inputs must be completed and checked for validity before Foundation inputs can be completed and checked for validity. The Saddles can be designed without designing Foundations.
3. The structure classification is set to III or IV per ASCE7-05, or ASCE7-10 Code, as applicable.
4. Concrete compressive strength (f'c) shall be specified by the customer. Cannot exceed 4000 psi.
5. The allowable soil bearing shall be specified by the customer.
6. The rebar yield strength is set at 40,000 psi minimum and cannot exceed 80,000 psi.
7. Footing width and length must exceed the saddle base plate width and length.
8. Footing depth is to be determined by calculation and/or as specified by the customer or local codes. Frost depth must be taken into consideration.
9. Rebar spacing should be kept to 18" maximum for the footing. There must be a minimum of 2 bars running in each direction.

Frequently asked questions (FAQ's)
1. Q - Can a horizontal tank be sloped so that one end is lower than the other – one saddle would be fabricated shorter than the other.
   A - If you have only the dead load of the tank as a design requirement, then the saddles can probably be the same. Expect the thickness required for the shorter saddle to be adequate for the higher saddle. If you have only a wind design, then there might be a difference depending upon the wind velocity and how closely the shorter saddle has been designed to the required values. If you have seismic design, then it is likely that there will be a difference in the design. This is because of the horizontal forces. Because of the additional height you are increasing the moment by almost 25%. This is significant.
2. Q – Can you design a saddle with no clearance between the wear plate and the base
   A – This will not work except on very small diameter tanks because of the splitting force on the saddle.
3. Q – Can the web plate and the rib plates to be of different thicknesses.
   A - This program was not designed to be a "do anything I want" type of program. It is possible to design the web and rib plates as different thicknesses but the program gets much more complex. The program was not designed to do everything that anyone might want to try to do. It was designed to do the vast majority of what people wanted.
4. Q – How do I design a double-wall vertical tank (or vertical Fireguard tank) on legs?
   A – The current program is not designed for this application.
5. Q – Can a saddle be made by putting in 6 web plates underneath the saddle instead of the 4 that are shown in the STI design.
   A - The picture is only a sketch. It does not show the number of plates required for every size saddle. At the bottom of the input screen there is the sketch with dimensions. In the table "RS" is the spacing between the stiffeners and "E" is the number of interior ribs. The two outer ribs are in addition to these.
6. Q - Was trying to do a 2 saddle calculation 12' dia. x 14' long tank and as you can see, per the attached spreadsheet, I put ridiculous steel gauges, saddle widths etc. and still have errors in the invalidation section.
   A - The problem stems from the fact that cell B30, wind speed, says to use the UBC figure for determining the wind speed. That map, which is part of the spreadsheet, does not have a wind velocity less than 70 mph. Because of the way that values are determined in later cells, you get errors all the way through the values for wind (see cells B37 thru B43). Change the wind velocity to 70 mph and it works fine.