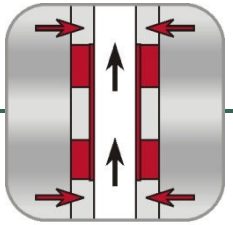
Weatherford®


High Productivity


Optimum Drainage


Effective Isolation


Application Versatility


Integrated Function

Well Completion Technologies

The use of FEA in sand screen design cuts costs and accelerates development

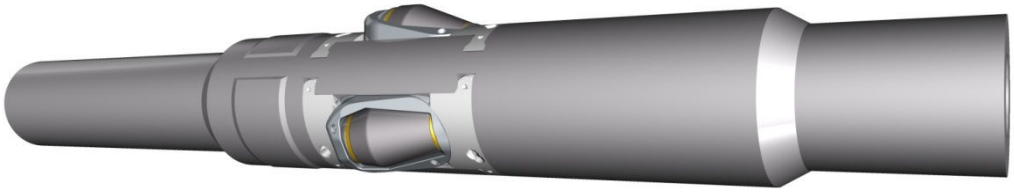
Ken Watson, 3D Design Analyst, Weatherford International Ltd

Hotel Fira Palace, Barcelona, Spain
May 17th to 19th 2011

Solving your sand control challenges.

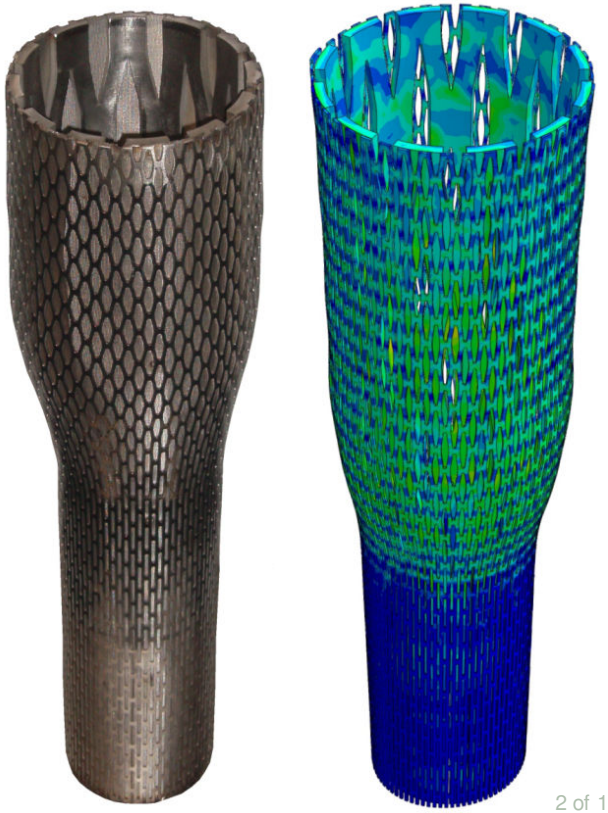
Presentation Overview

- Our ESS® product – a brief introduction to the design and background
- Client Requirement for Erosion Plates / ten designs / what happens if it goes wrong
- Abaqus/Explicit testing of the ten designs
- Physical testing of the two Abaqus suggested “winning” designs
- Conclusions / Q and A



Rotary Expansion Tool for 7” ESS

- *800-1200 psi operating pressure*
- *Requires 20-30 klbs setdown weight*
- *Requires 50 RPM rotation*
- *4-8ft/min expansion rate*

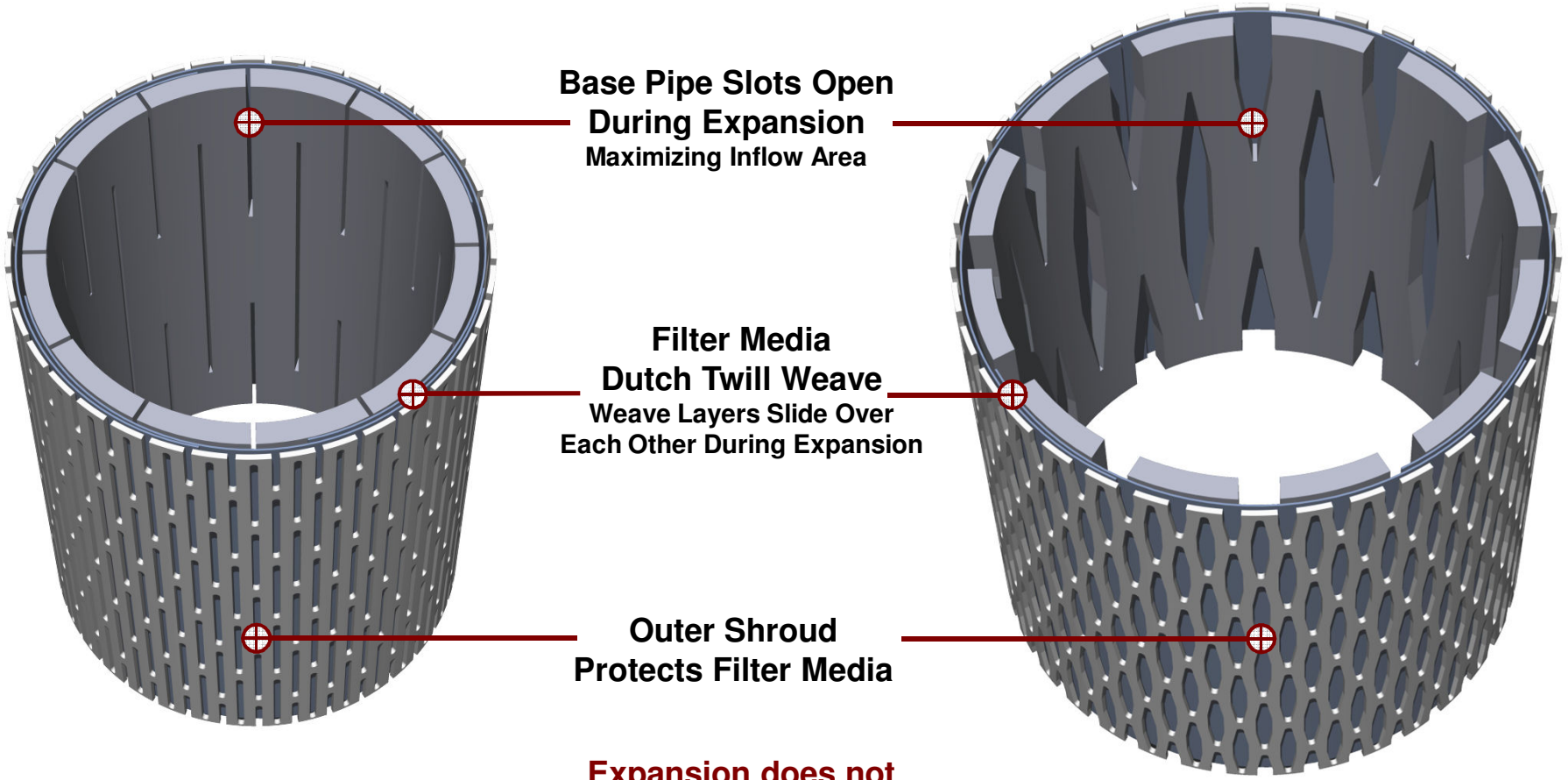


ESS® = Expandable Sand Screen

ESS® Product – Design / Background

ESS is a product that controls the ingress of solids in oil and gas reservoirs with weak and unconsolidated formations. *ESS* improves well production and significantly reduces well costs when compared with other systems.

Product sizes; 4", 4-1/2", 5-1/2" and 7"
There are also a variety of Weave aperture sizes / ratings



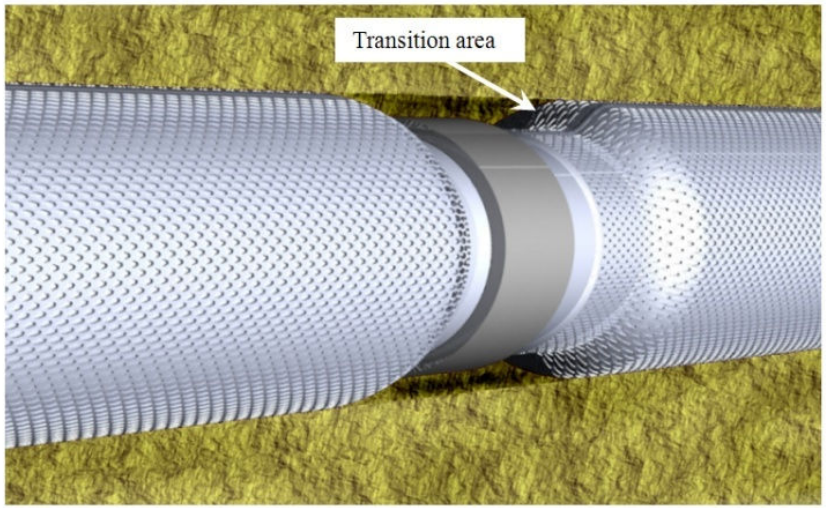
Expansion does not change the Weave aperture size / rating

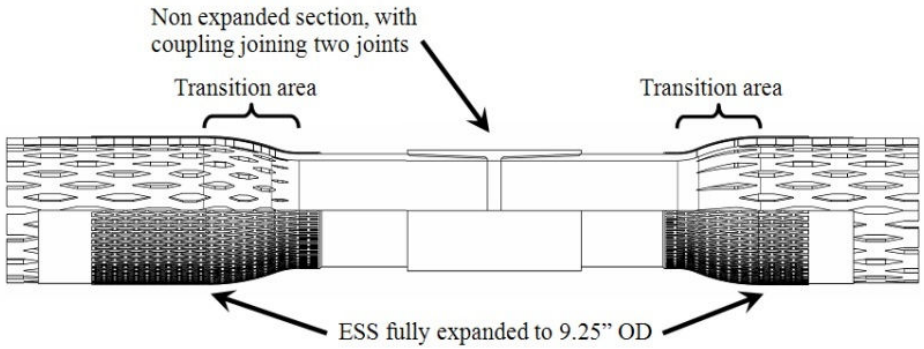
ESS ® Product – requirement for Erosion Plates

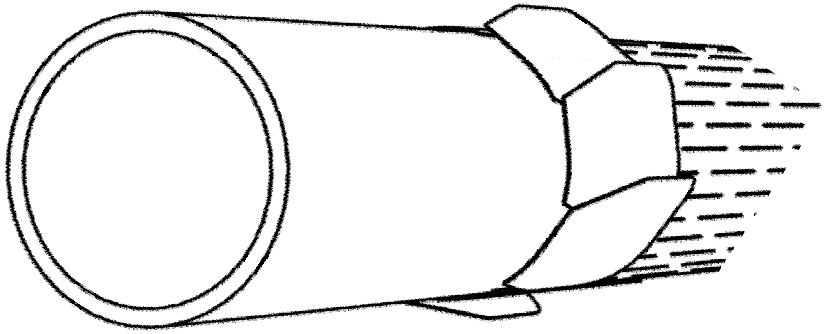
Background to the Erosion Plates studies

To create a non-flowing transition area between the expanded and non-expanded section on 7" ESS. Erosion of the weave could occur in the transition area in especially high-rate wells.

Unlike a "Standard" ESS joint, where the connection is slotted (and expanded), the 7" ESS joint uses a Coupling (with premium connection)

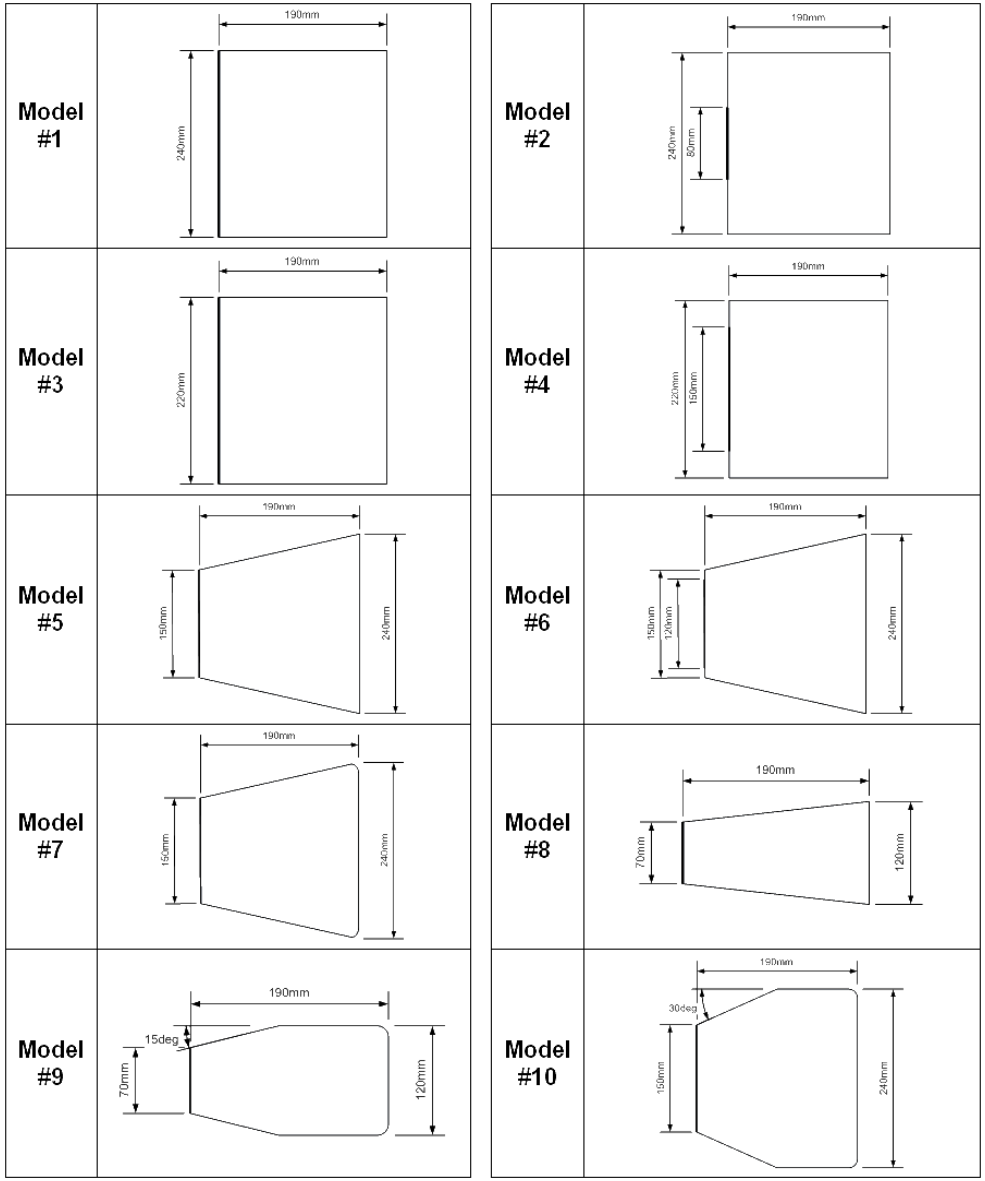






Example of how the Erosion Plates would be applied to the basepipe (at the transition area)

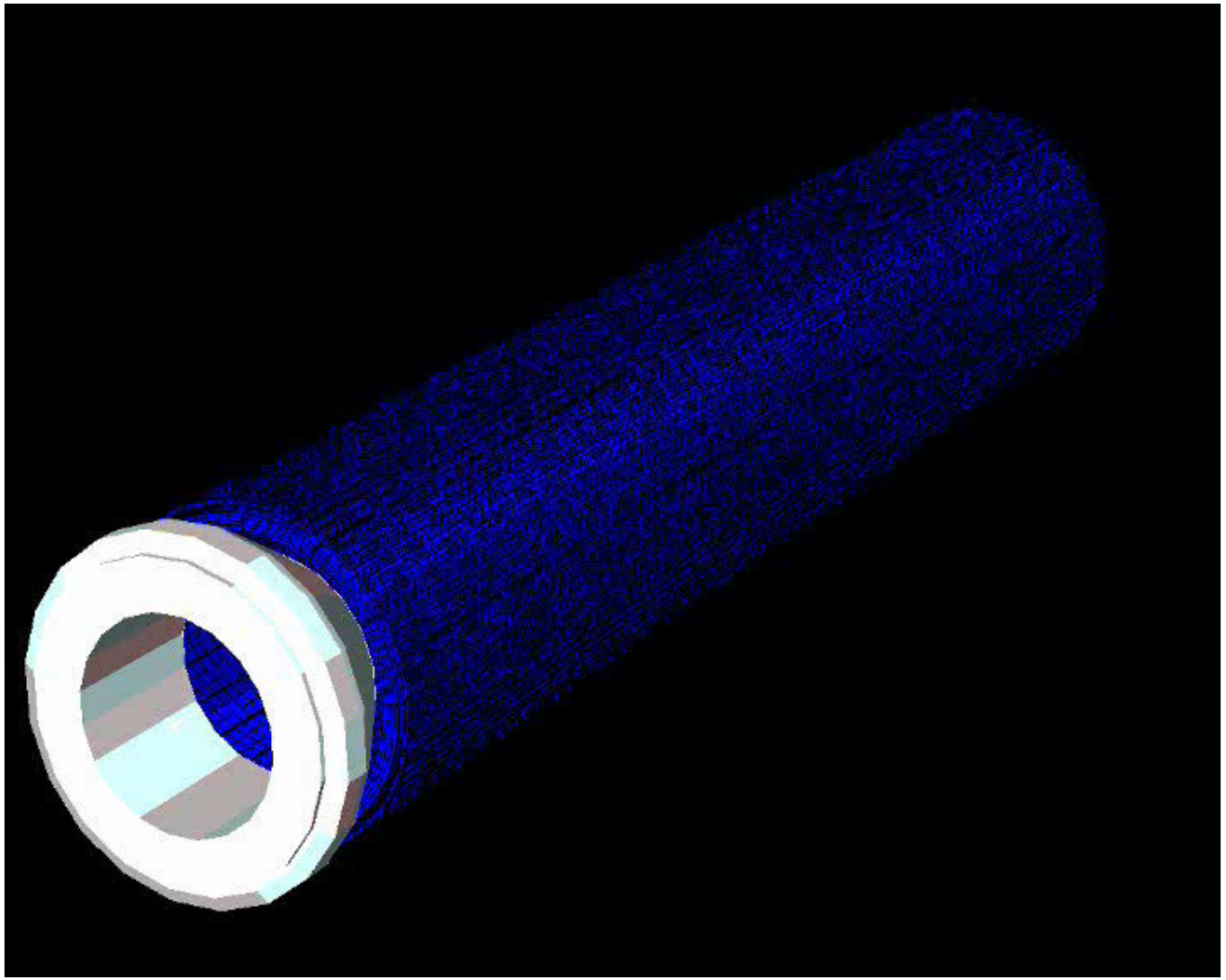
ESS ® Product – Erosion Plates – ten designs

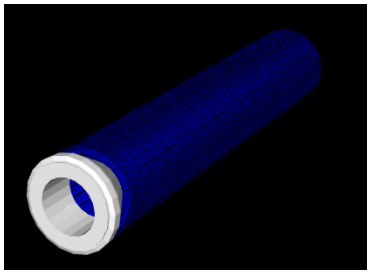


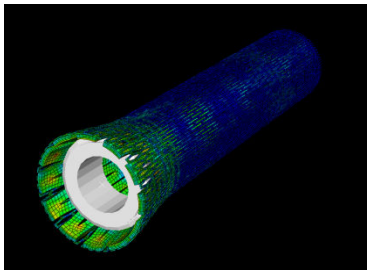
Examples of the ten designs

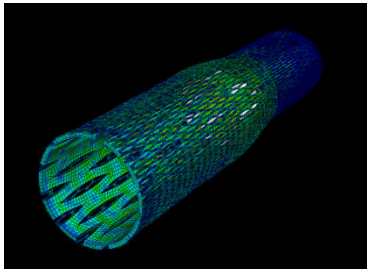
ESS® Product – Expansion using a Cone

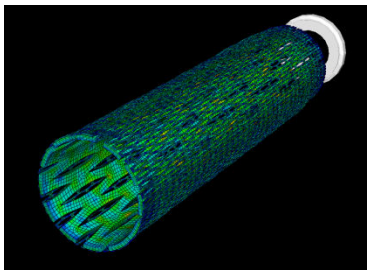
Elements; C3D8R Slotted 3D parts modelled in Pro-Engineer then imported into Abaqus/CAE





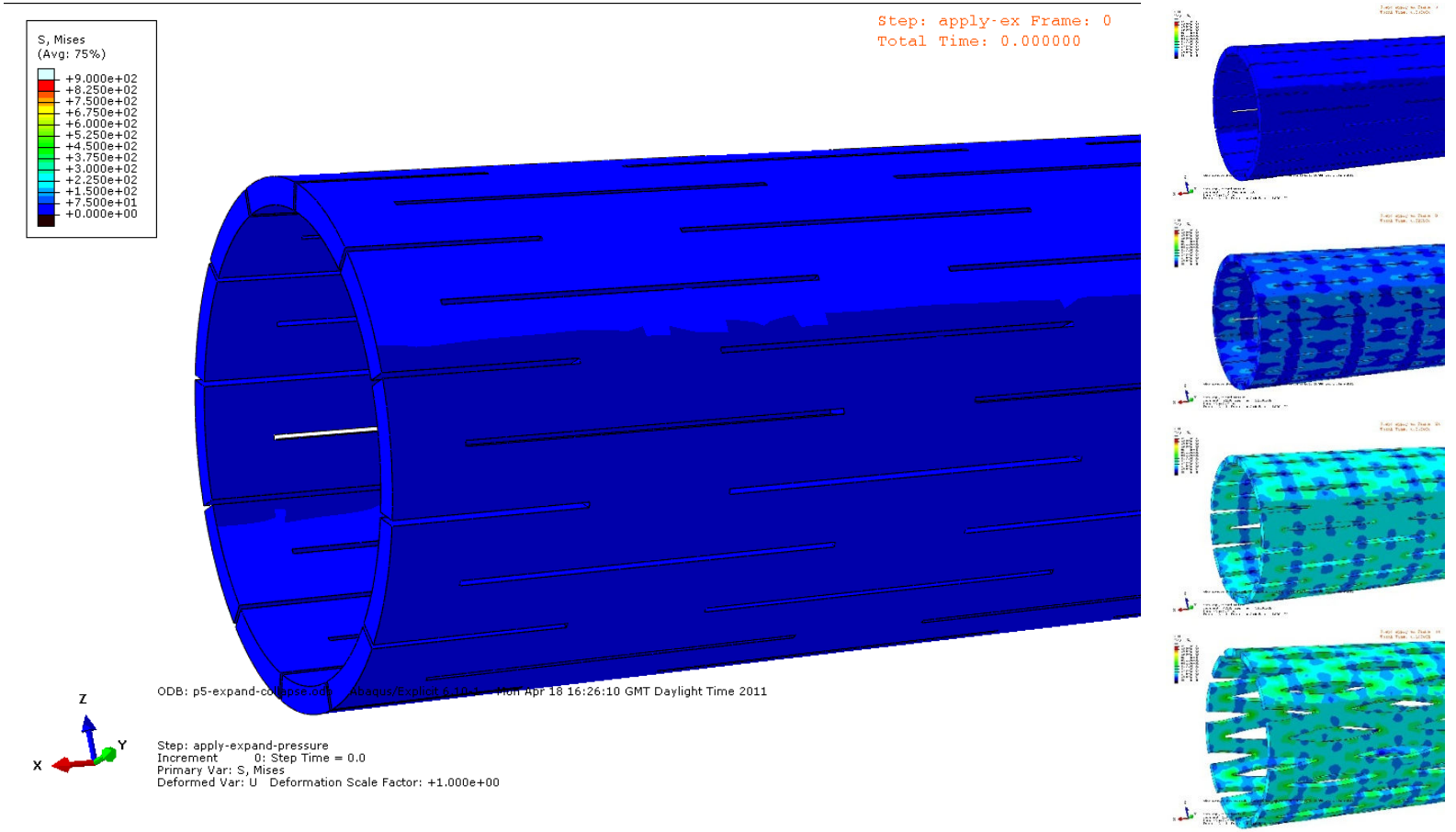




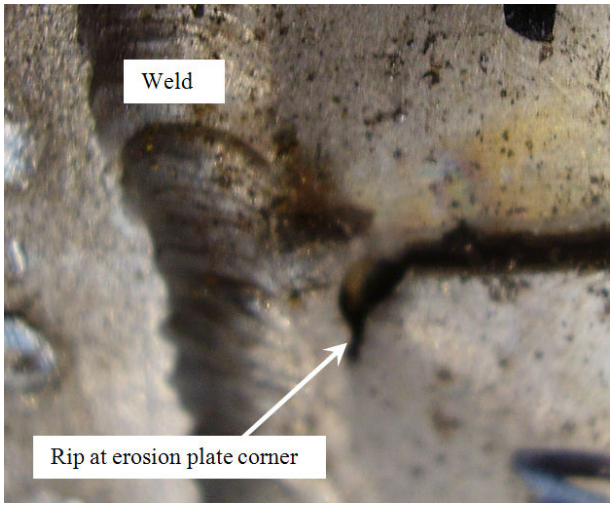


ESS® Product – Expansion using Pressure

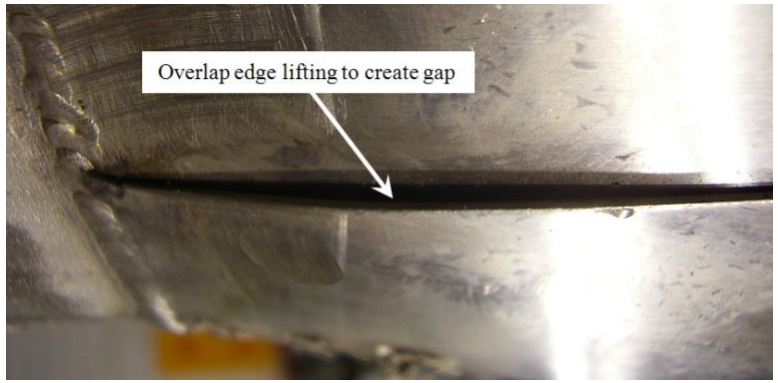
Elements; C3D8R Slotted 3D parts modelled in Pro-Engineer then imported into Abaqus/CAE



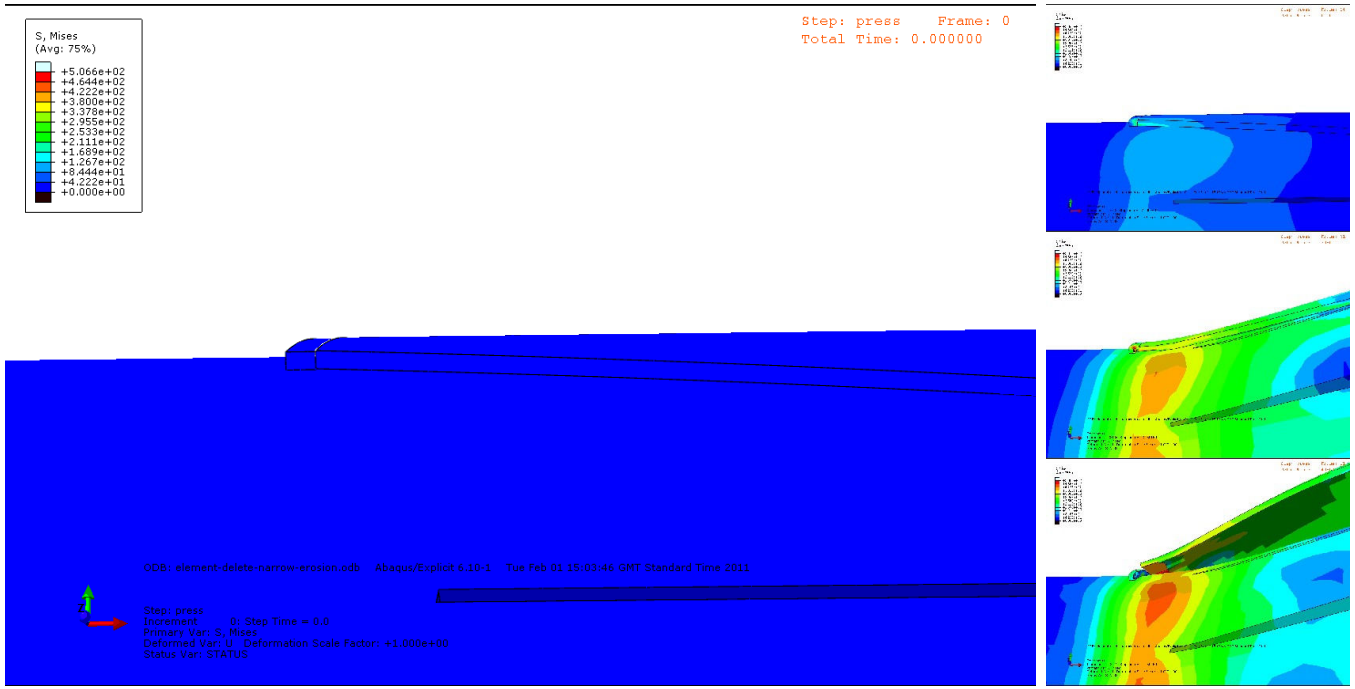
ESS® Product – Erosion Plates – if it goes wrong



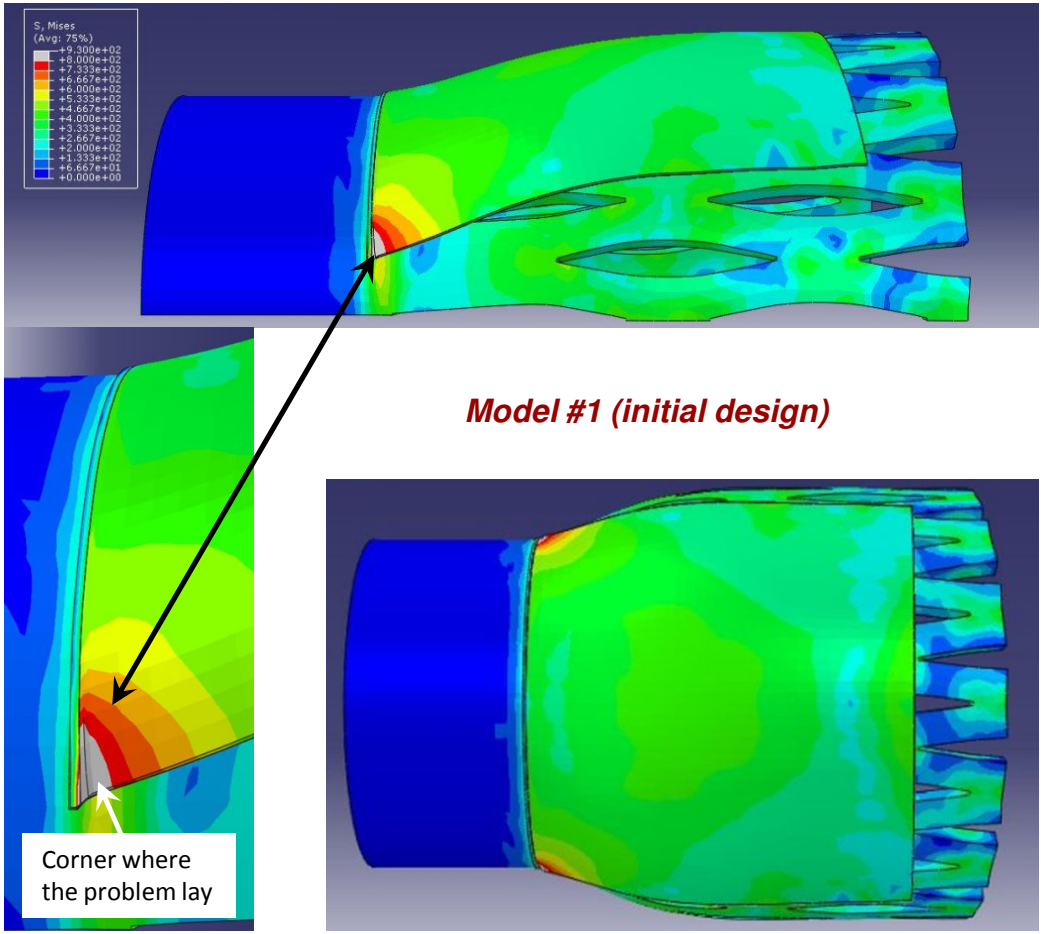
Example of a rip at the erosion plate corner



Example of the overlap edges lifting away



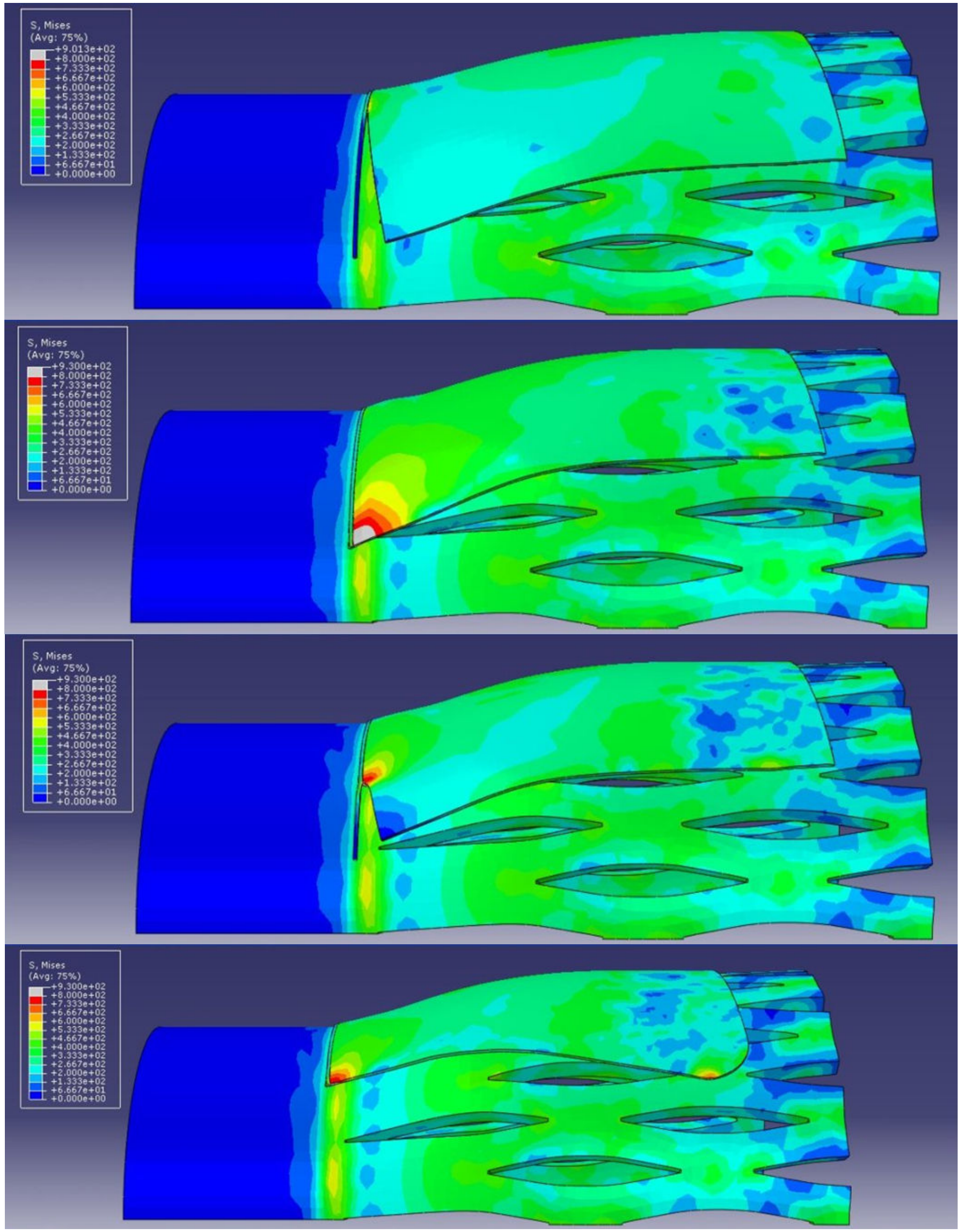
ESS ® Product – Erosion Plate designs



Model #1 (initial design)

Legend was set to a constant value throughout all simulations so direct comparisons of stress could be made

ESS ® Product – Erosion Plate designs



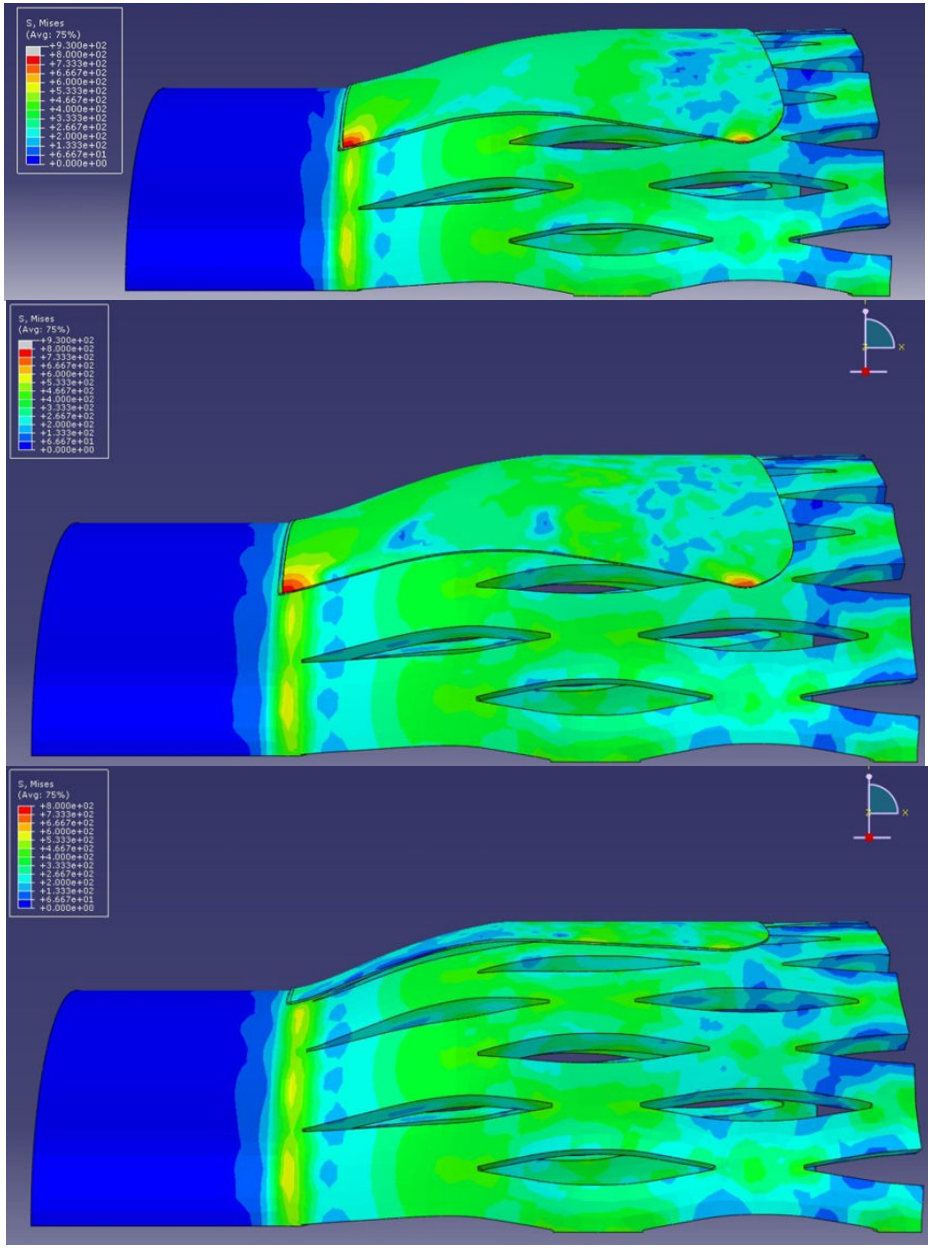
Model #2
Low stress throughout
but not ideal due to edge lifting

Model #3
High stress at corner

Model #4
High stress at weld/plate interface

Model #5
High stress at corner

ESS ® Product – Erosion Plate designs

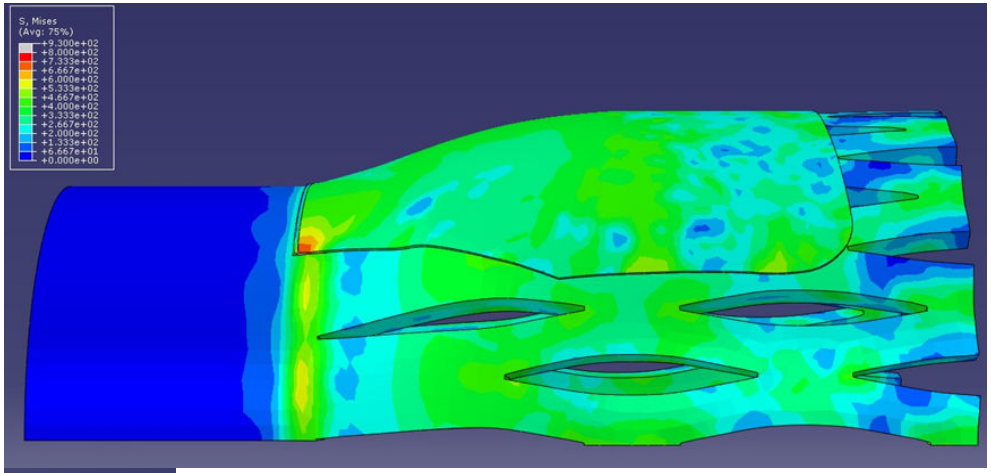


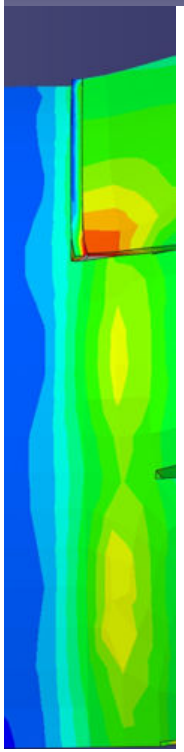
Model #6
High stress at corner

Model #7
High stress at corner

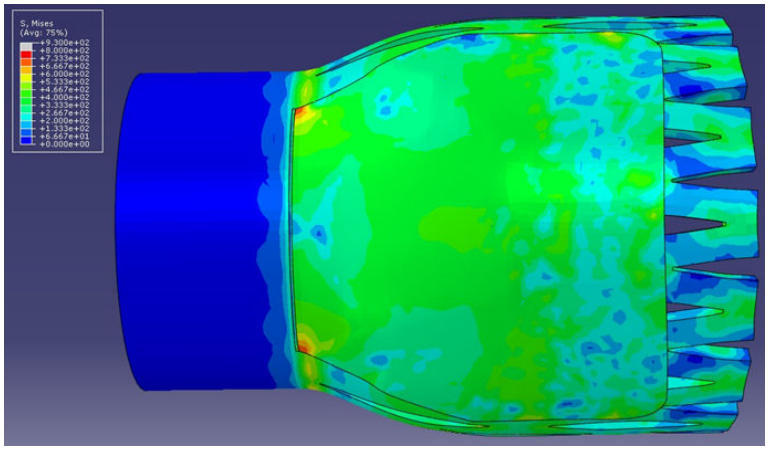
Model #8
Low stress at throughout
but potential for overlap edges to lift apart

ESS ® Product – Erosion Plate designs

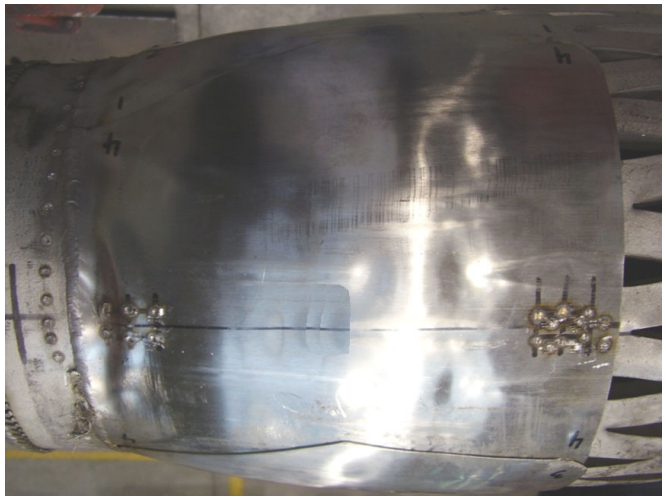




Model #10
Low stress throughout

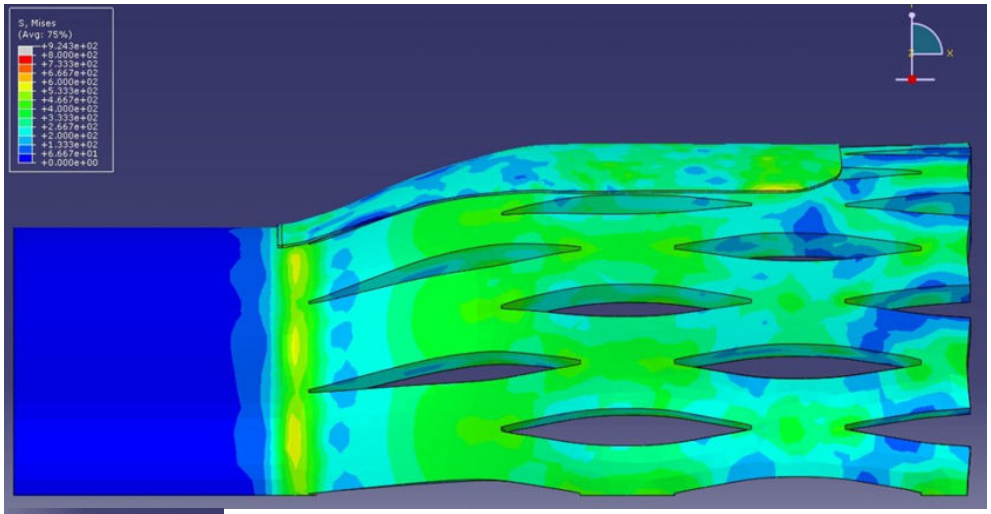


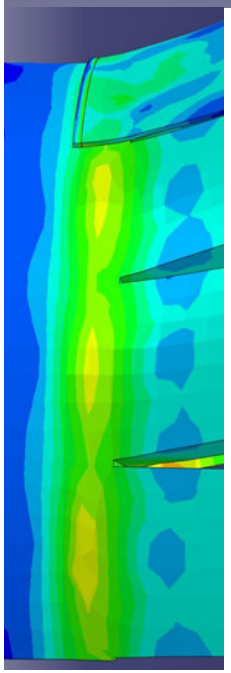
Model #10
During fabrication – with circumferential weld



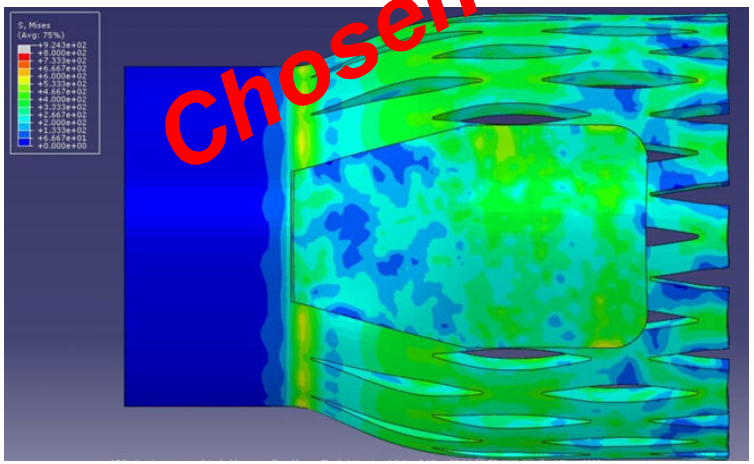
An expanded example
(shroud and filter layers stripped off)

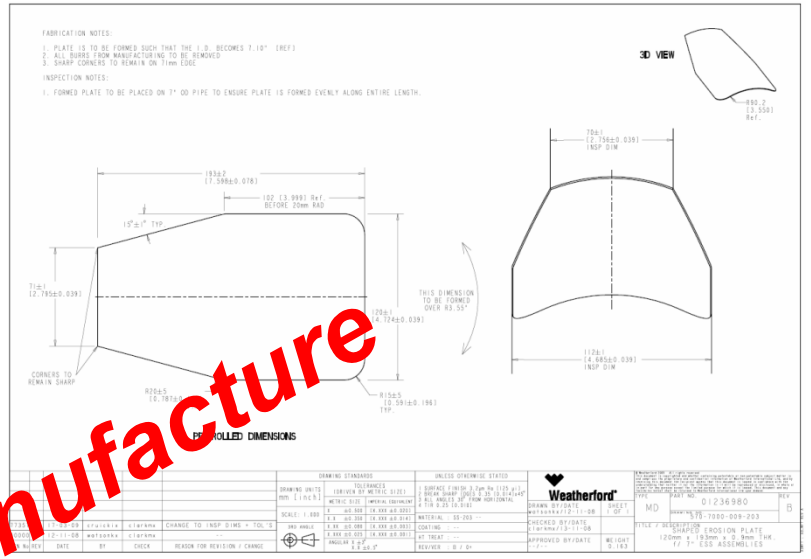
ESS ® Product – Erosion Plate designs



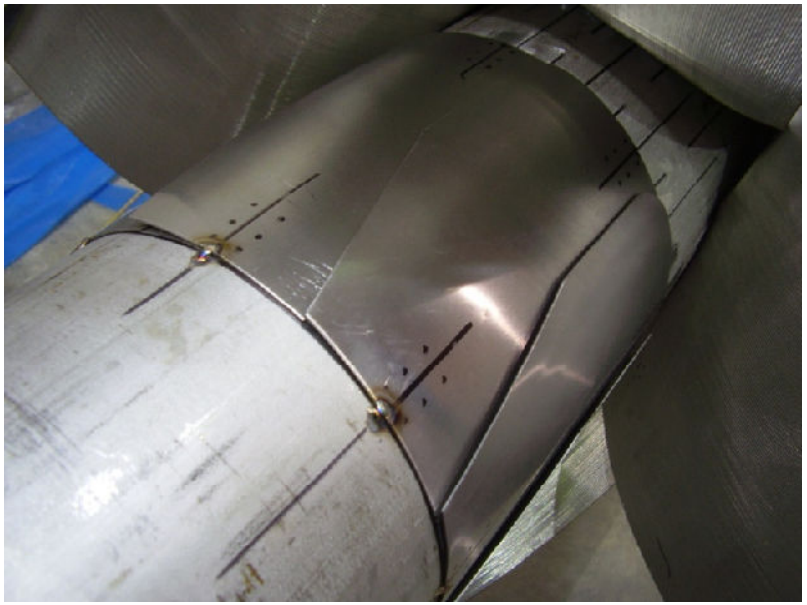


Model #9
Low stress throughout





Chosen for manufacture



Model #9 During fabrication

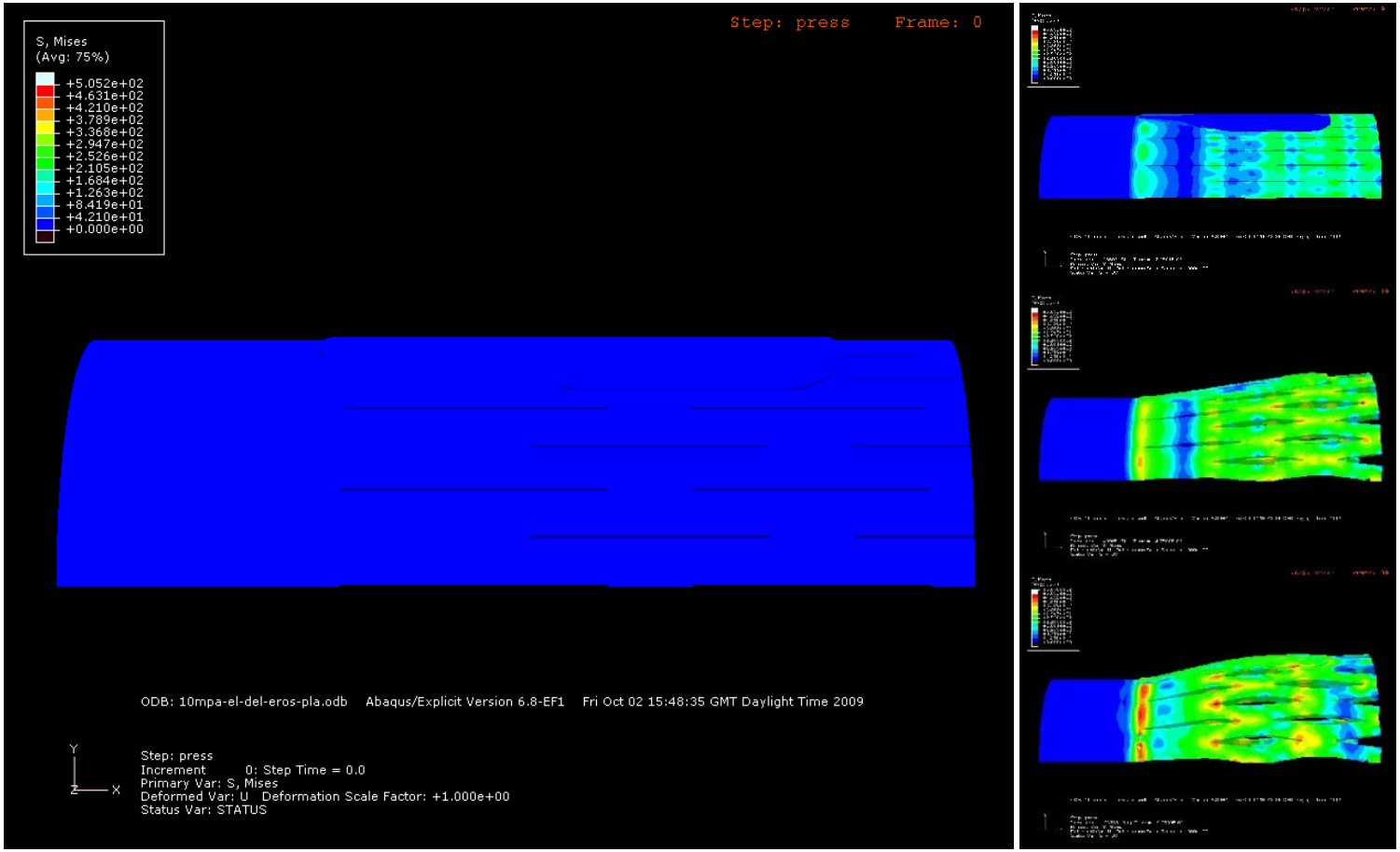
ESS ® Product – Expansion (Pressure) with Erosion Plates

Case Study, for a specific Client requirement

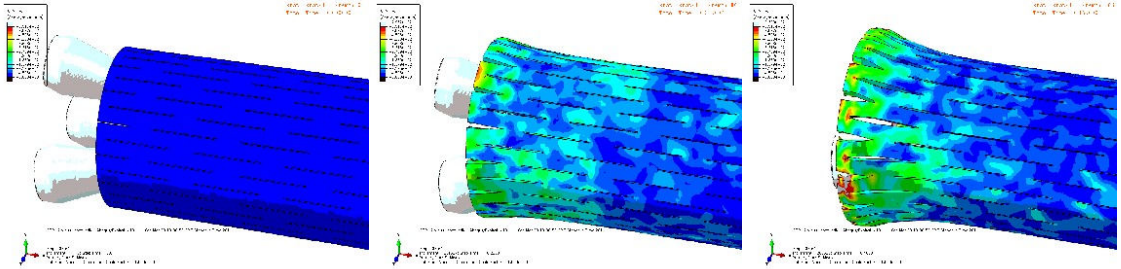
New Plate designs – 10 off

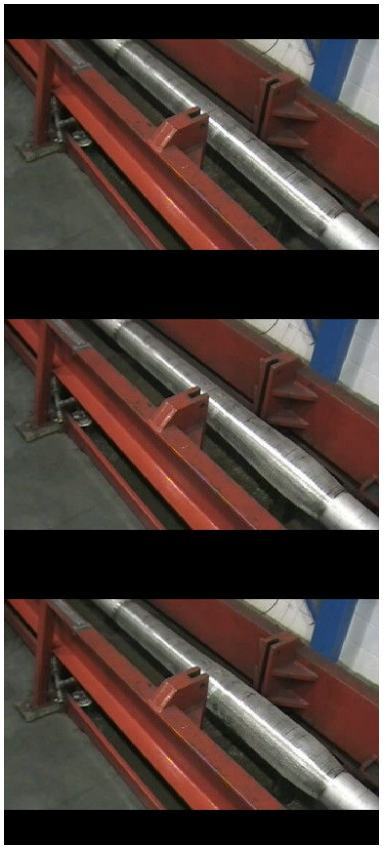
Physical test pieces – 2 off

Weatherford ESS Engineers benefited by saving time; 60% and costs; 75% by using Abaqus/Explicit in this study



ESS® Product – Expansion (tested) with Erosion Plates

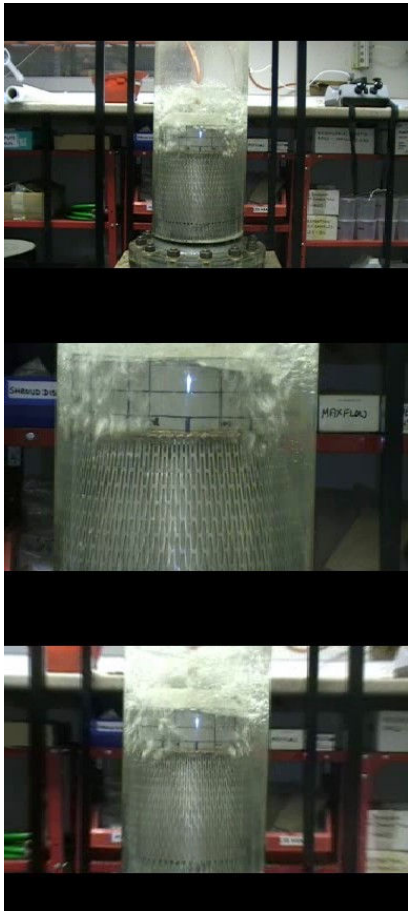




ESS ® Product – Erosion Plate testing (laboratory)

Air bubbled through a water filled sample

Where the bubbles come out give an indication if / where the problem is in this case, possible rips at the weld / corners of the plates



ESS ® Product – Erosion Plate testing (laboratory)

Air bubbled through a water filled sample

Where the bubbles come out give an indication if / where the problem is in this case, possible lifting at the overlaps between plates

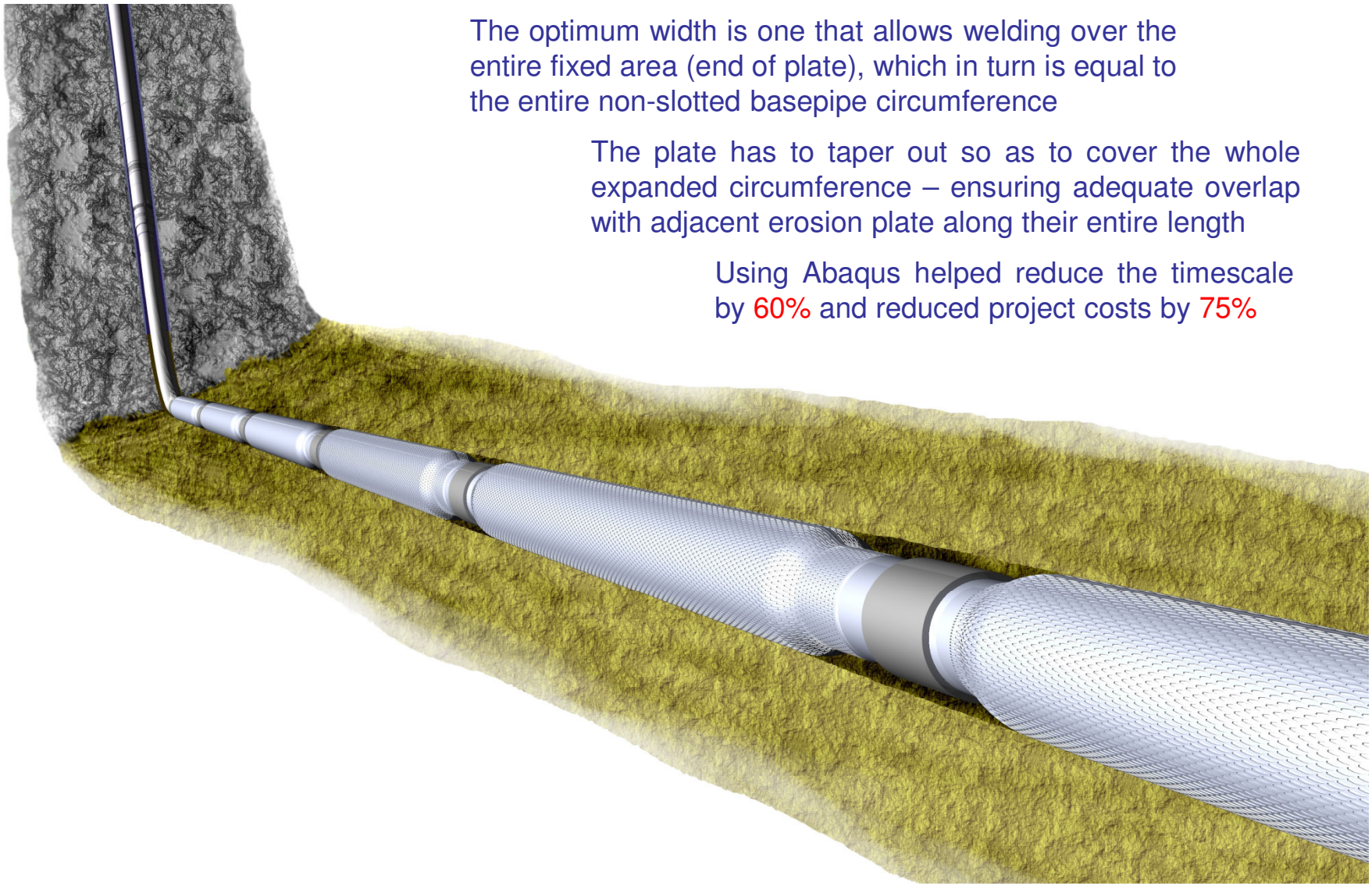
Conclusions

Abaqus/FEA modelling revealed that a shorter weld reduces the stress levels in the erosion plate.

The optimum width is one that allows welding over the entire fixed area (end of plate), which in turn is equal to the entire non-slotted basepipe circumference

The plate has to taper out so as to cover the whole expanded circumference – ensuring adequate overlap with adjacent erosion plate along their entire length

Using Abaqus helped reduce the timescale by 60% and reduced project costs by 75%



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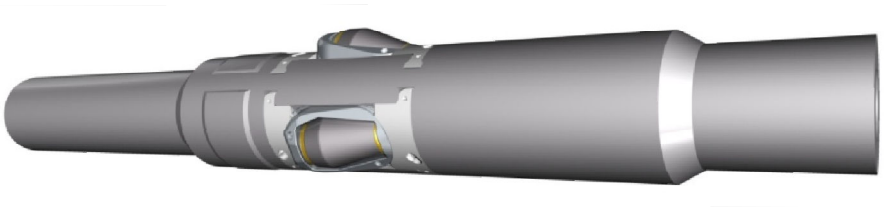

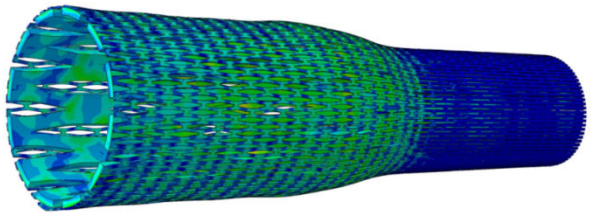

Thank you for your attention **Please feel free to ask any questions**

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