An indicative overview of shell elements for the walls of ITER VV vessel sectors

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This report gives an indication how the vacuum vessel shell can be divided into large panels.
This approach saves costs of welding and, therefore, improves the manufacturability in terms of overall accuracy.
The purpose of this report is to find support for further development of this approach.

The 3D surface is determined from a reference geometry of 2007. *Figure 1* shows the cross section of the centerline of the 60 mm shell and a 3D image.

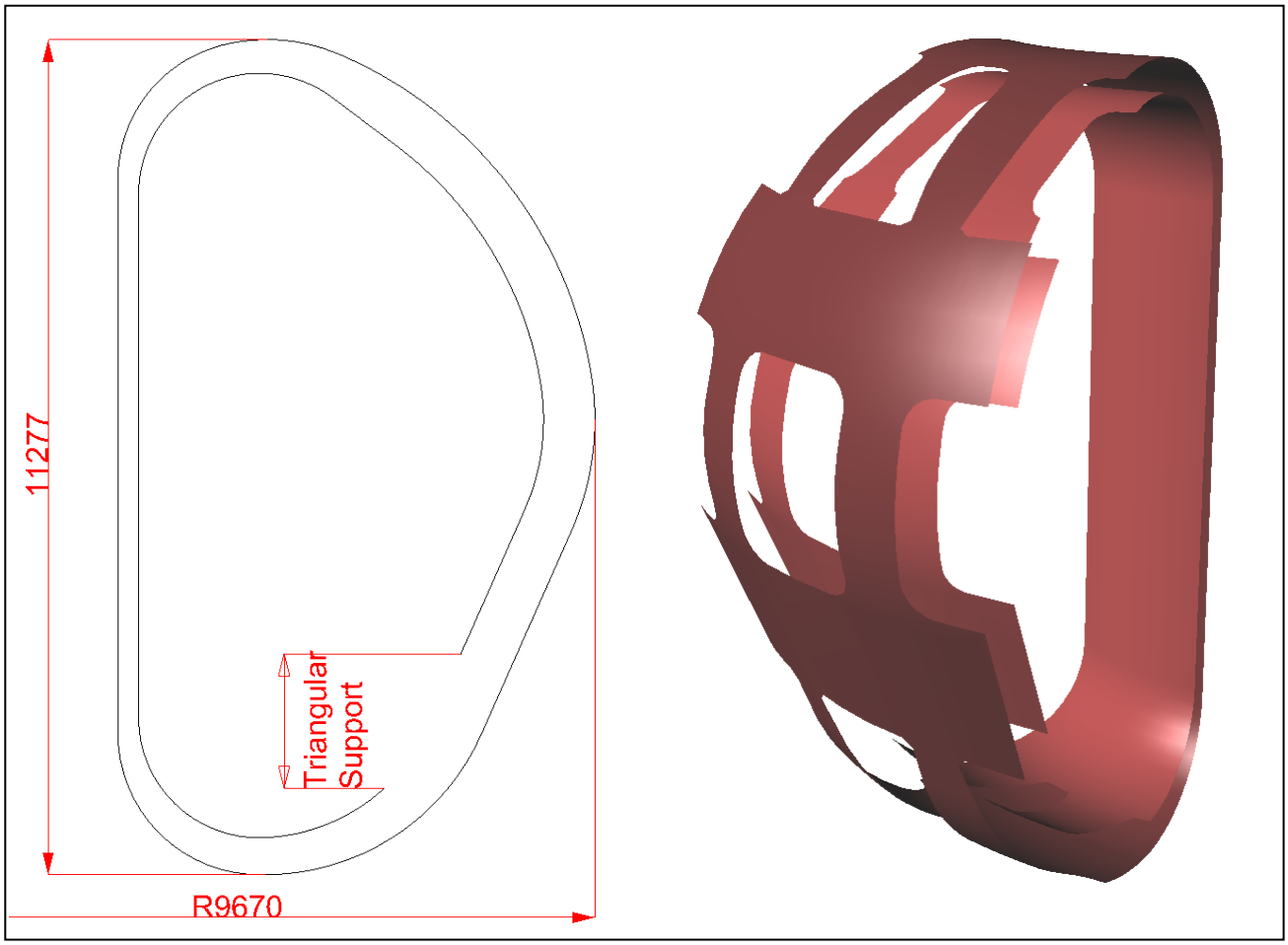

Figure 1. cross section of the neutral lines of the double Shell and 3D image of the double shell of a VV sector

Note: not taken into account are the Triangular Support, the interconnecting ribs, the Stub Keys and the Ports.

The surfaces can be divided into large panels as shown in *Figure 2*.
The red panels can be made by conventional bending.
The blue panels can be made by conventional bending, followed by a calibration by explosive forming.
The green panels can be made by explosive forming plates from a conventionally bent shape.

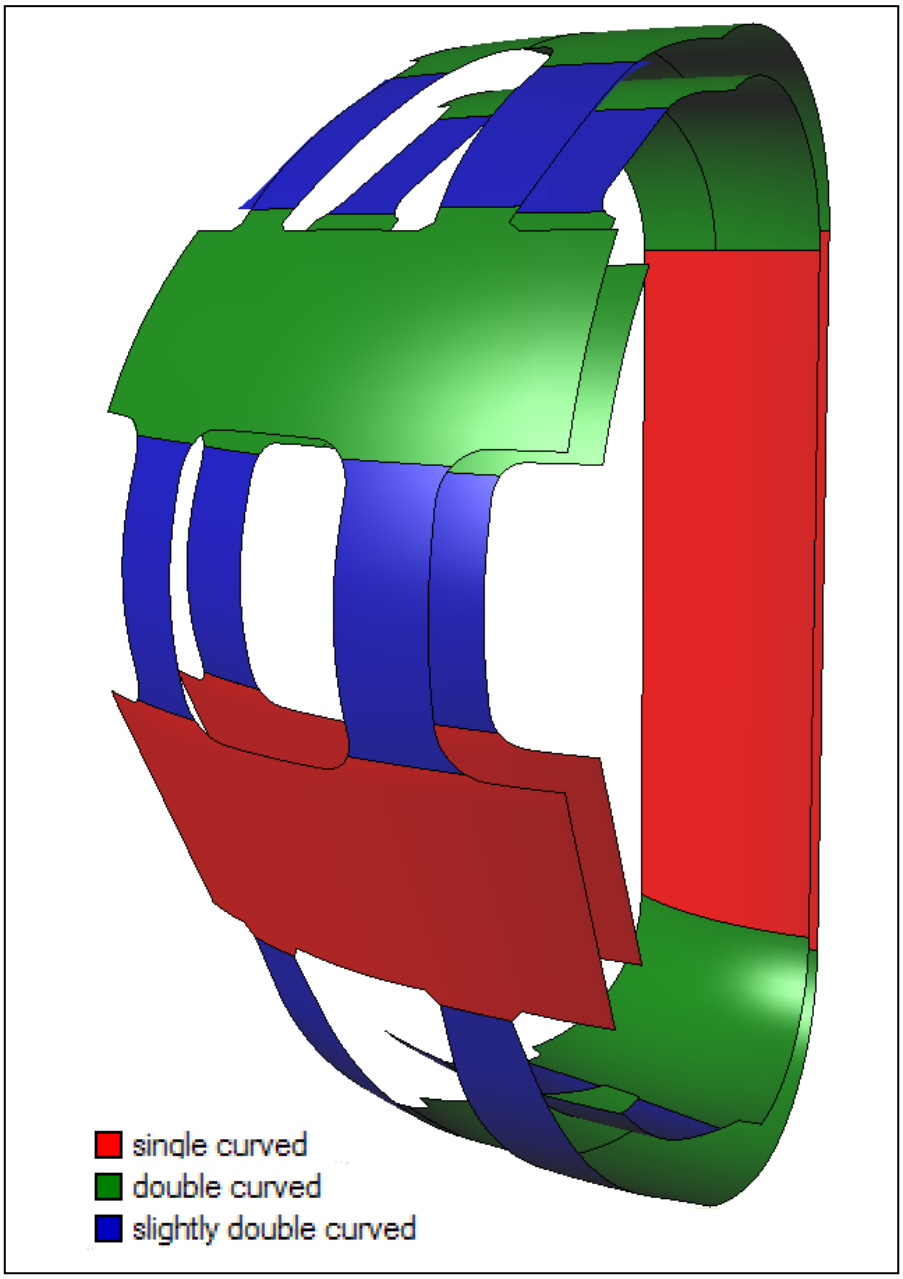

Figure 2. Degree of double curvature of the panels

An overview of the panels with identifications is shown in figure 3.

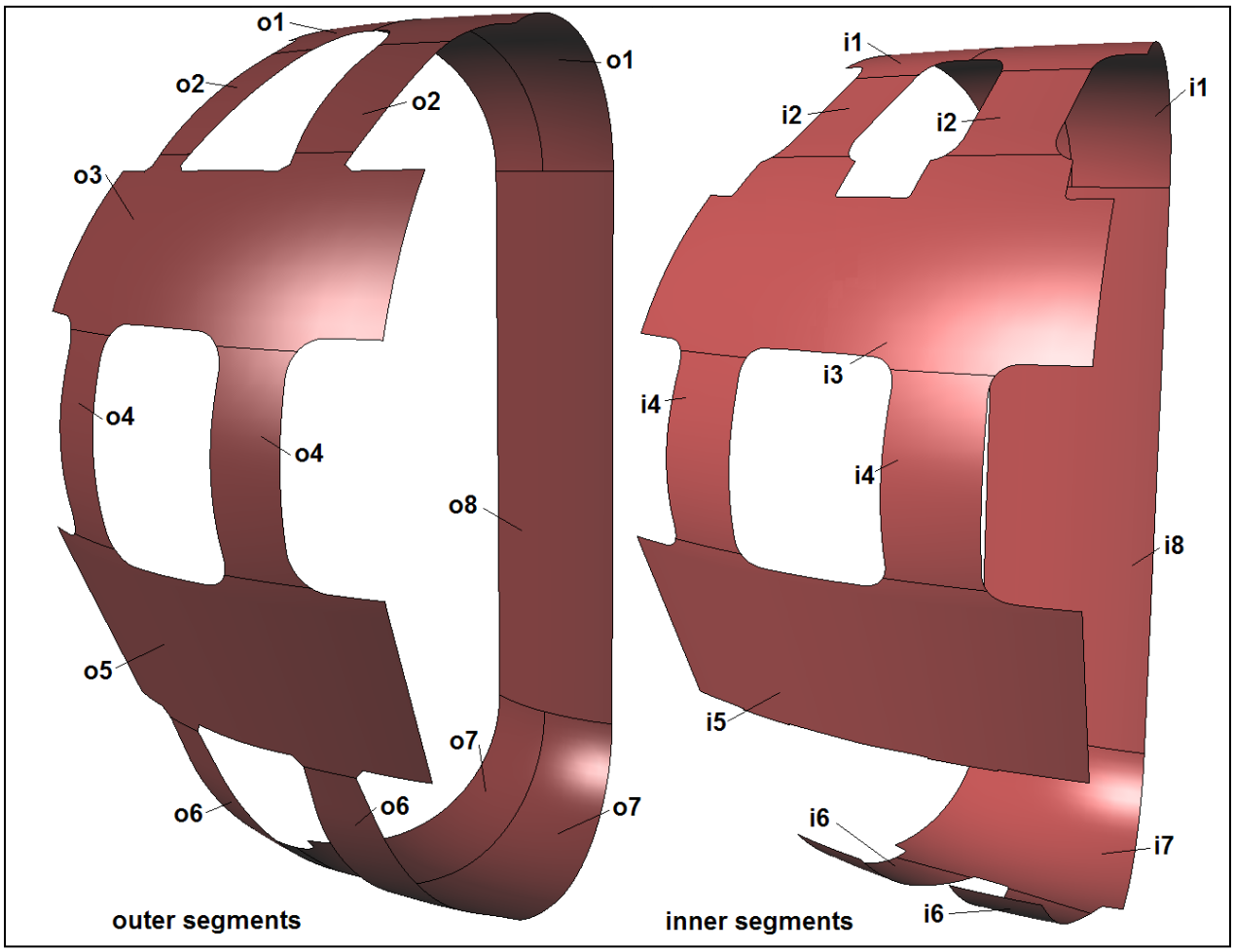

Figure 3. Identification of the panels

Figure 4 shows the developed shapes (black) with the extra material needed for allowing forming (brown). It is assumed, that 150 mm extra length is necessary on both sides where the conventional bending operation is started or ended. 50 mm extra length is assumed for the other two sides.

Figure 5 shows an indicative overview of the plate sizes when all panels for one sector are nested. The total weight of the plates will be 108 tons.

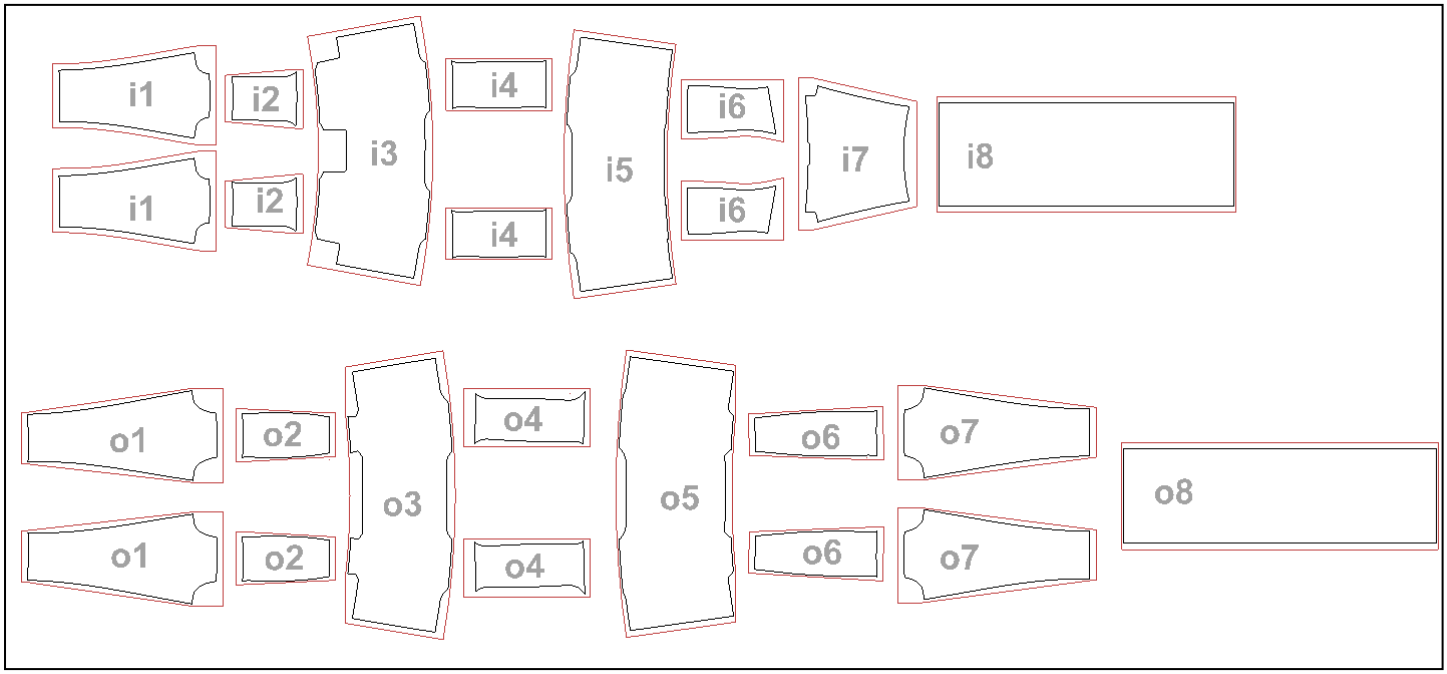

Figure 4. developed (flat)shapes for the segments (black) and cutting lines for the blank plates (brown)

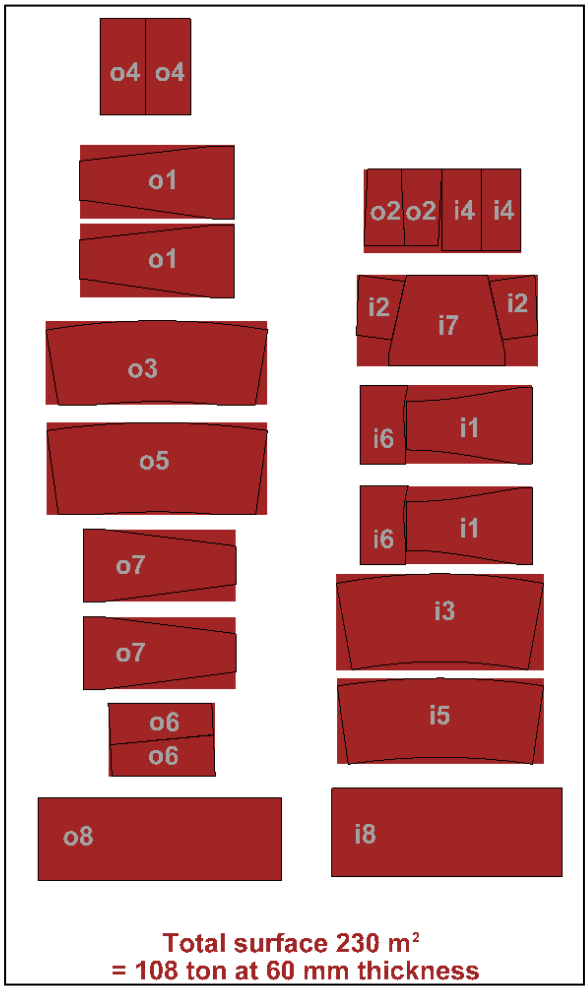

Figure 5. Overview of the necessary plates for one sector

The deformation that will be necessary for forming the wanted shapes is determined by Autoform simulations. Autoform works with shell elements. Multiple shell layers are defined over the sheet thickness in order to account for the thickness effect.
Plate i7 is selected for simulation because this has the shape with the strongest double curvature and, therefore, expectedly the strongest deformation. Plate o8 is also selected because this has the shape with the strongest single curvature.

Figures 6 and 7 give the Autoform results.
The Forming Limit Diagrams of *figure 6* shows the ranges of plastic deformation over both the upper surfaces, the lower surfaces and at the middle planes of the formed plates.
Figure 7 shows the major strain values over the middle planes of the formed plates.
The predicted maximum deformations are very low, in the order of 6% for part i7 and 2% for o8.

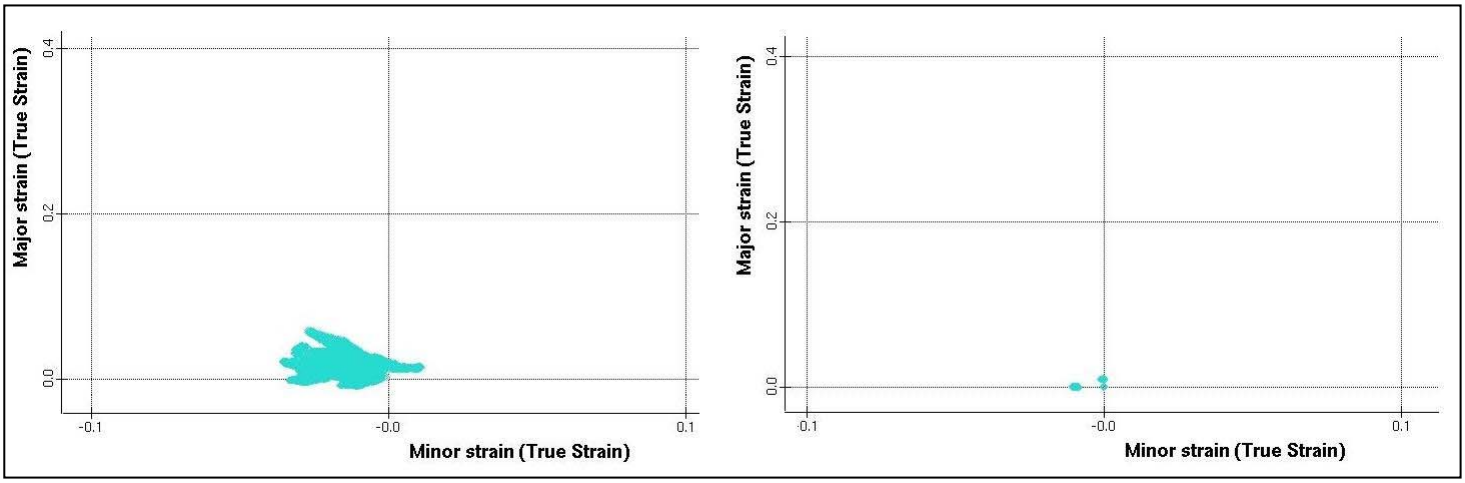

Figure 6. Forming Limit Diagrams of midplane and outer planes for forming parts i7 and o8

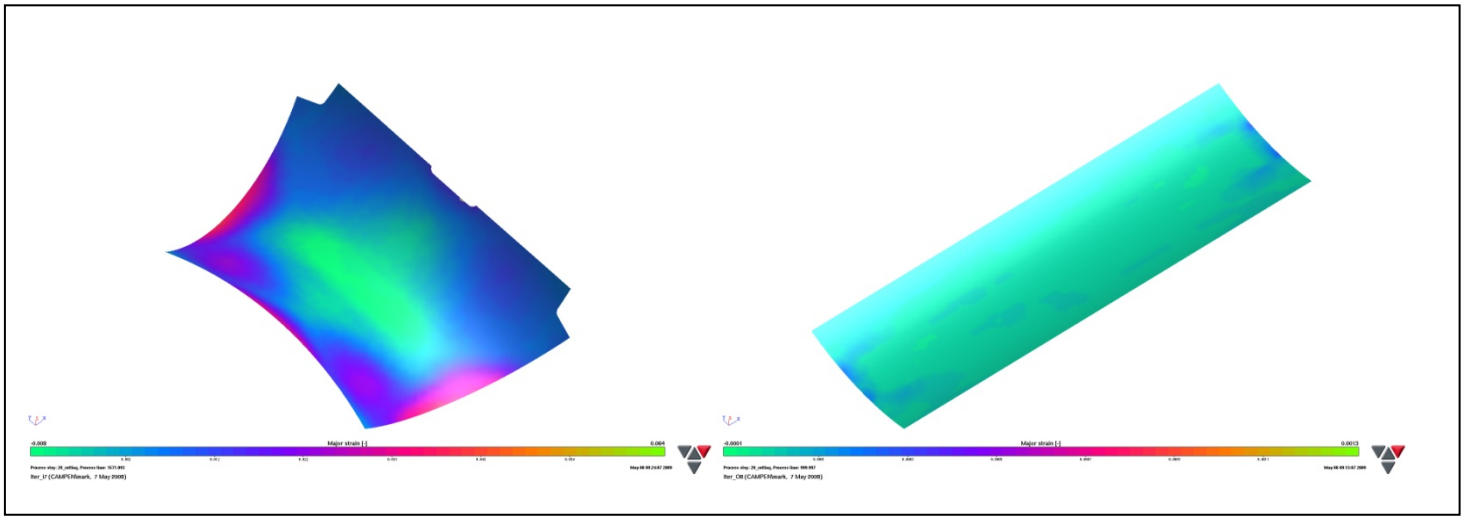

Figure 7. Deformation plots on midplanes for parts i7 and o8