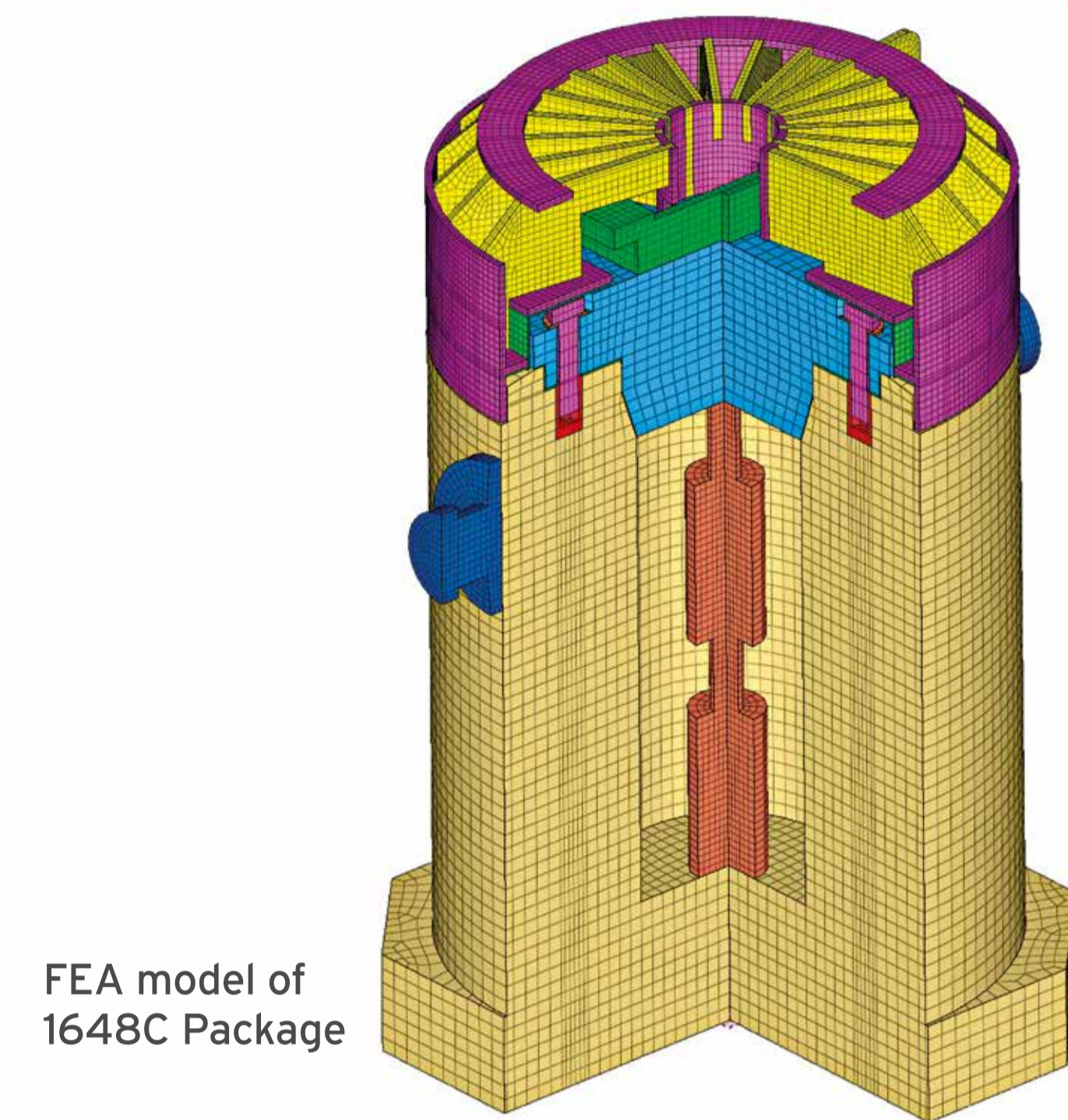


# 1648C FEA Model Impact Validation and Verification

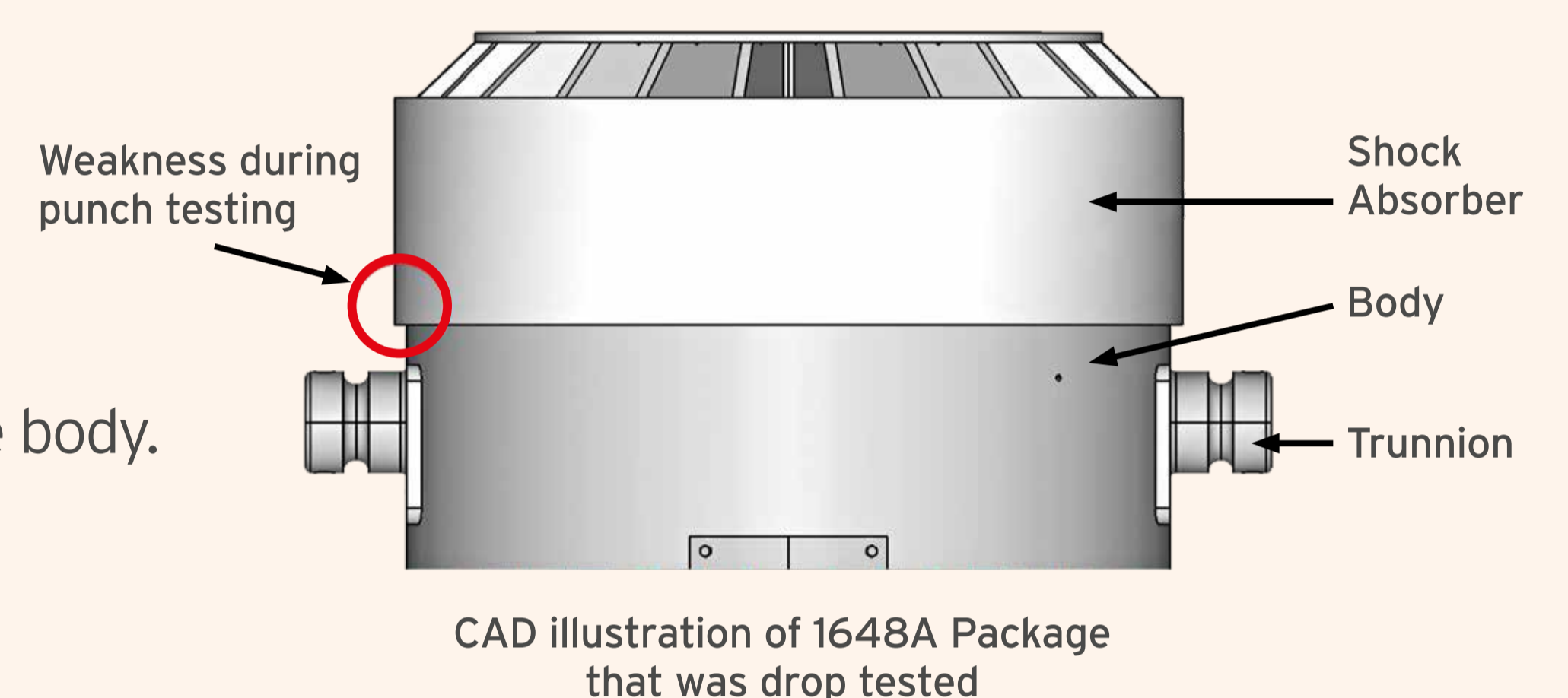
## Why do we need validation and verification?

- 1648C package to be re-licensed as a Type A(F).
- It's regulatory performance has always been compared to the 1648A package.
- It has never been physically drop tested.
- The 1648A was physically drop tested in 1980.
- The validation work looked to accurately model the 1648A drop test with FEA.
- The FE model of the 1648C was then verified against the FE model of the 1648A.
- This was to prove the methodology was sufficient for further detailed analysis to justify the Type A(F) license.



## Package Differences

- Both the 1648A and the 1648C packages are very similar designs.
- Materials changed from the 1684A to improve performance during ACT.
- One of the key design changes was the shock absorber.
- On the 1648A package that was drop tested, the shock absorber sat proud of the package body.
- On the 1648C package the shock absorber sat inbound of the body diameter.
- This meant there was no lip for the punch to catch on.

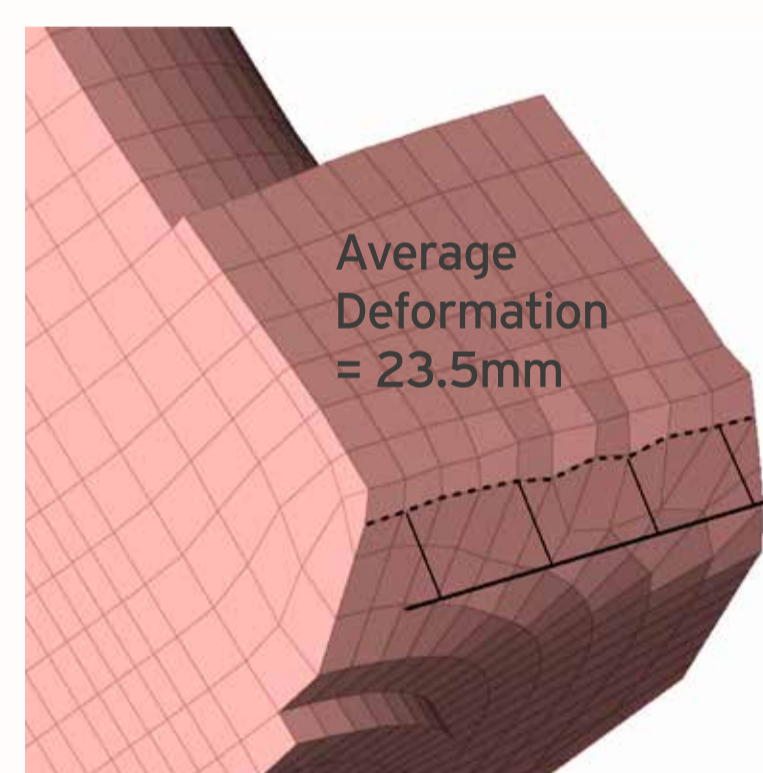


## Drop 2:

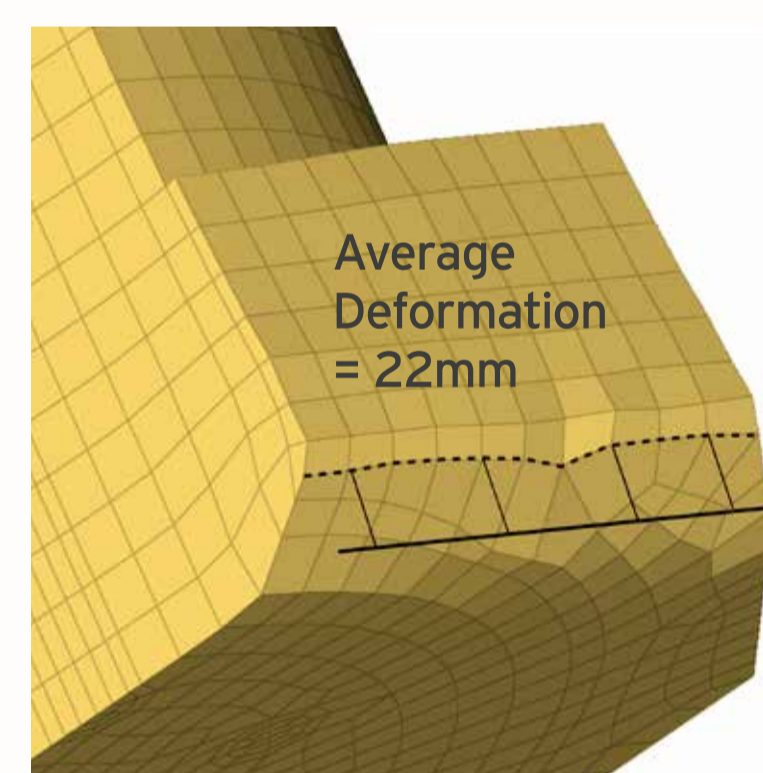
Drop tested from 9m onto a flat target below.  
Package orientated 35.5° from vertical, base down.



1648A initial test orientation



1648A FEA base edge deformation, rotated for clarity



1648C FEA base edge deformation, rotated for clarity

### Physical test:

- Package impacted in the intended orientation and rebounded to ~400mm.
- The base edge was deformed approximately 20mm from the primary impact, and an indent of 2.5mm was measured in the drop test target plate.

### 1648A FEA:

- The deformation ranged from 19.9mm to 27.9mm across the nodes on the impacting edge.
- The average deformation was 23.5mm.

### 1648C FEA:

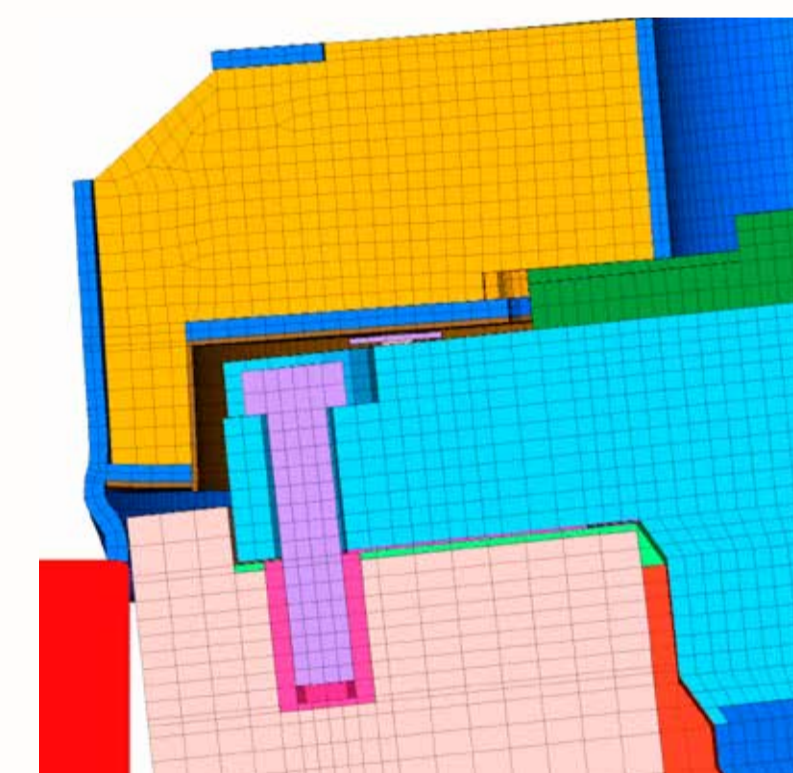
- The deformation ranged from 17.4mm to 25.9mm.
- Average deformation of 22mm on the base edge.

## Drop 9:

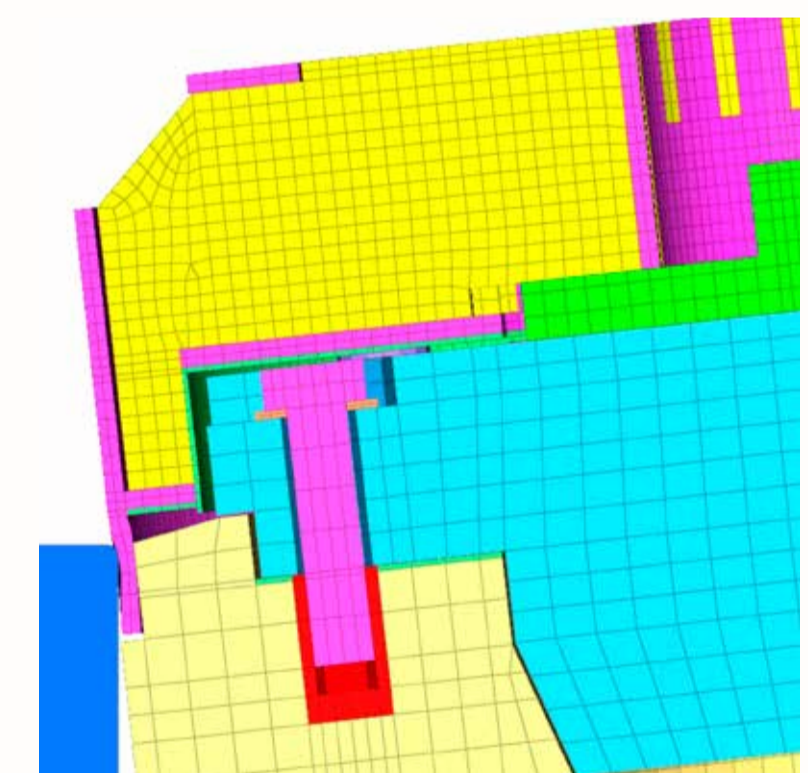
Drop tested onto a steel punch from 1m above.  
Package orientated 6.5° from vertical.



1648A initial test orientation



1648A FEA shock absorber lip caught on punch causing the attachment bolts to pull through



Redesigned 1648C shock absorber no longer contacted by punch

### Physical test:

- The lip of the shock absorber caught on the punch causing it to lift ~65mm upwards.
- Three of the shock absorber bolts were completely pulled through as a result of the impact.

### 1648A FEA:

- The shock absorber was lifted 38mm, which pulled on the shock absorber bolts.
- The two bolts closest to the punch elongated by 11.3mm.

### 1648C FEA:

- Due to the shock absorber design, there was not a lip to catch on the punch.
- The shock absorber bolt and the lid bolt all remained elastic throughout this analysis.

## Solution

The impact performance of the 1648C has been demonstrated to date by comparing it with the earlier 1648A variant. Models of both the 1648A and the 1648C have shown sufficient similarity and agreement with test data to validate the 1648A drop test model and verify the modelling approach for the performance of the 1648C package. The change in the package designs (the shock absorber in particular) and the materials used showed an improved performance for the 1648C. The verification of the 1648C package allows for further assessments and more detailed analysis to substantiate its ongoing use for the transport of radioactive materials.