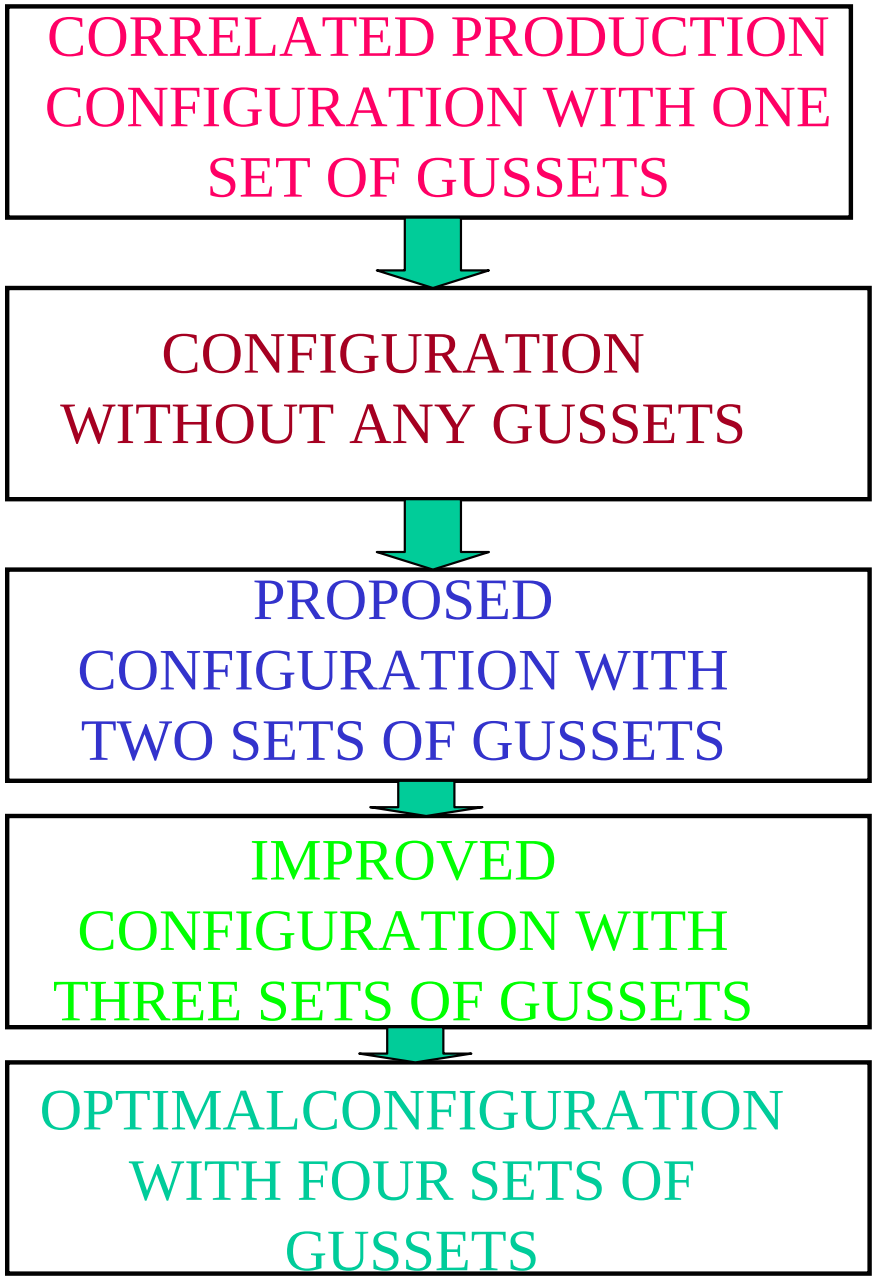
PIPER SEMINOLE –PA-44 TWIN ENGINE AIRCRAFT

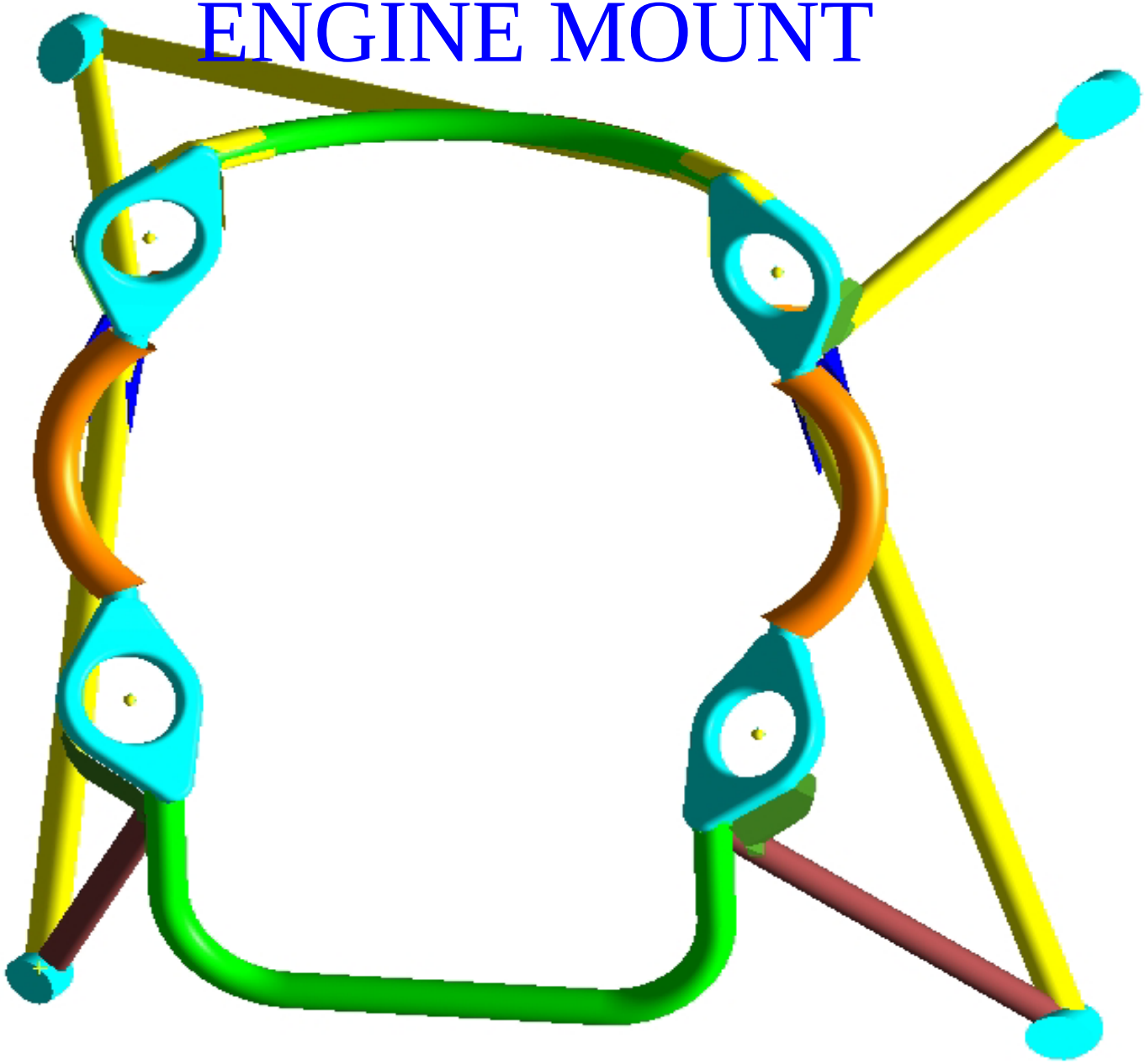
SEMINOLE ENGINE MOUNT

ENLARGED VIEW OF GUSSET

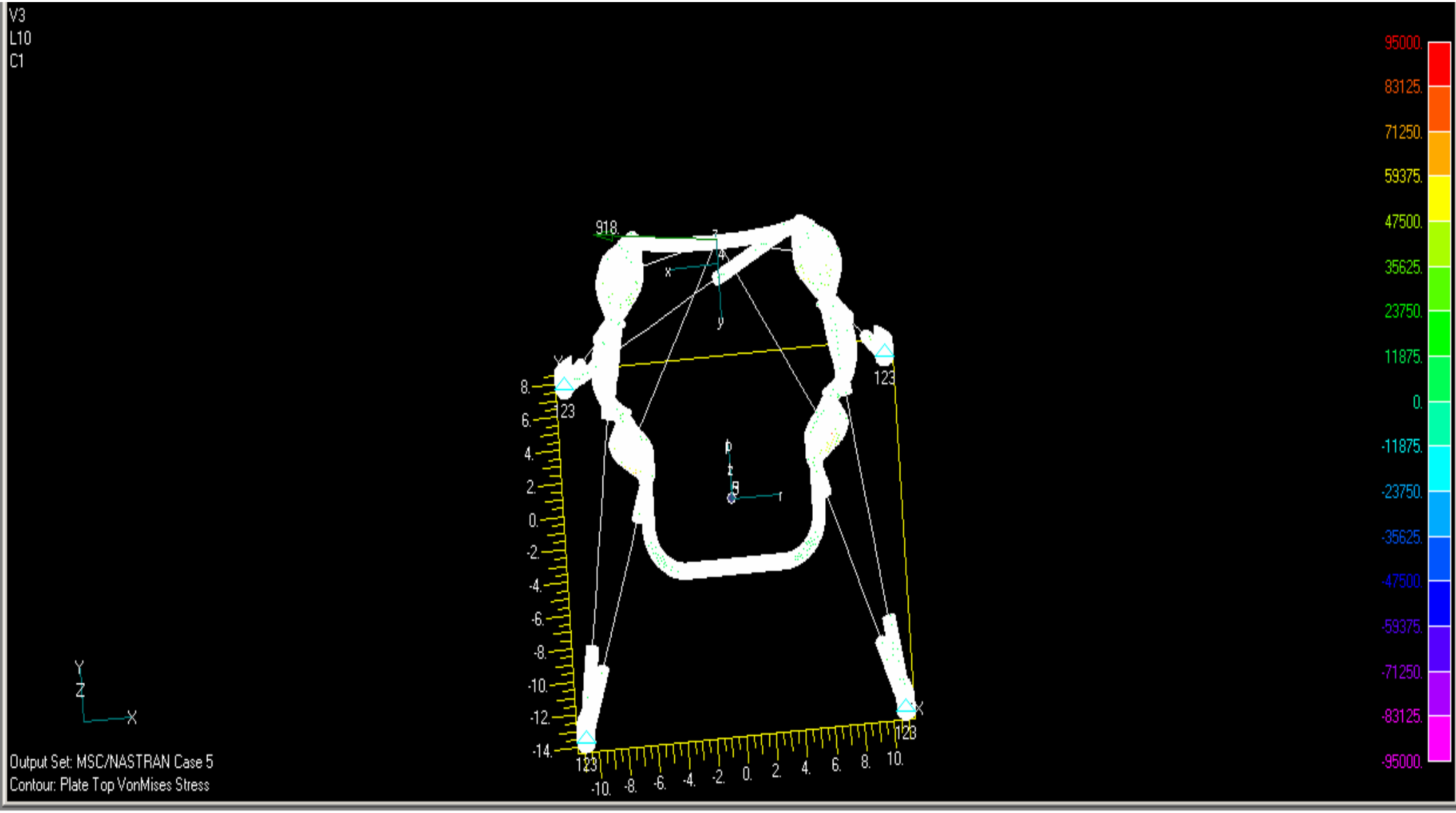
METHODOLOGY OF ANALYSIS



SURFACE UG MODEL OF PA-44 ENGINE MOUNT



FINITE ELEMENT MODEL OF PA 44 ENGINE MOUNT



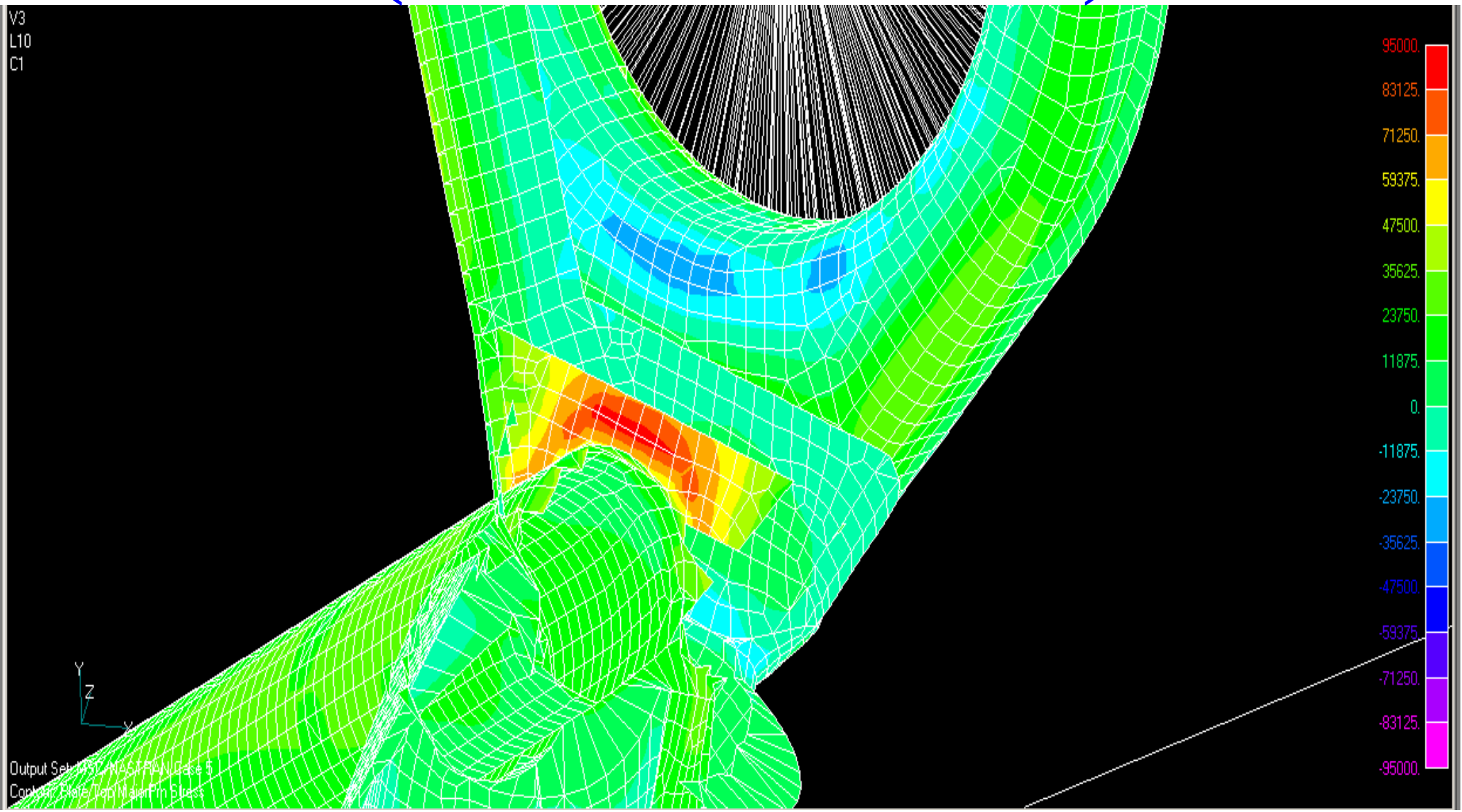
FINITE ELEMENT MODELING DETAILS OF PA 44 ENGINE MOUNT

- Tube clusters and gussets are modeled using plate elements for thin walled structure.
- Portion of the tube clusters connecting leg area are modeled using beam elements.
  - This simplifies the model by reducing number of plate elements and still retaining stiffness properties.
- The end of the beam elements are connected to tubes by rigid body elements

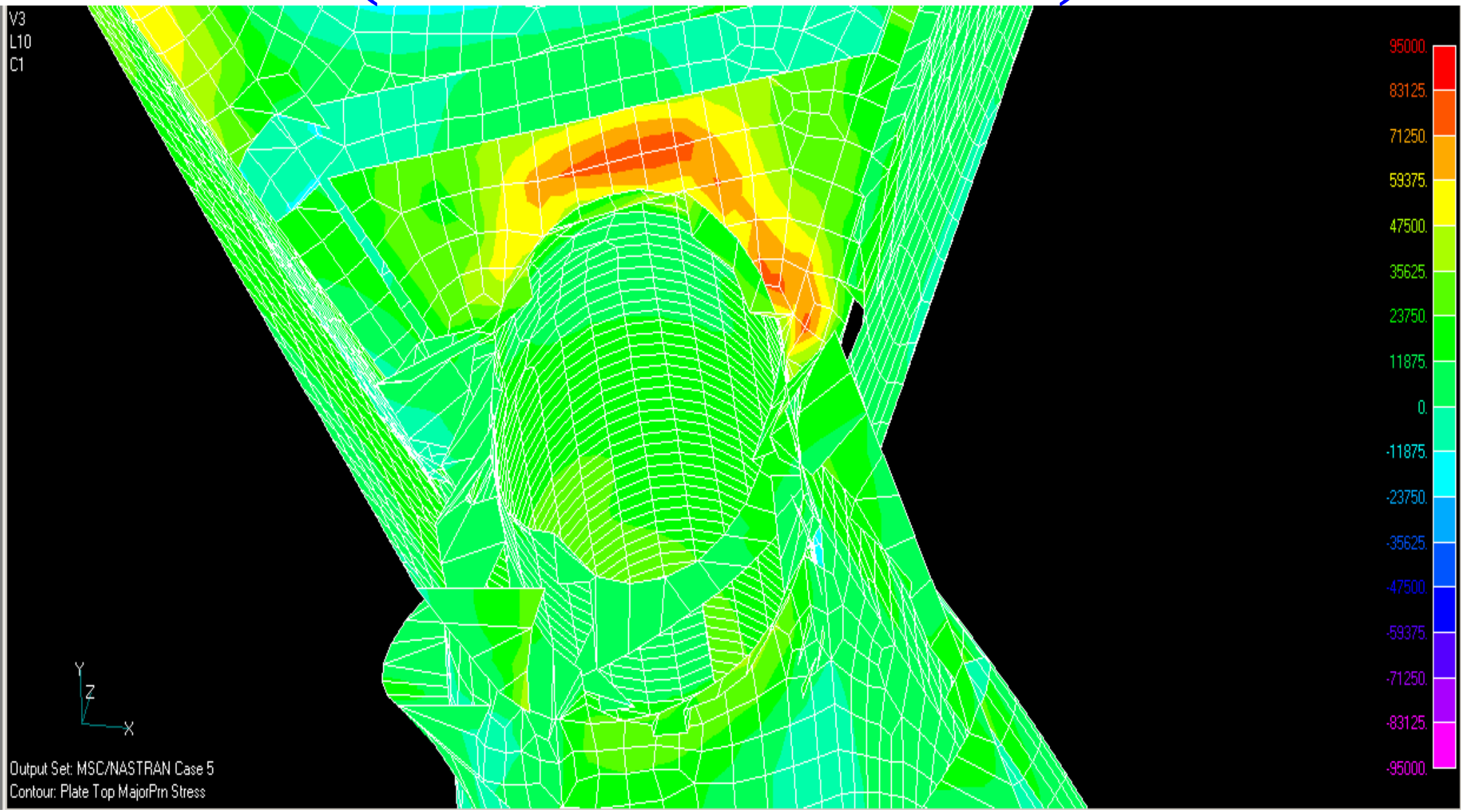
FINITE ELEMENT MODELING DETAILS OF PA 44 ENGINE MOUNT

- Rigid body elements are used to transfer forces between beam and plate elements
- Loads and boundary conditions are applied according to static test conducted previously
- The model is analyzed using NASTRAN for Windows®, version 2002
- The results are plotted using FEMAP®, which is the pre and post processor of the FEM package

Proposed gusset cluster (critical area in Red)

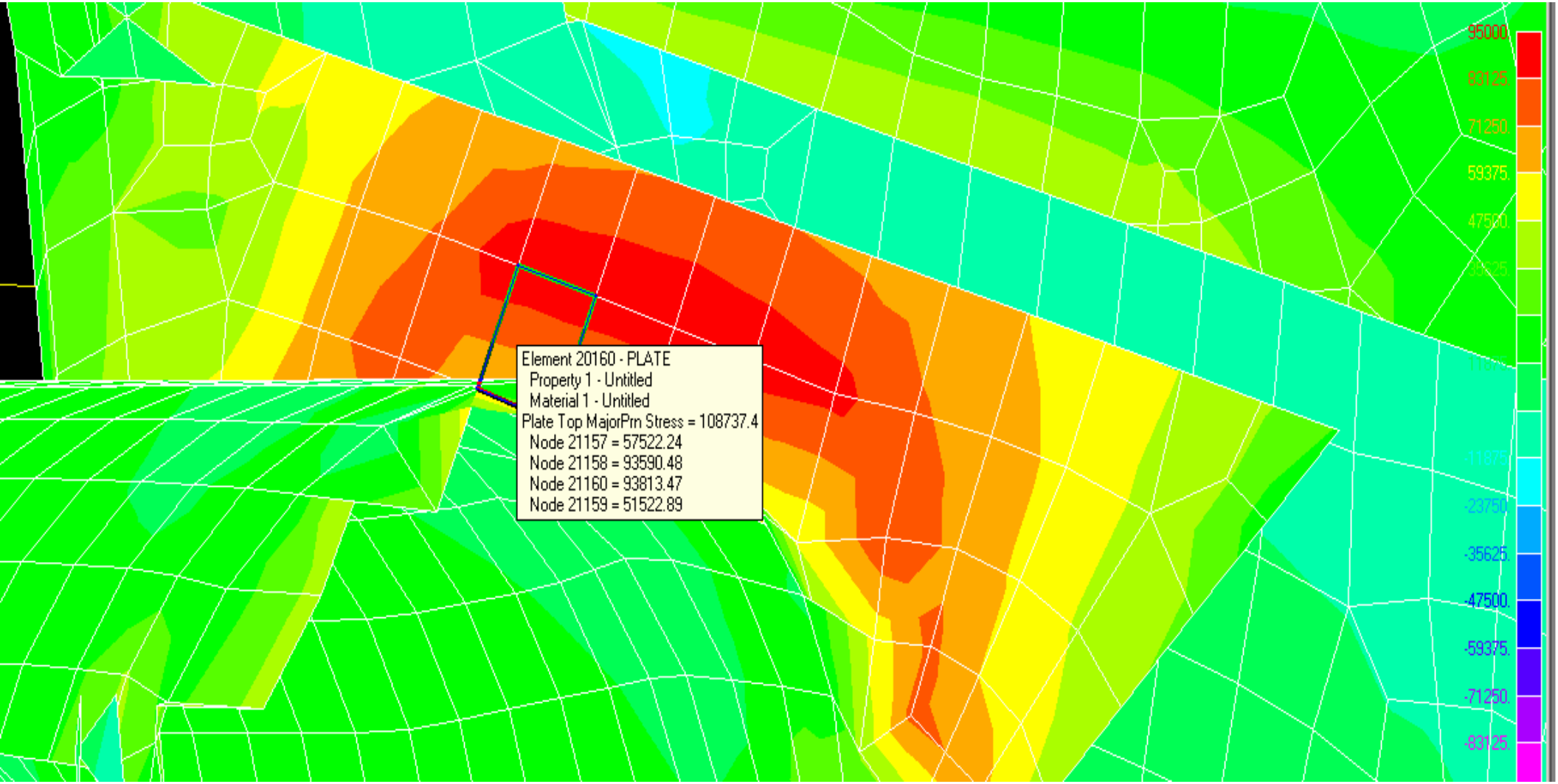


Current gusset cluster (critical area in Red)



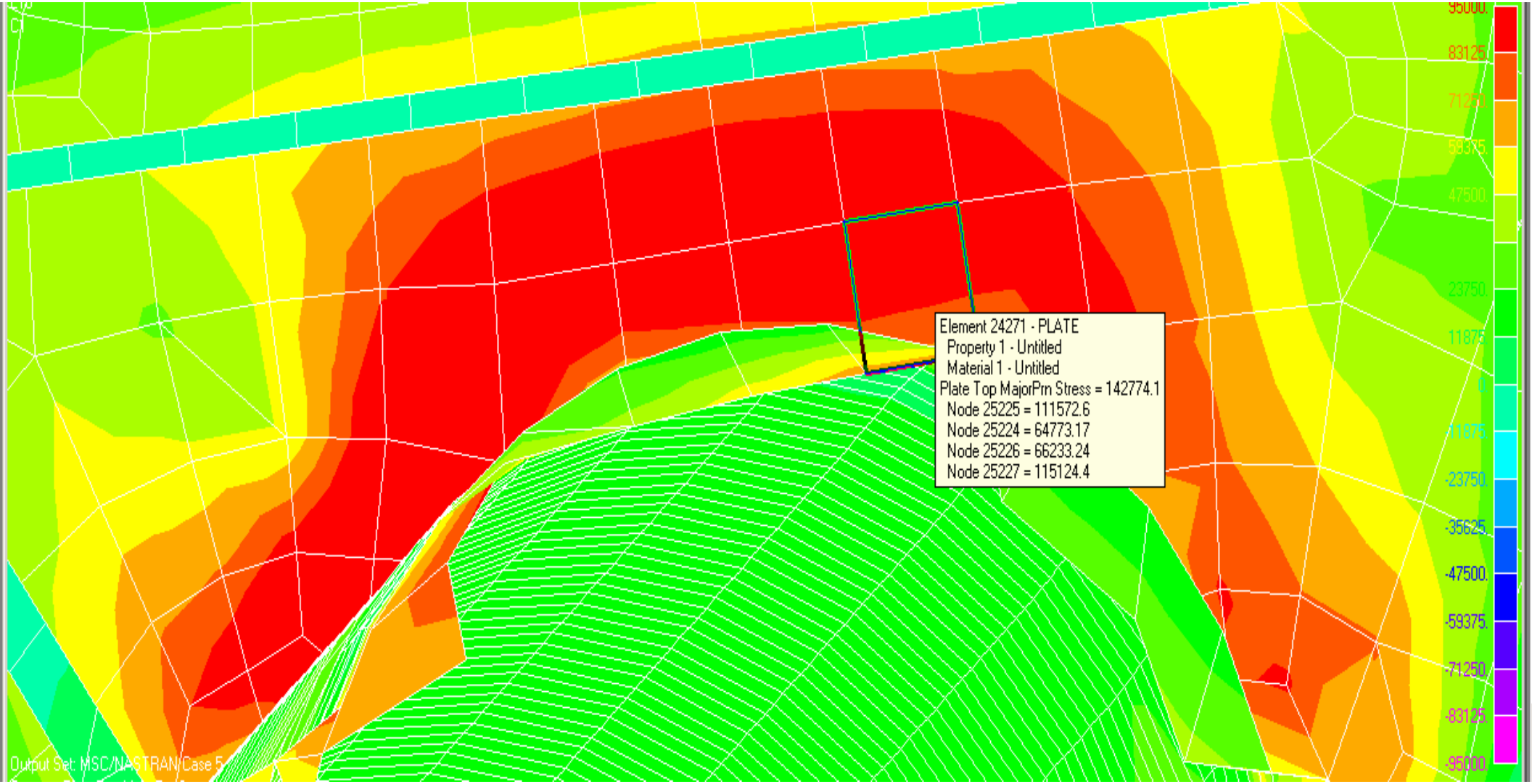
Principle Stresses in the area of the proposed gussets with no gussets on the model

The max stress is 108 Ksi



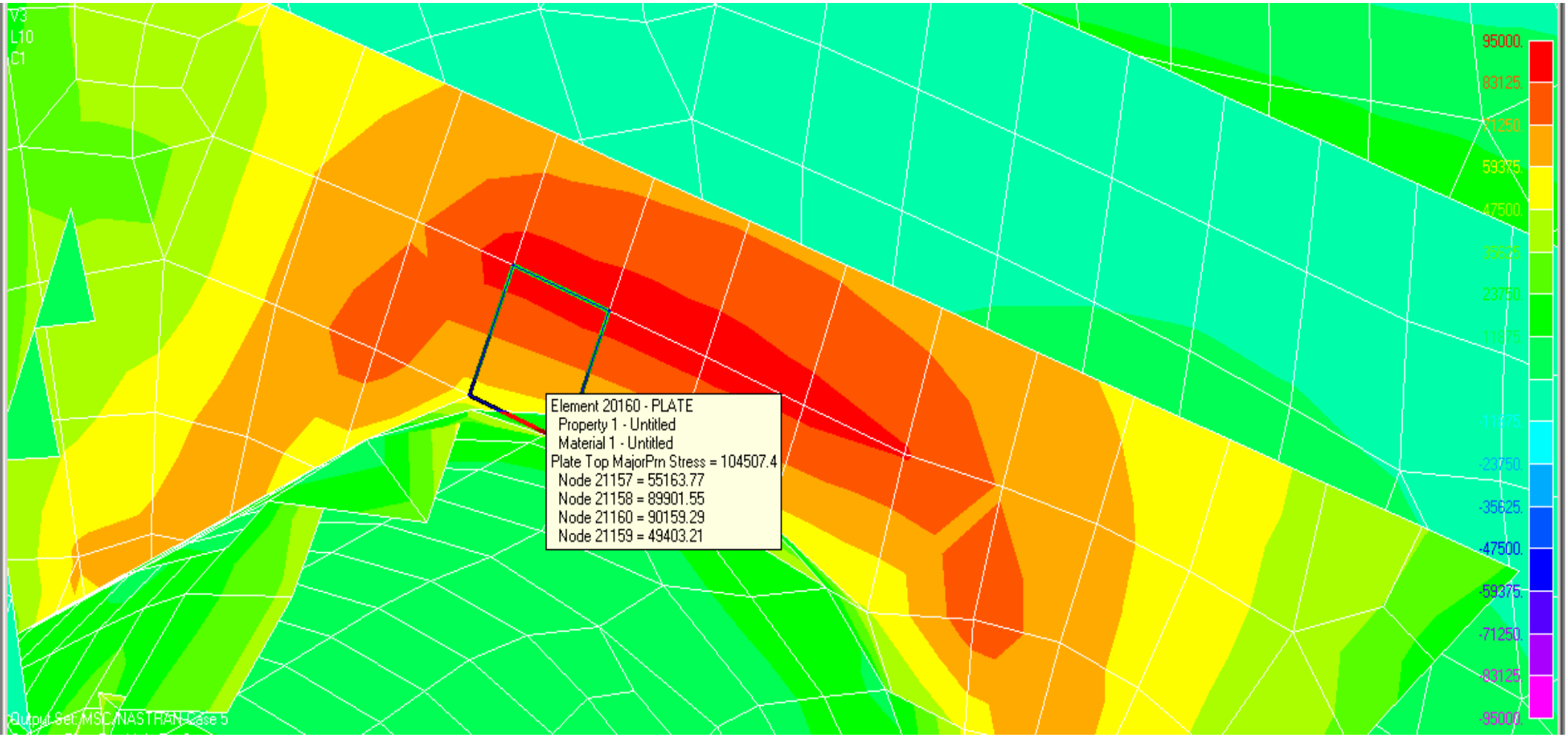
Principle Stresses in the area of current gussets with no gussets in the model

The max stress is 142 Ksi



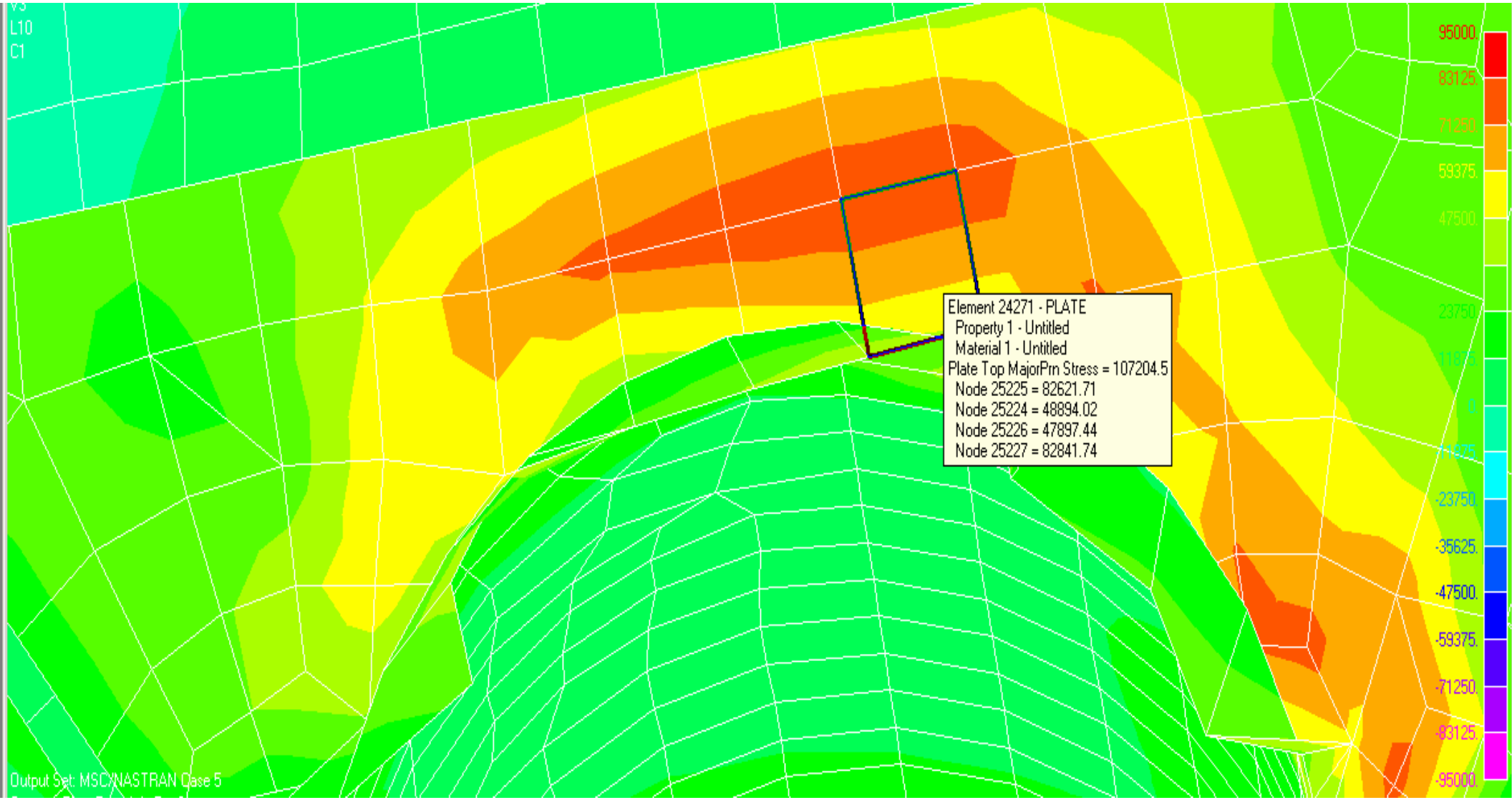
Principle Stresses in the area of proposed gussets with current production gussets in the model

The max stress is 104 Ksi



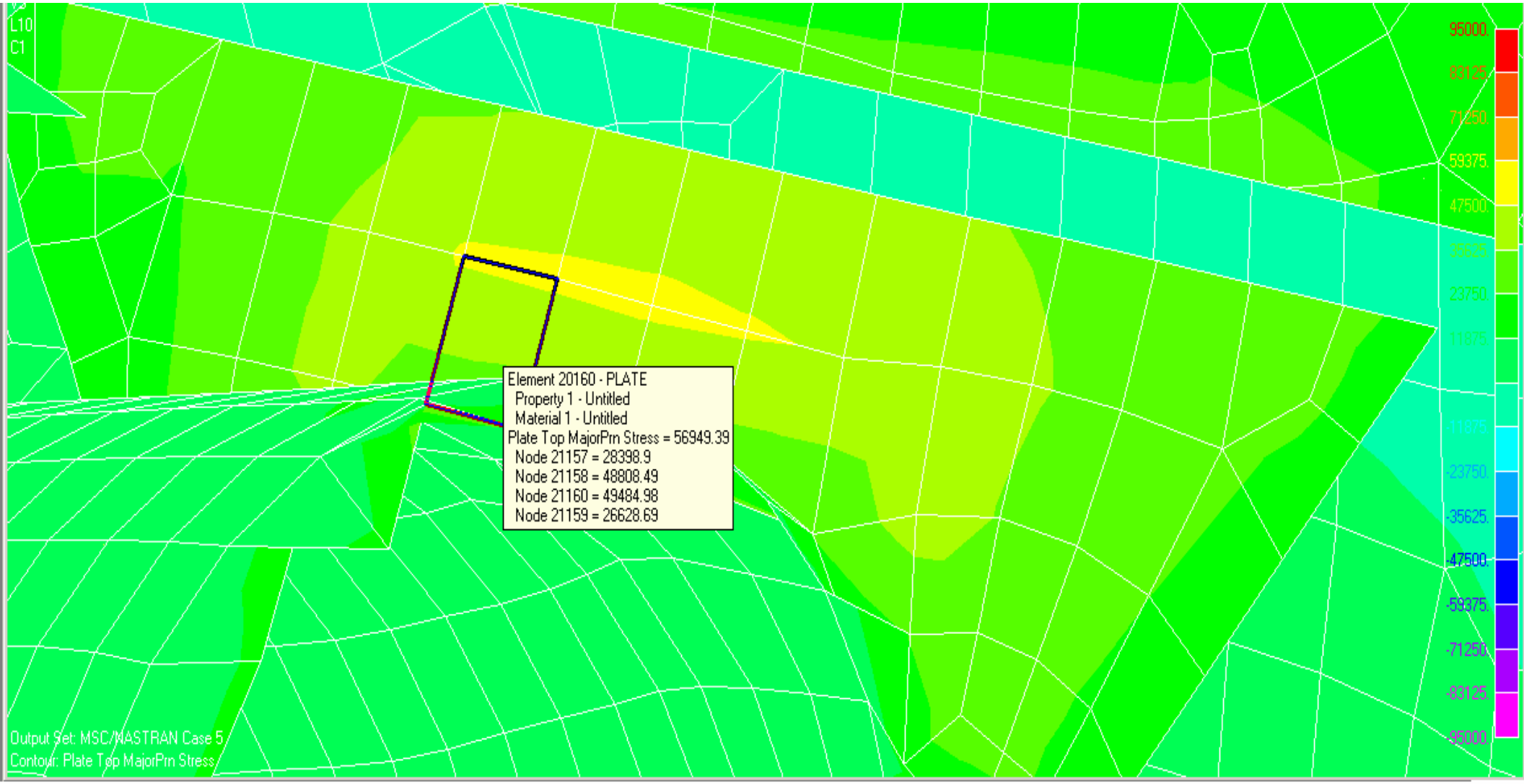
Principle Stresses in the area of current production one set(2) gussets in the model

The max stress is 107 Ksi



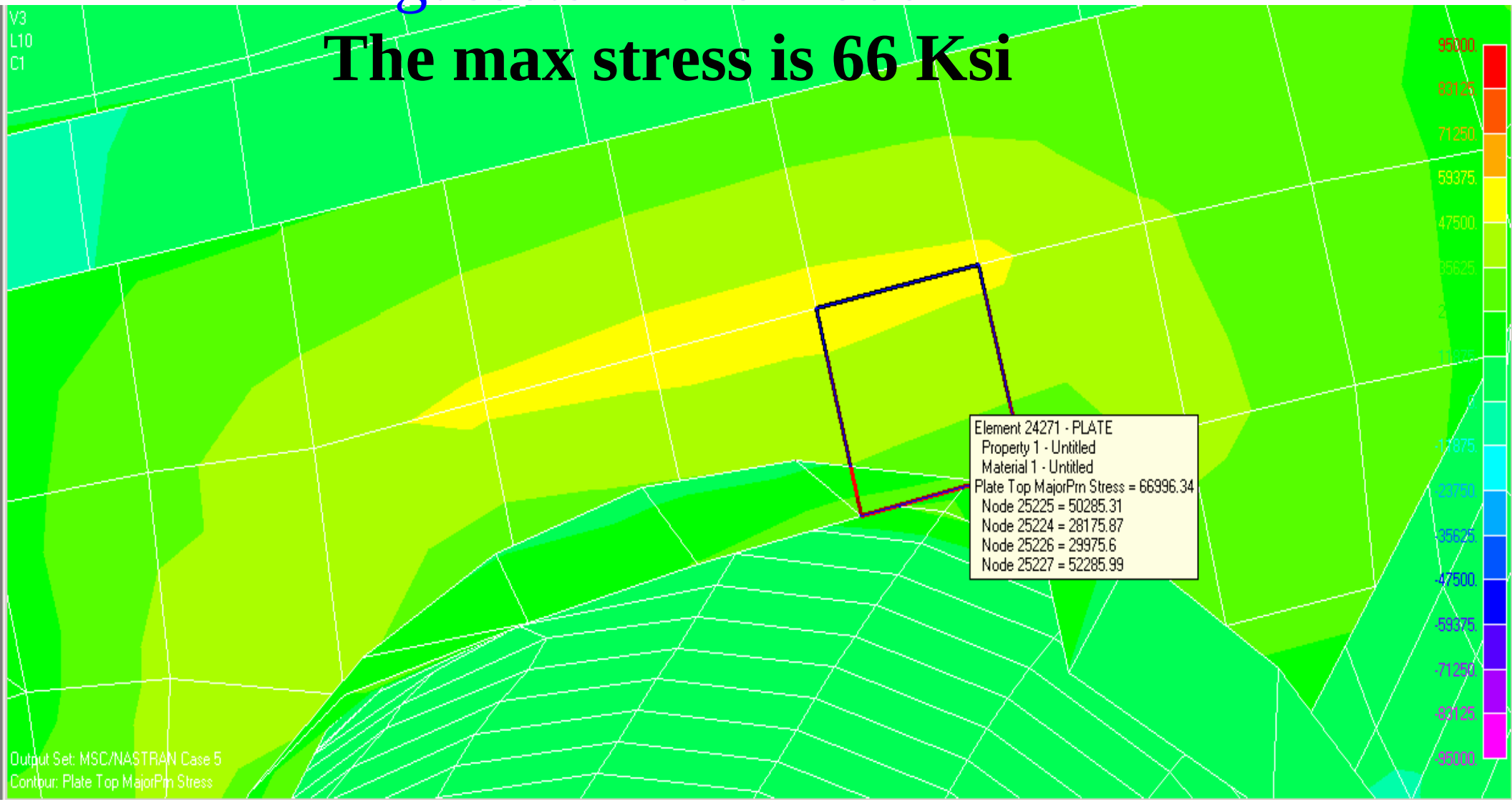
Principle Stresses in the area of proposed gussets with two sets of gussets in the model

The max stress is 57 Ksi

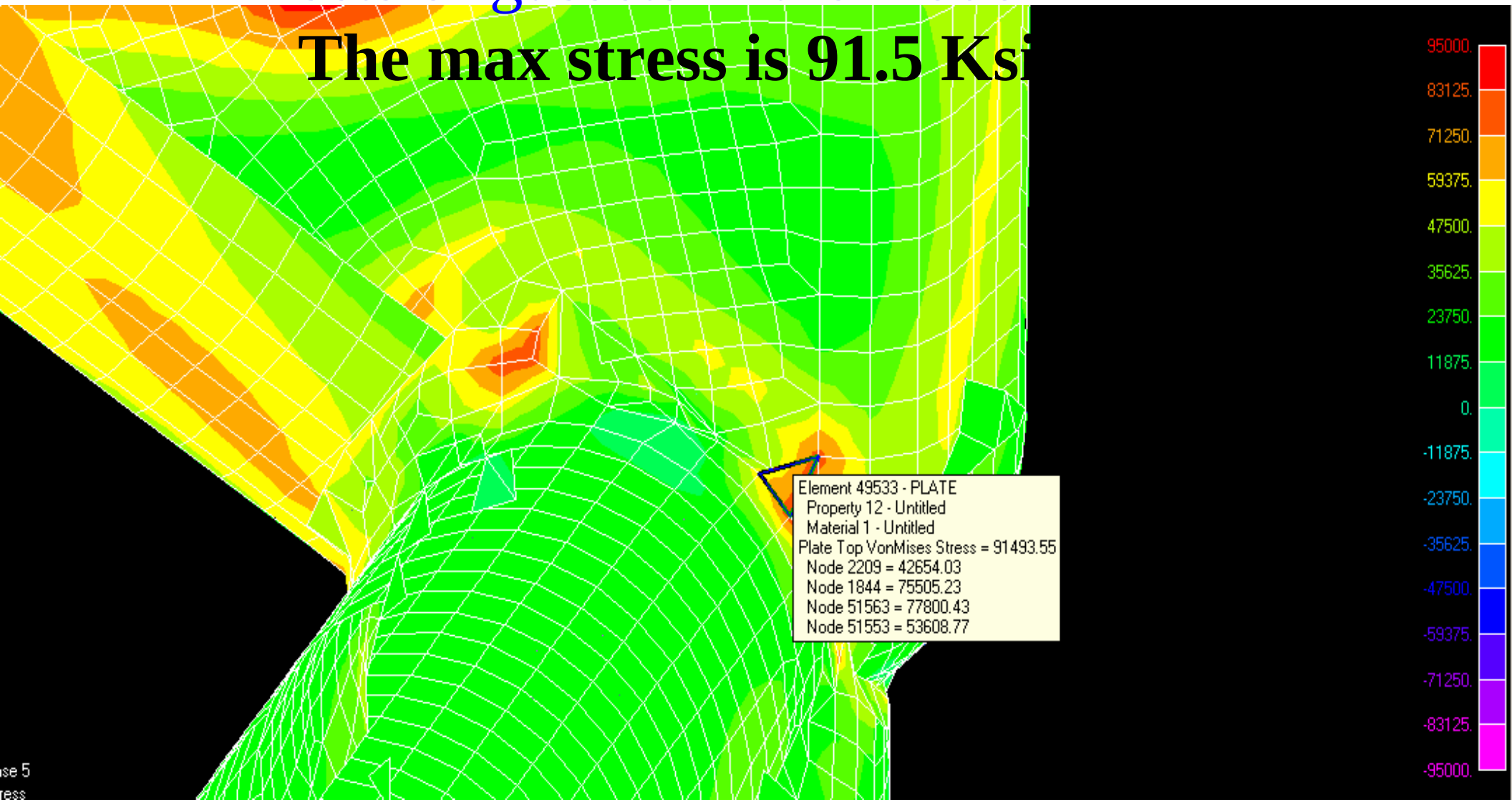


Principle Stresses in the area of current production gussets with two additional sets of gussets in the model

The max stress is 66 Ksi



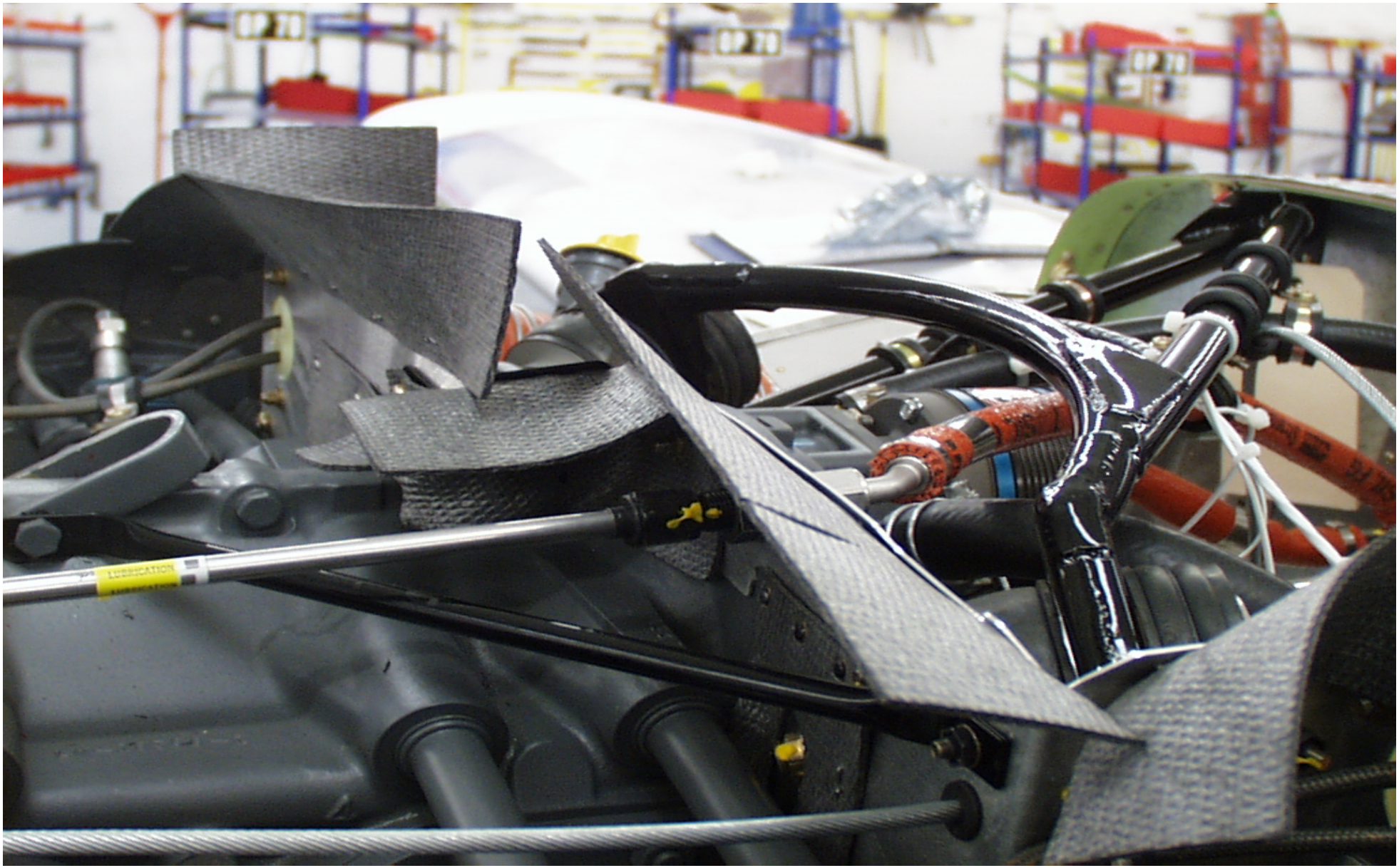
Von Mises Stresses in the Cluster located below proposed gussets with two additional sets of gussets in the model



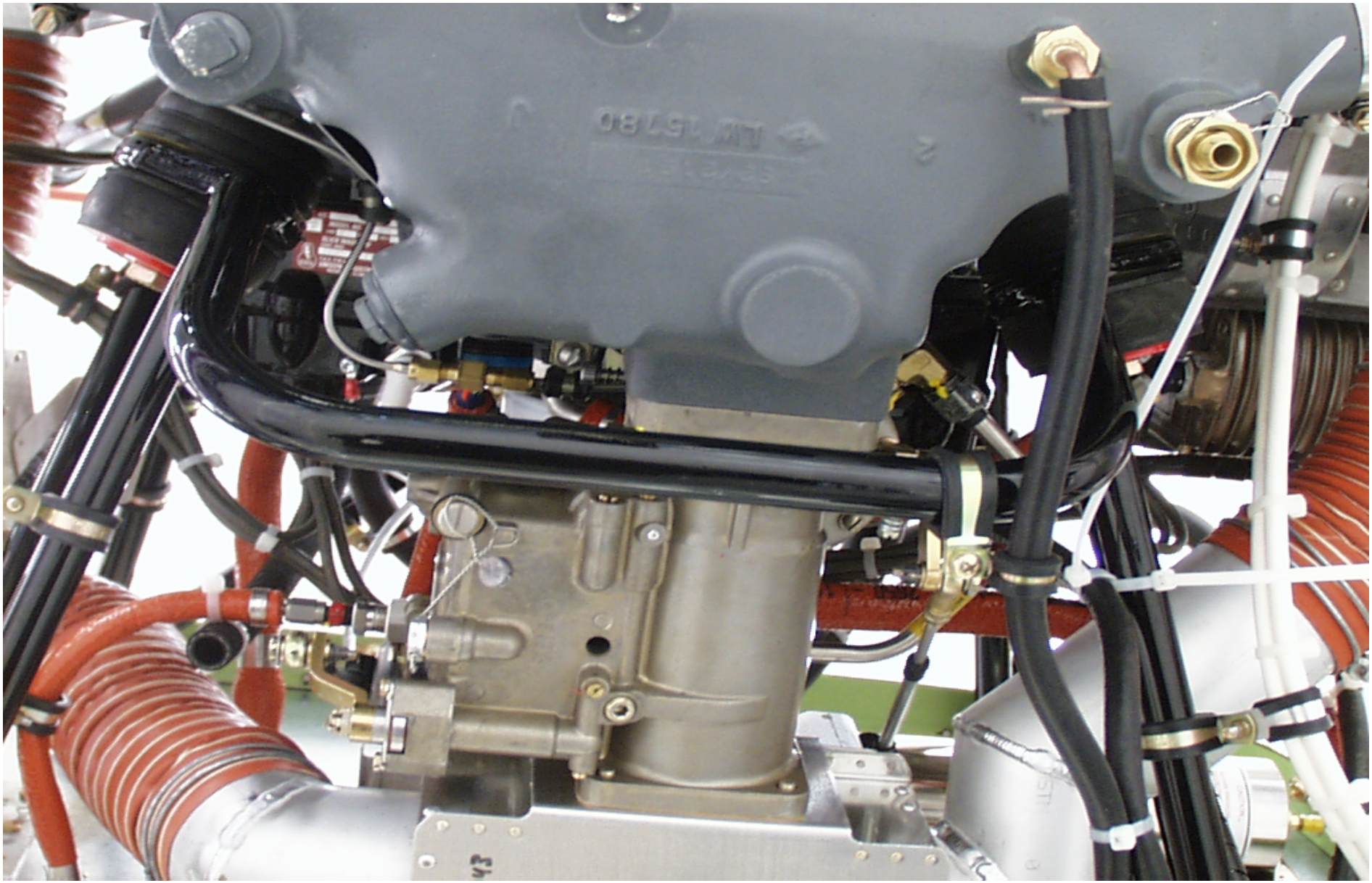
Summary Of Predicted Raised Principle Tensile Stress

	Proposed Gusset area (Ksi)	Current production gusset area (Ksi)
Stresses with no Gussets	**108**	**142**
Stresses with one set of Gussets	**104**	**107**
Stresses with two set of Gussets	**57**	**66**

UPPER HALF OF THE ENGINE MOUNT IN TENSION



LOWER HALF OF THE ENGINE MOUNT IN COMPRESSION

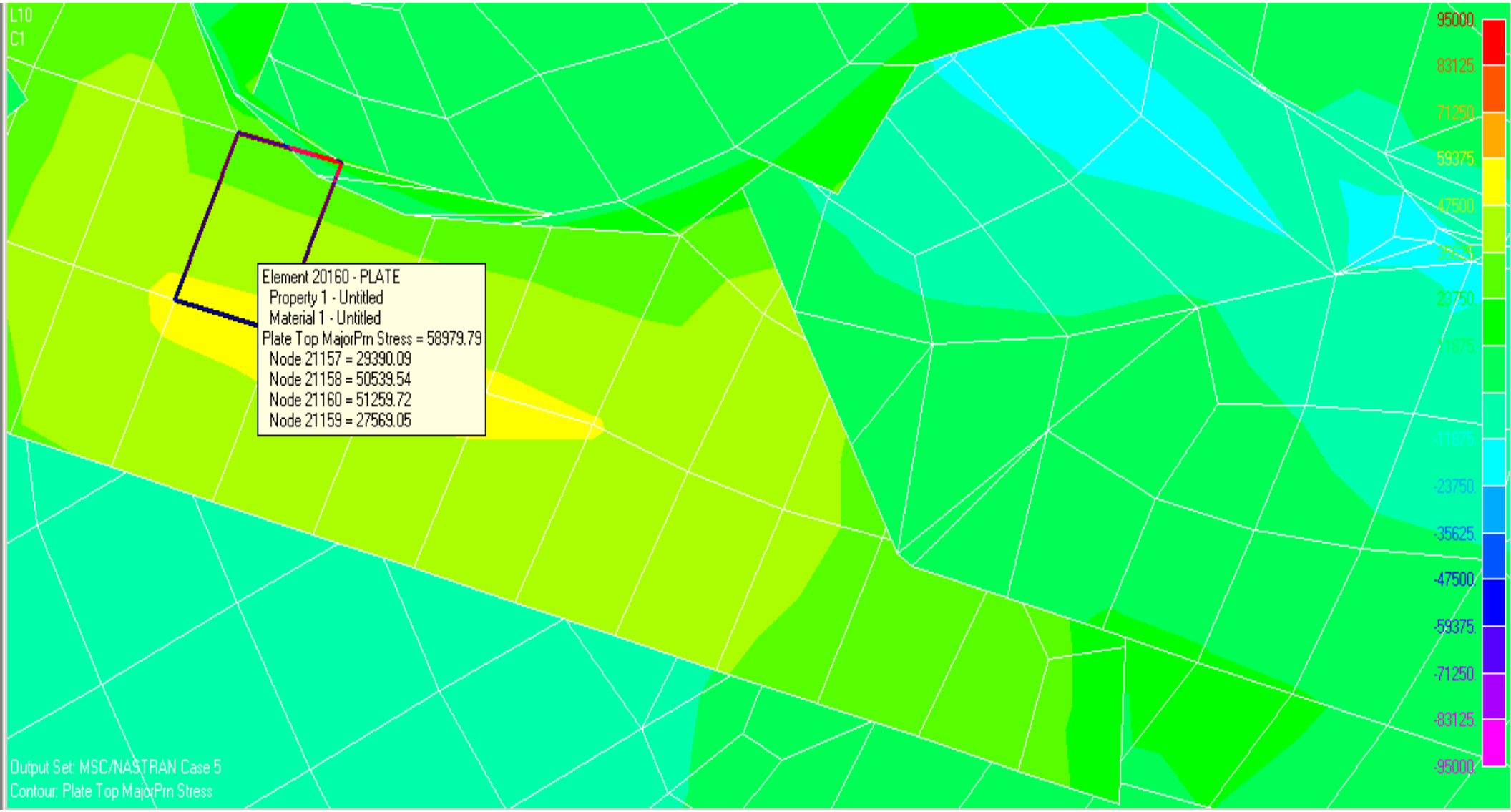


Direct Stress Comparisons

- 45% reduction in stresses in the proposed cluster of gusset addition versus no gusset design
- 28% reduction in stresses in the current production gusset cluster set
- Transfer of load path from proposed gusset area to the clusters right below it should be investigated

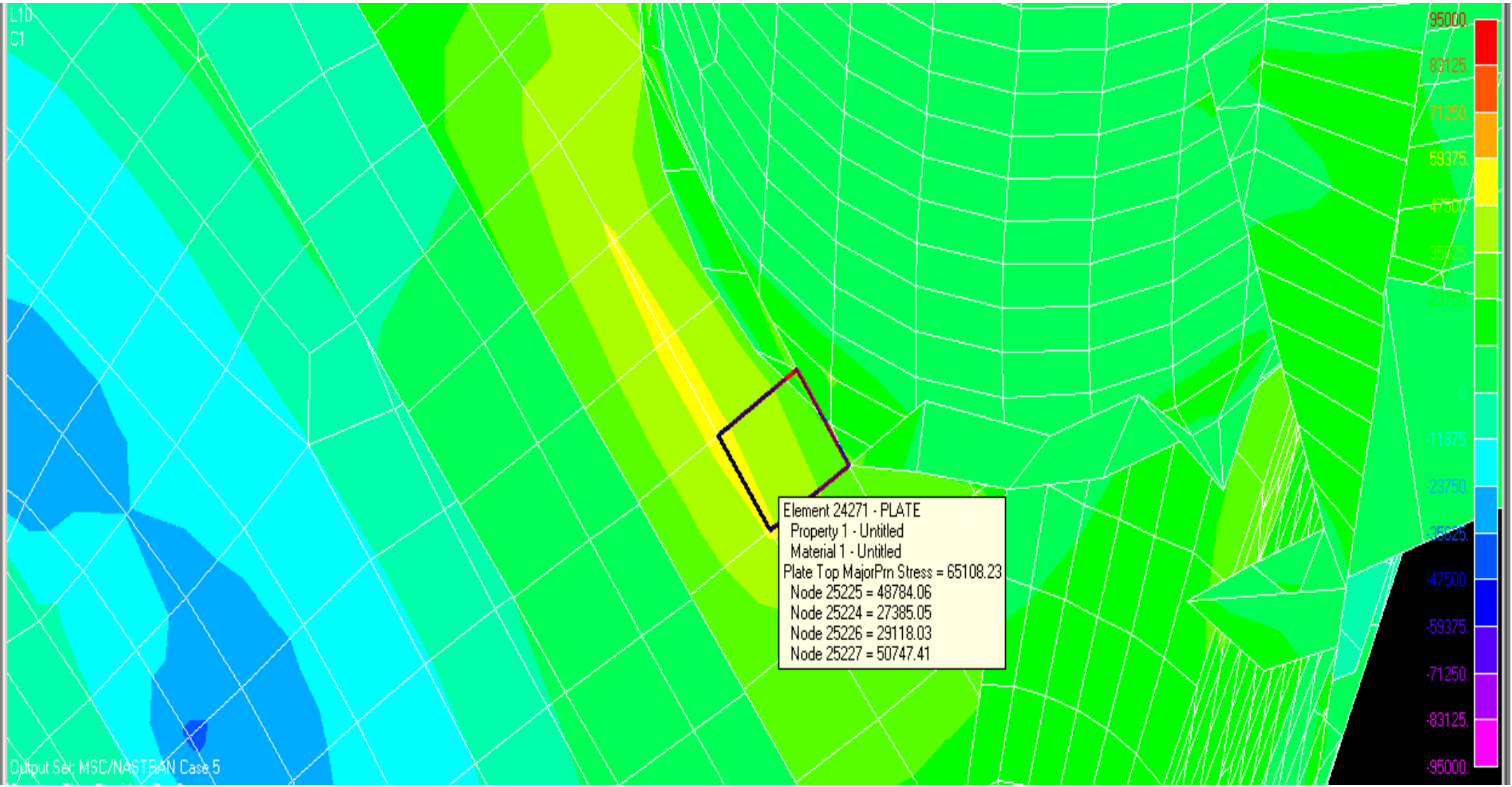
Principle Stresses in the area of proposed gussets with three gusset sets

The max stress is 59 Ksi



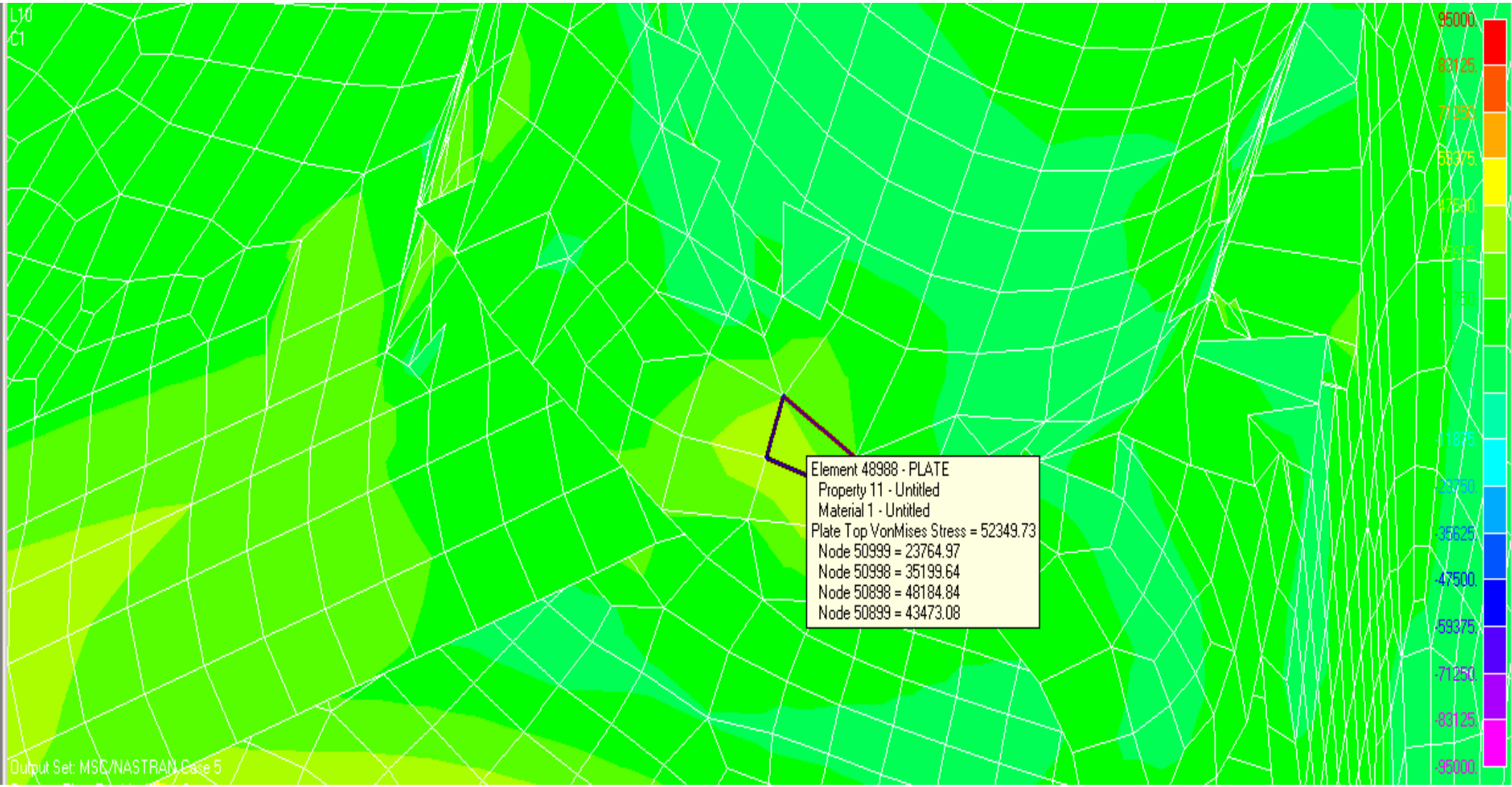
Principle Stresses in the area of current production gusset set with three gusset sets

The max stress is 65 Ksi



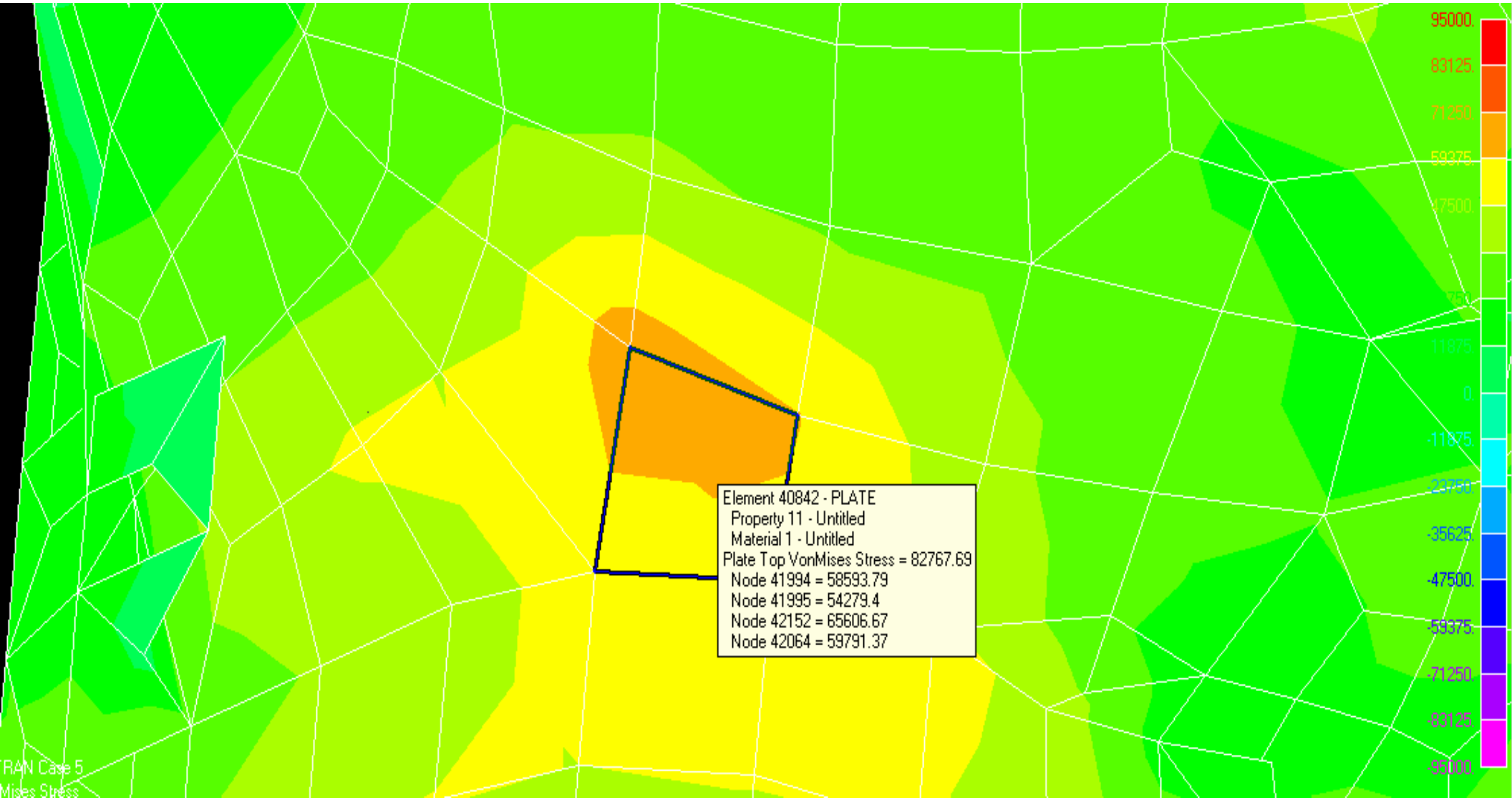
Von Mises stresses in the area of third set of gussets with three total gusset sets

The max stress is 52 Ksi



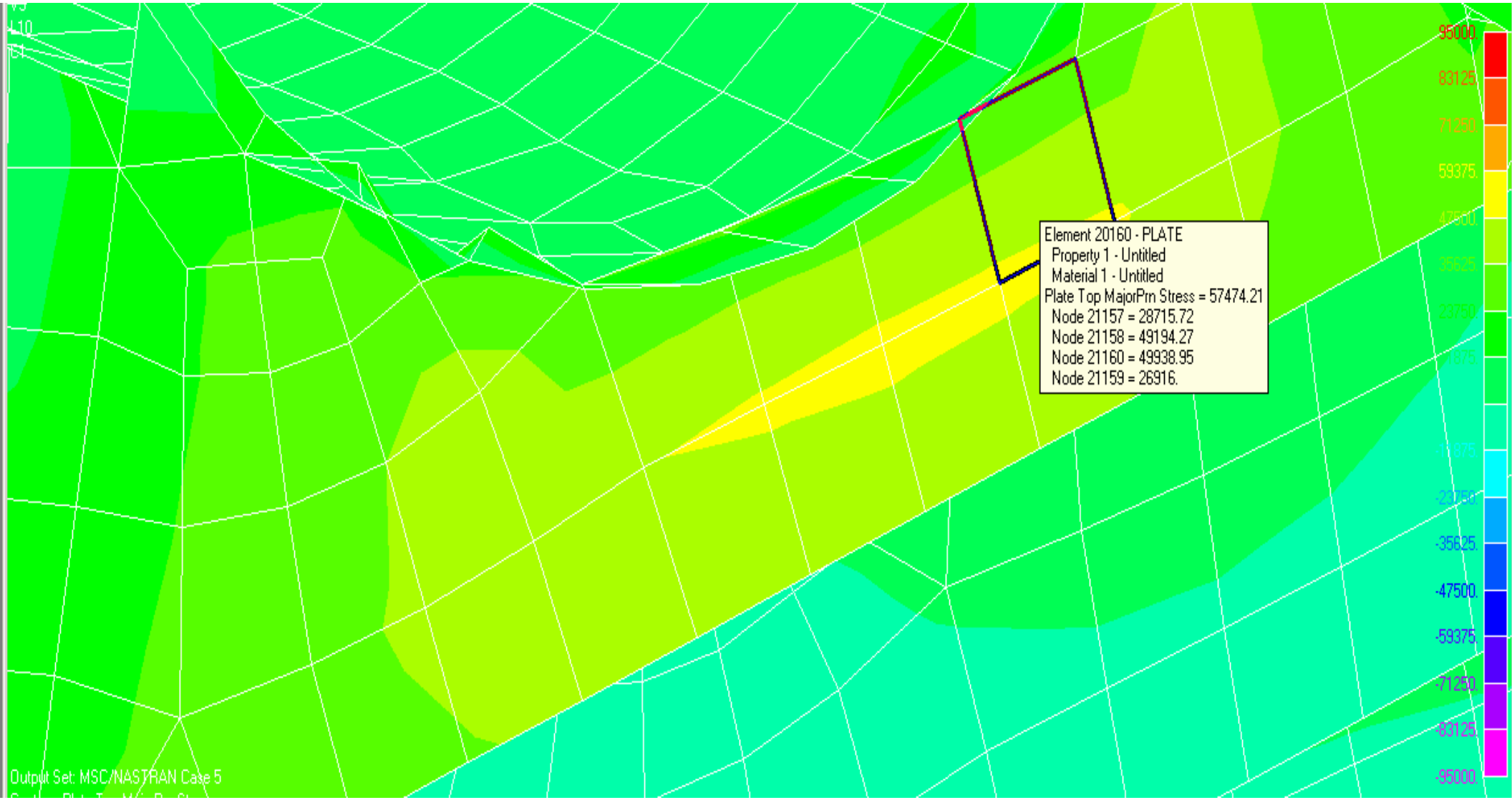
Von Mises stresses in the area of fourth cluster with three gusset sets

The max stress is 83 Ksi



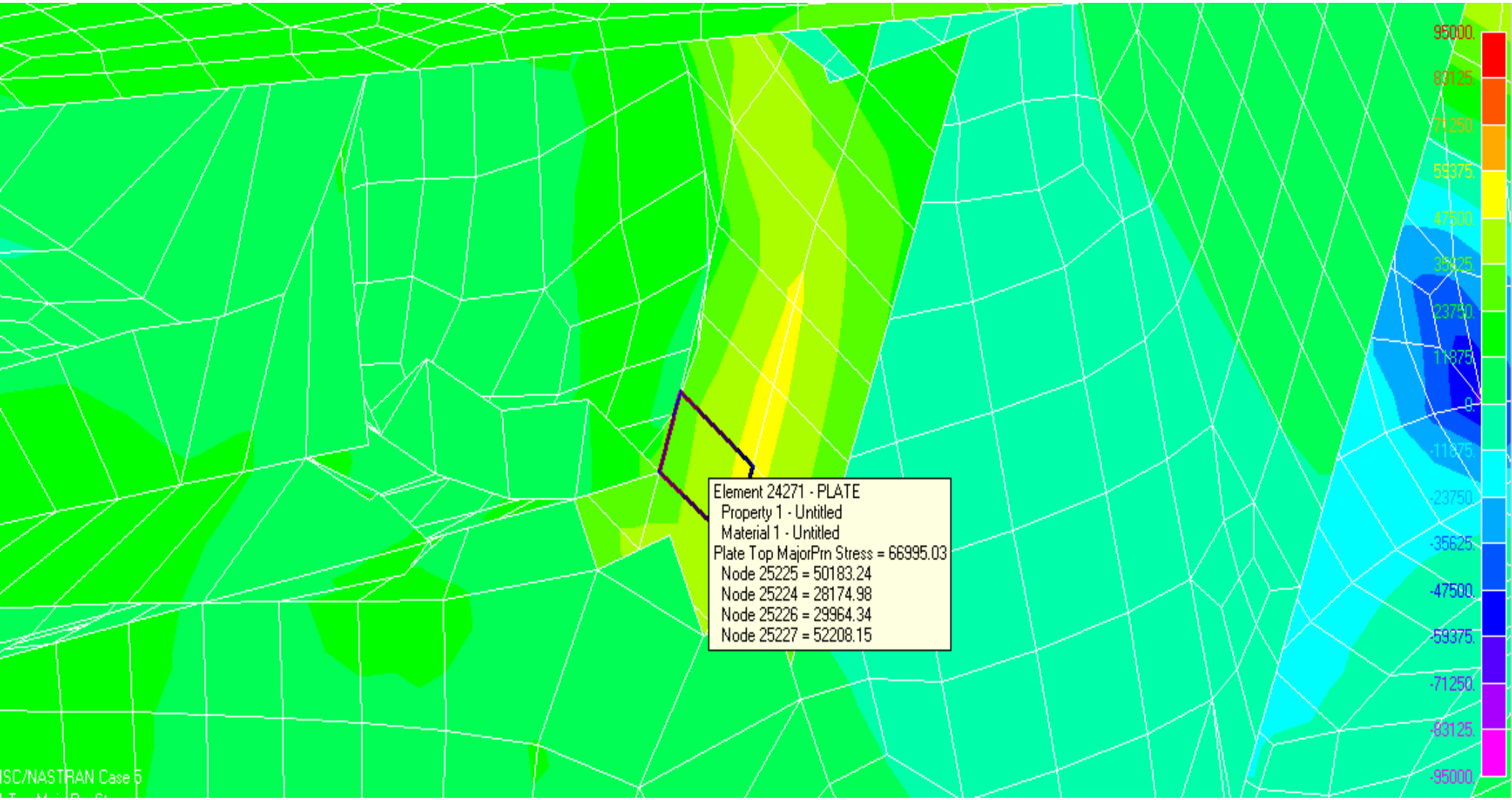
Major Principle stresses in the area of Proposed added gusset with four gusset sets

The max stress is 57 Ksi



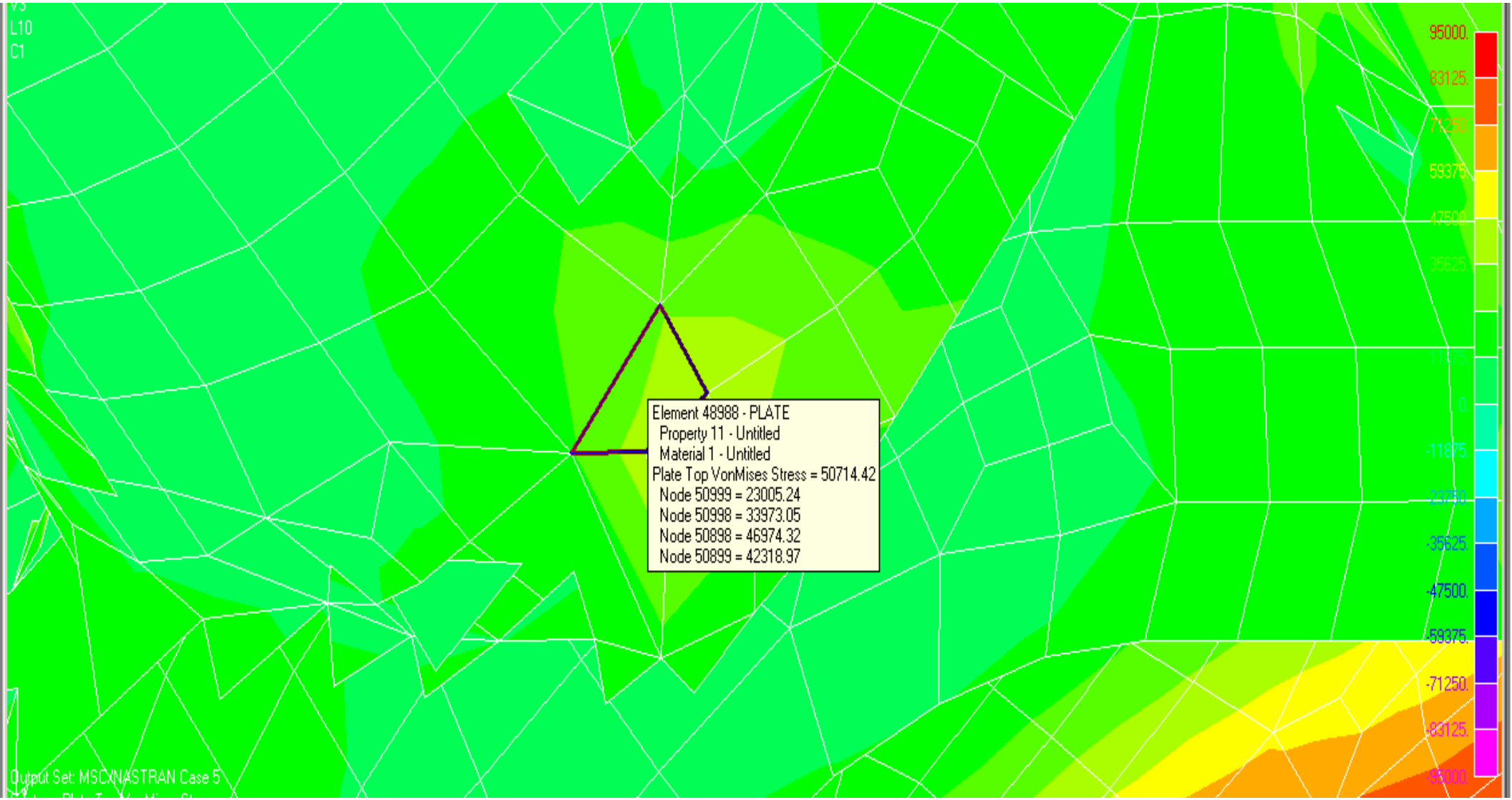
Major Principle stresses in the area of current production gusset set with four gusset sets

The max stress is 67 Ksi



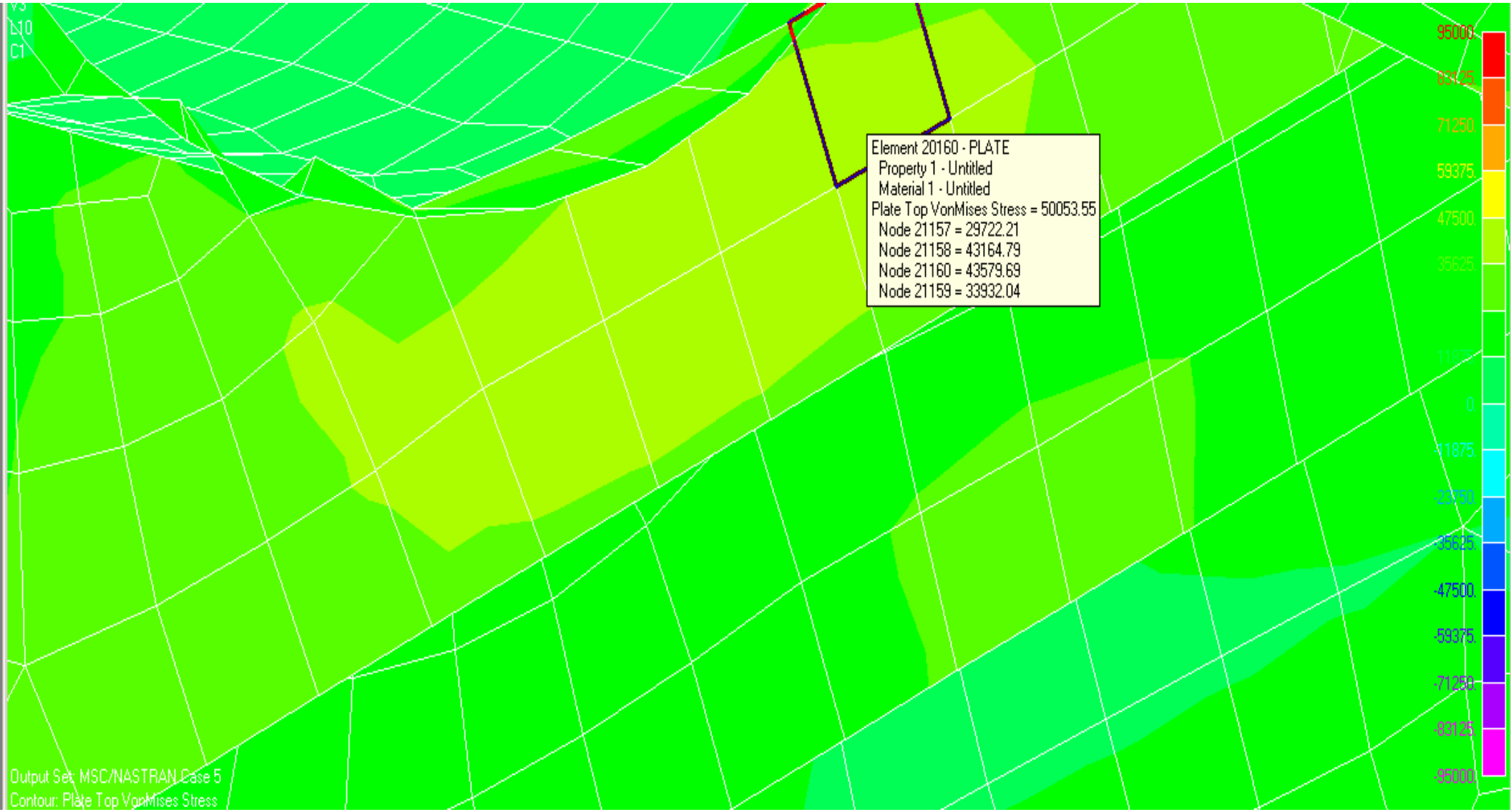
Von Mises stresses in the area of third set of gussets with four gusset sets

The max stress is 51 Ksi



Von Mises stresses in the area of fourth set of gussets with four gusset sets

The max stress is 51 Ksi



Observations

- Addition of third set of gussets reduces the Von Mises stress at that cluster
- Increases the stresses to the fourth cluster
- Addition of fourth set of gussets reduces the stresses in that cluster
- Upper half clusters increase in stress with the addition of the lower 2 sets of gussets

Stresses at different clusters

	Upper Half		Lower Half	
	Proposed Gusset area, Max Principle Stress (Ksi)	Current Gusset area, Max Principle Stress (Ksi)	Third Cluster, Max Von Mises Stress (Ksi)	Fourth Cluster, Max Von Mises Stress (Ksi)
Stress with no Gusset	108	142	93	84
Stress with one set of Gusset	104	107	90	86
Stress with two set of Gusset	57	67	91	85
Stress with three set of gusset	59	65	52	83
Stress with four set of Gusset	57	67	51	51

Conclusions

- The Finite Element Model peak predicted stress correlates to the location of service cracking observed
  - This validates the FEM to substantiate this product enhancement
- Reduction in production stresses in the upper cluster failing cluster with added gussets
- Reduction in production stresses in all clusters with added gussets.
- Upper half clusters are subjected to tensile loading and the lower half to compressive for critical fatigue design condition.
- The Load path movement is predictive using FEM

Recommendations

- Addition of gussets to the next cluster in the load path
- Improving welding process to reduce the heat affected zone
- Conduct a fatigue test to study the fatigue loads and life of the mount