Visual Pipe Stress Analysis for AutoCAD Plant 3D

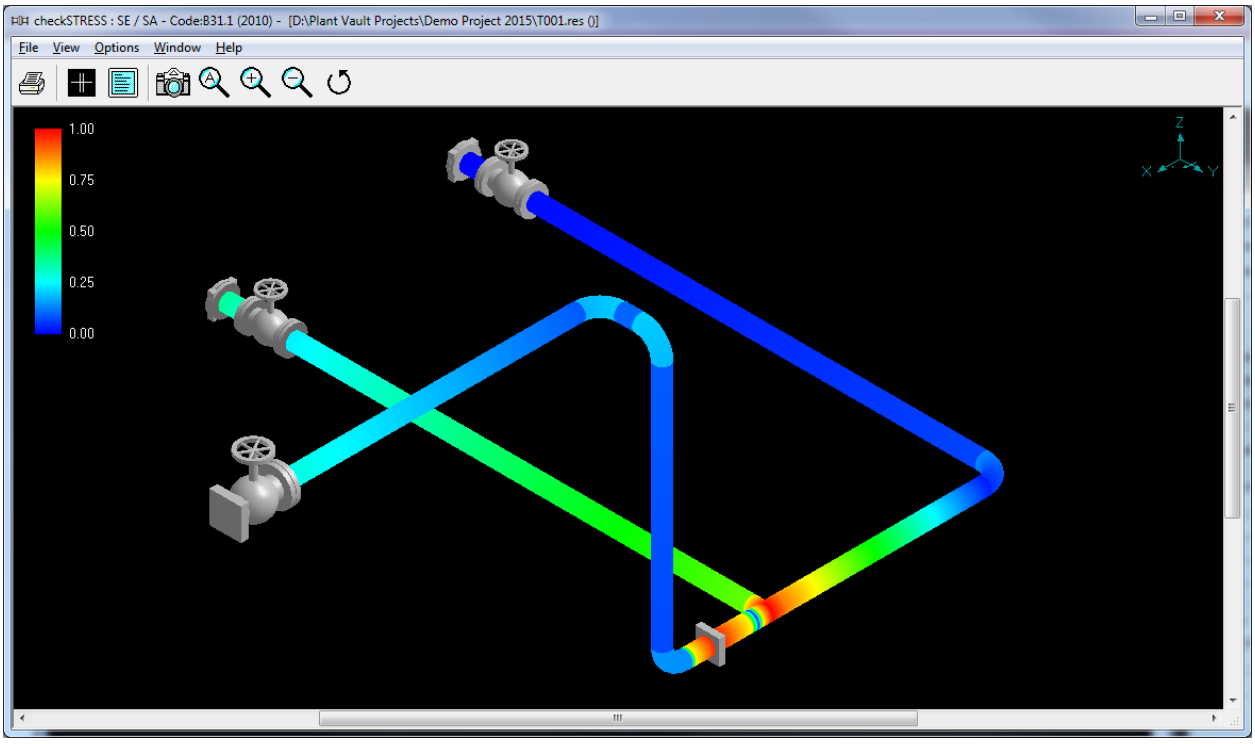
AutoCAD Plant 3D 2015 and checkSTRESS

It is common practice for piping designers to consider space constraints, process and flow constraints (such as pressure drop) and other requirements of construction, operation and maintenance whilst routing pipes, often overlooking pipe stress requirements.

This results in initial designs that are either too rigid to provide the flexibility required to absorb the expansion and contraction of pipes due to thermal load or are in need of support to carry the loads exerted by pipes of the wall thicknesses required to maintain high operating pressures and temperatures.

So, when the piping designer submits an initial design to a pipe stress engineer for analysis, the sytem is often “stiff” and rejected, requiring routing changes to make it more flexible.

checkSTRESS is a standalone application that enables a piping designer to perform a preliminary check on pipe stresses during an initial design before submitting the layout for detailed stress analysis.

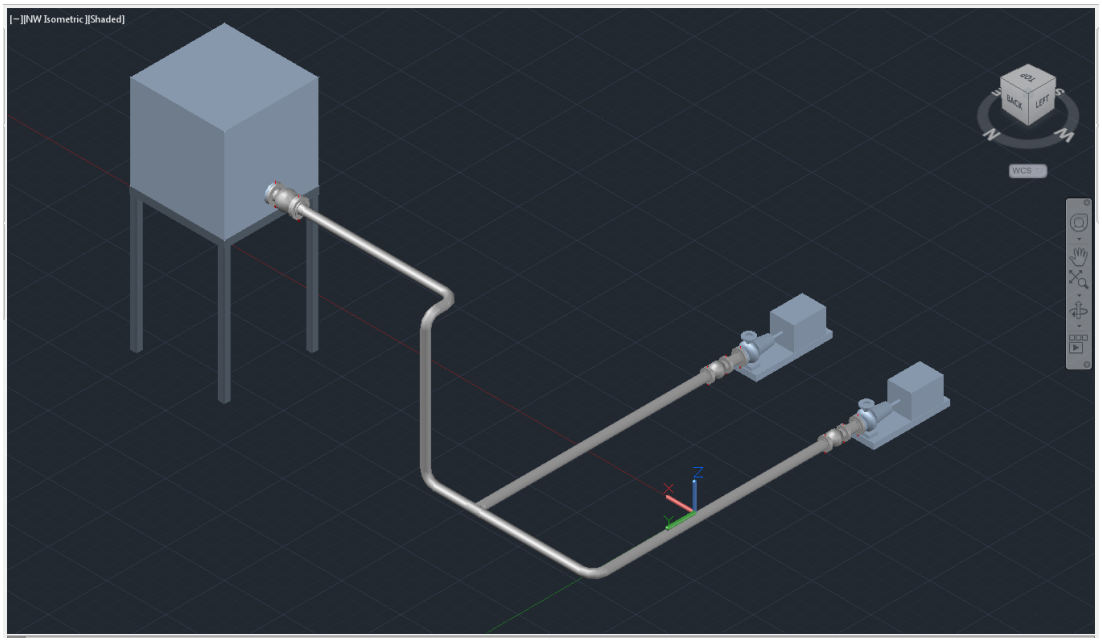


Using ***checkSTRESS*** together with AutoCAD Plant 3D, a piping designer can quickly and easily create a “Code Compliant” piping layout by simply reviewing a colour-coded model of his piping deisgn. ***checkSTRESS*** is able to take a standard PCF file as input and from that re-construct a 3D piping model and calculate the relative stresses due to expansion, weight and pressure which it uses as a key to colour-code the model.

Export to PCF

We will start with a simple 3D piping model in AutoCAD Plant 3D and show how we can use ***checkSTRESS*** to identify the need for and effectiveness of pipe supports to support our pipework.

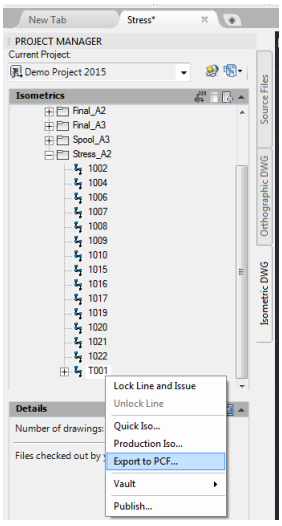
We will use the following model for our example. A simple run of pipe from a tank to feed two pumps.

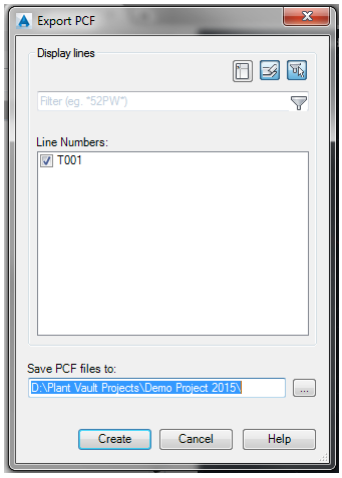


We need to generate a PCF file that describes our pipework for use as the input to checkSTRESS.

From the Isometric DWG tab of the Project Manager window, we can use the Export to PCF… menu option to generate a PCF file without having to generate an Isometric drawing.

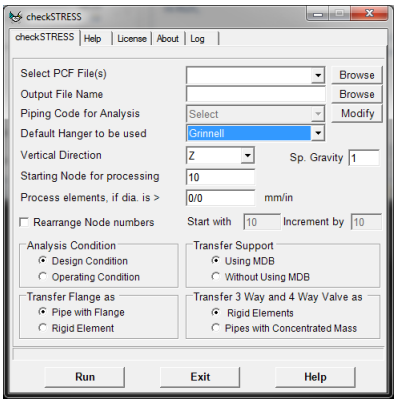
All of our pipework has been assigned the linenumber of T001, so we will select the Stress_A2 isometric style and generate our PCF file for line number T001. We will write the file to the project folder.





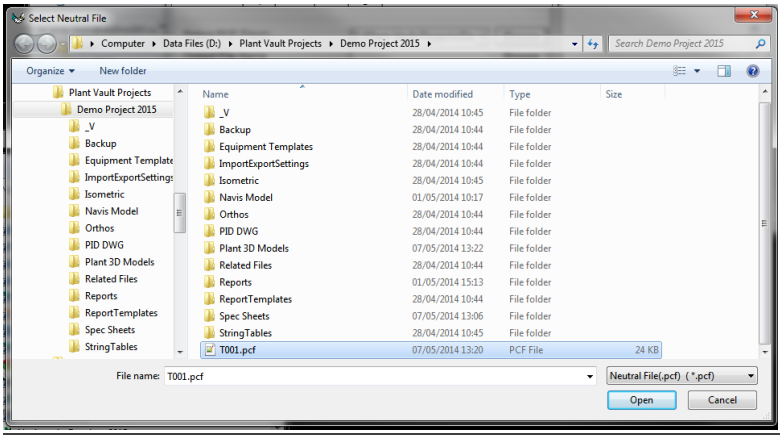
Run checkSTRESS

Now that we have generated a PCF file, we will launch checkSTRESS and select the file as input.

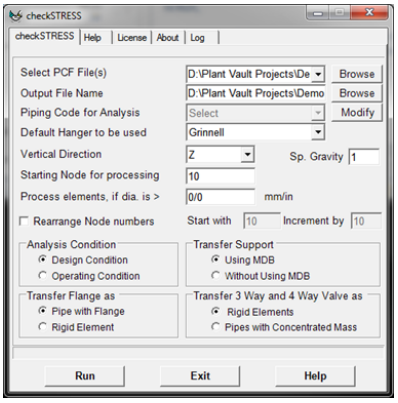


When we click the first Browse button, we are prompted to select an input file.

We will navigate to the project folder and select our PCF file.



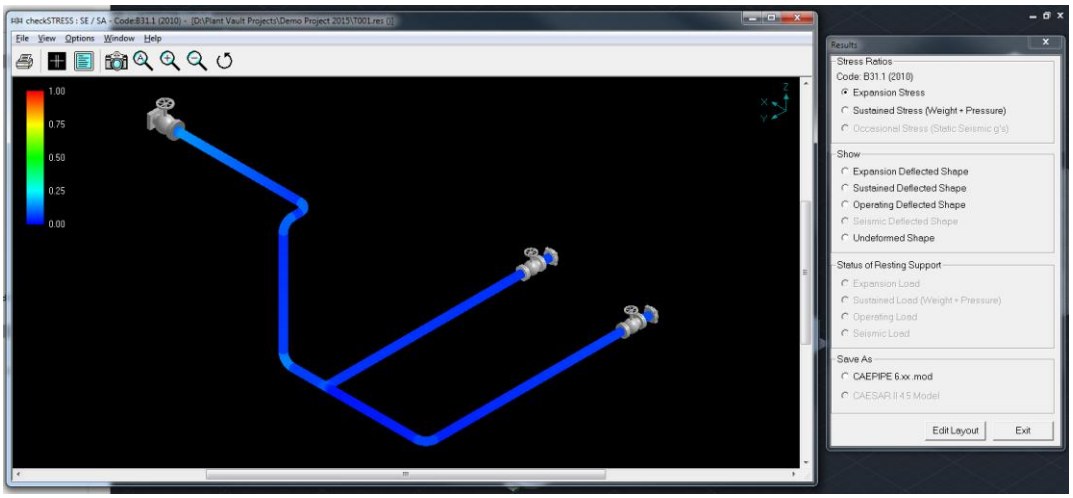
If we are simply performing a preliminary check on our pipework, then we do not need to change any of the other default values.



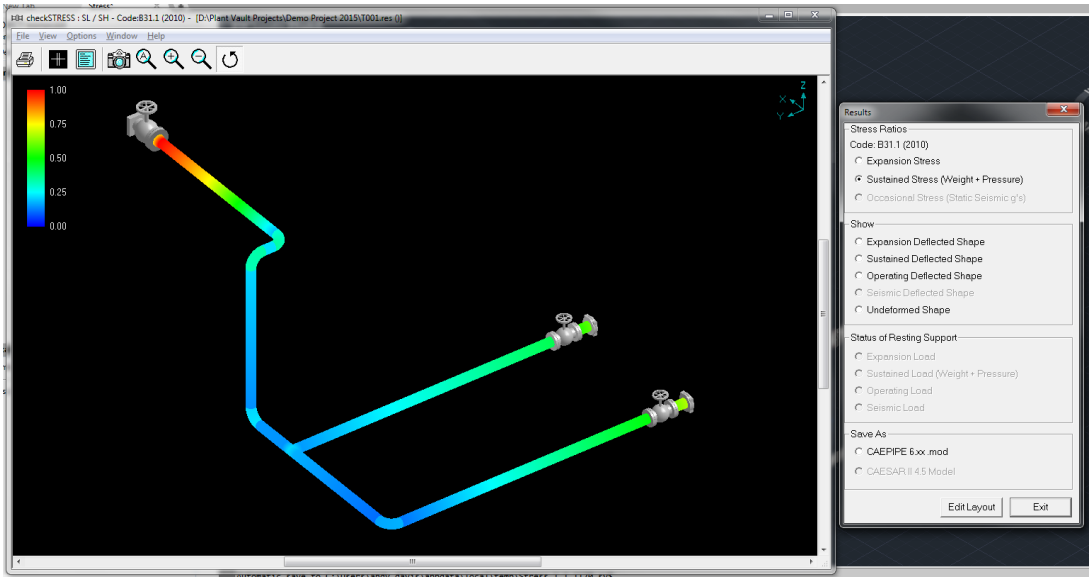
We simply click the Run button to process the PCF file.

The results of the analysis are presented in a colour-coded 3D model. Relative stress values from 0.00 to 1.00 are shown visually in the model using the spectrum of colours from blue to red respectively to indicate the stresses exerted upon the pipework.

The first view below shows us a 3D view of our pipework showing relative stress due to expansion. Here we see that all of the pipework is blue, indicating that the pipes are able to expand and contract freely.

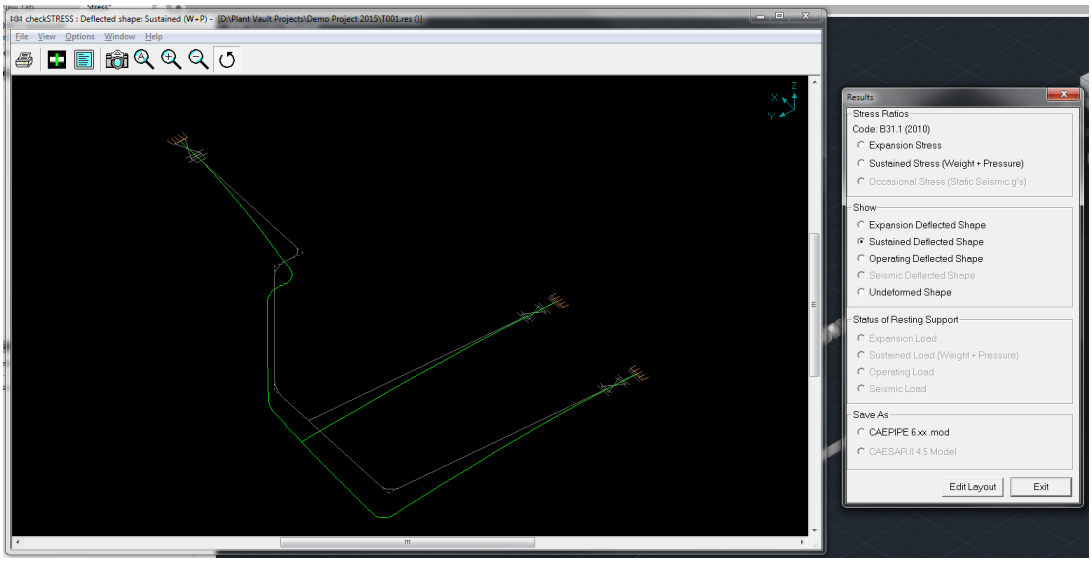


The next view shows us a 3D view of our pipework showing relative sustained stress due to the weight of the pipework and internal pressures. We can see immediately from the colour of the pipework that there are points of high stress in our model.

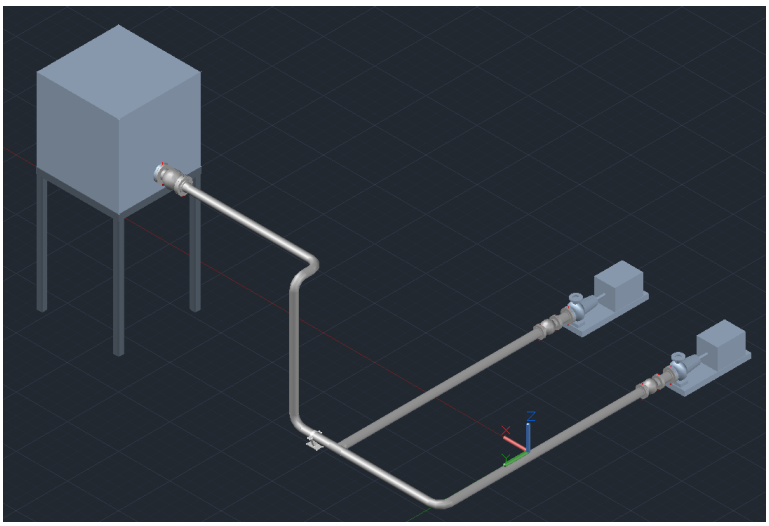


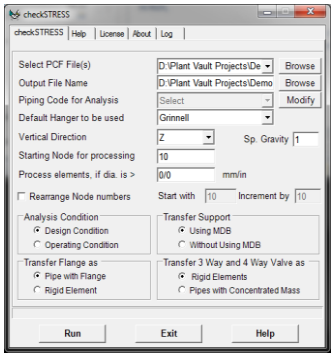
Any areas highlighted in red, orange or yellow are of immediate concern as they indicate areas of high stress in the pipework that need to be relieved.

If we look at the sustained deflected shape of our pipework, we can see that we need to provide support to the horizontal pipe below the drop from the tank to relieve the stress at the valve on the outlet from the tank.



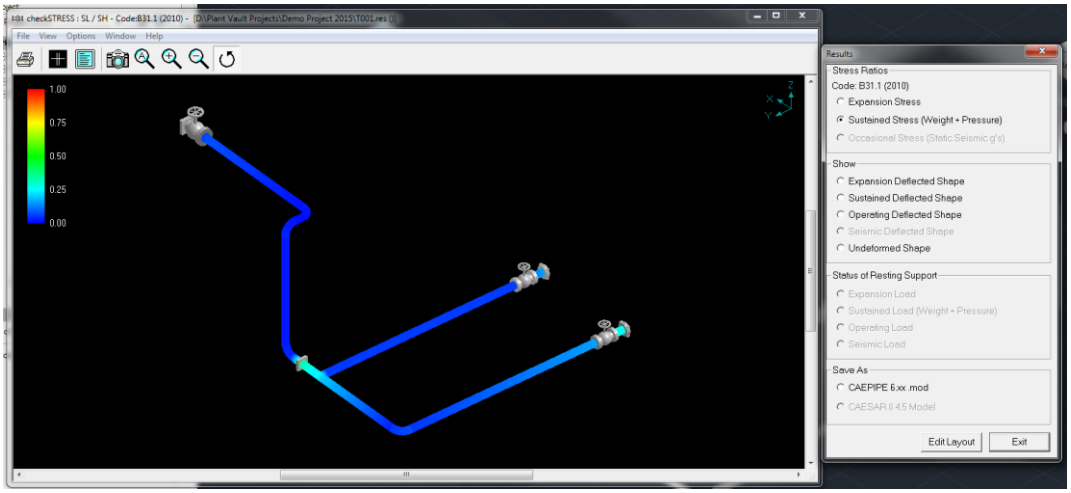
We will click Exit on the Results window and return to our example in Plant 3D, to add a support to our model as shown below.



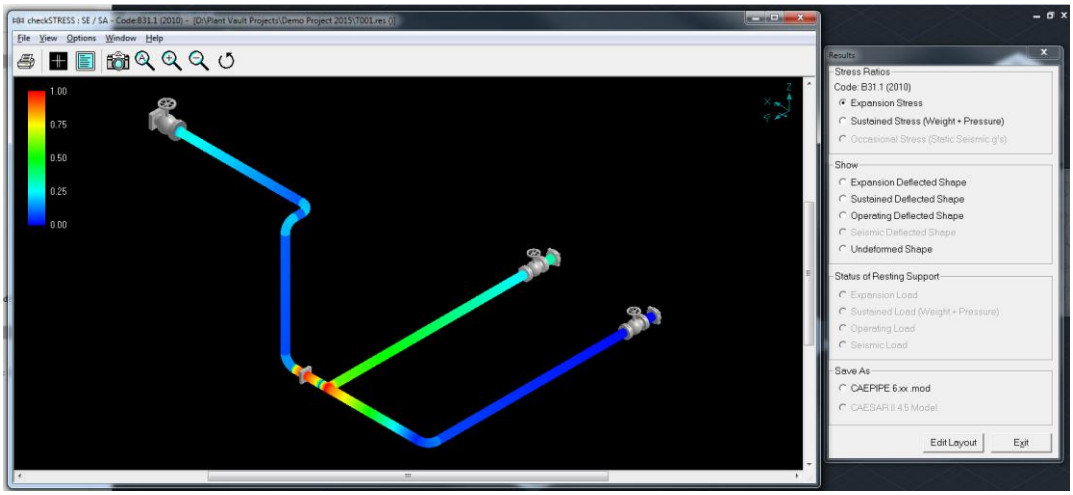


We will Export to PCF…
And click the Run button again in ***checkSTRESS*** to analyse our updated pipework.

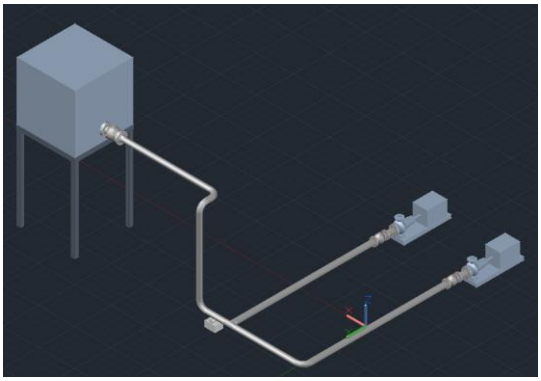
When we view the sustained stress results, we see that adding the one support has relieved all of the high stress areas.



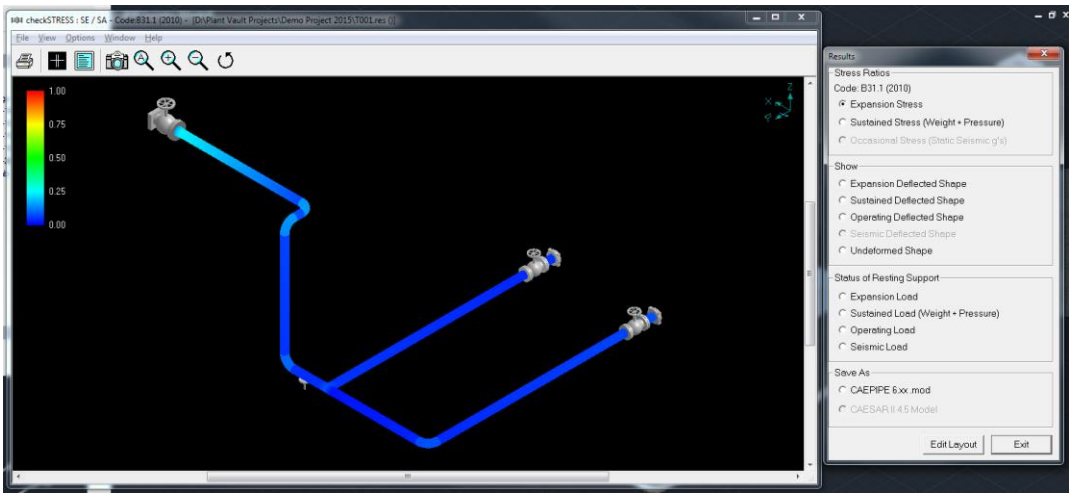
However, if we now look again at the expansion stress, we can see that by anchoring the pipe to relieve the sustained stress we have restricted the pipe's ability to expand and contract with changes in temperature and thus added high areas of thermal stress.



By changing the type of pipe support to allow lateral movement of the pipe we can relieve that thermal stress.



We now have a preliminary design that is not intrinsically stressed and is ready to be submitted to a specialist for detailed stress analysis.



At this point we have not provided any resting supports to enable valve replacement , so we should perhaps add these and verify that they do not add any additional stresses to the pipes.