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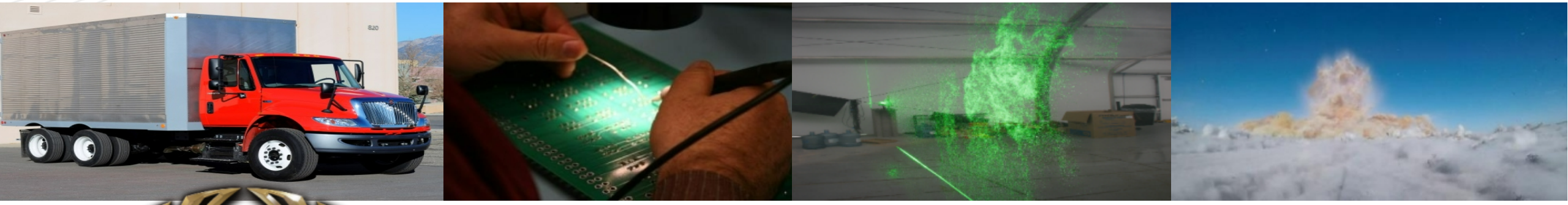

ASSET SECURITY & WMD RESPONSE

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

DESIGN MODIFICATIONS TO THE EXPLOSIVE DESTRUCTION SYSTEM CLOSURE SYSTEM

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Outline

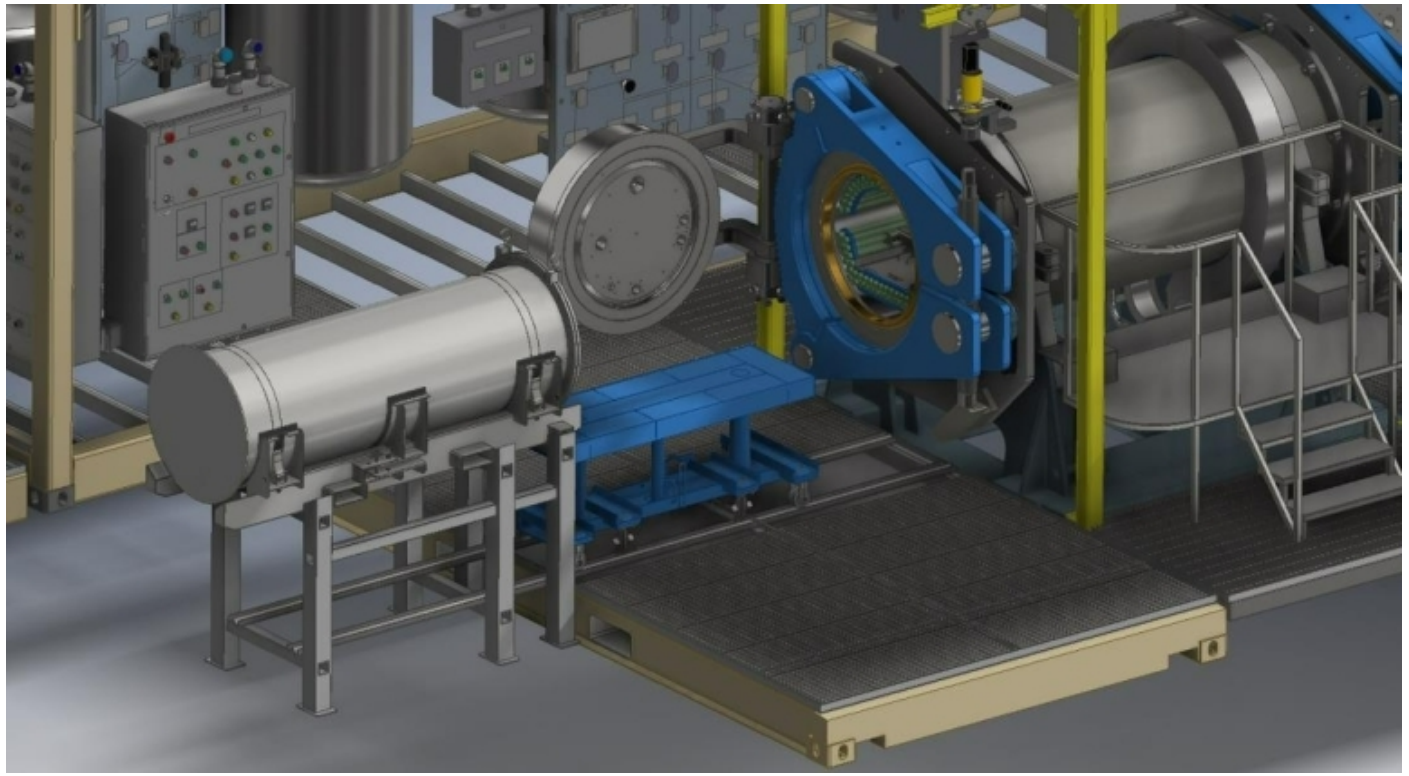
1. History and operation of the Explosive Destruction System (EDS).
2. Description of the, Phase 1, Phase 2 and Phase 3 EDS explosive containment vessels.
3. Design changes to the Phase 3 (P3) door clamping system required by the significantly increased explosive loading requirements.
4. Performance of the P3 design with updated door clamping system.
5. Comparison to actual data.
6. Conclusions.

History explains the need for an Explosive Destruction System (EDS)

- Ground burial and ocean dumping were approved methods of chemical munition disposal.
- Some burial sites are known with very little documentation about their contents. Certainly there are others that are unknown.
- Many chemical munitions are located in small numbers scattered around the country.
- Safety concerns prevent the munitions from being moved, so transporting to a central decontamination facility is not possible.
- Chemical munitions found in 1992 in DC initiated the development of EDS.

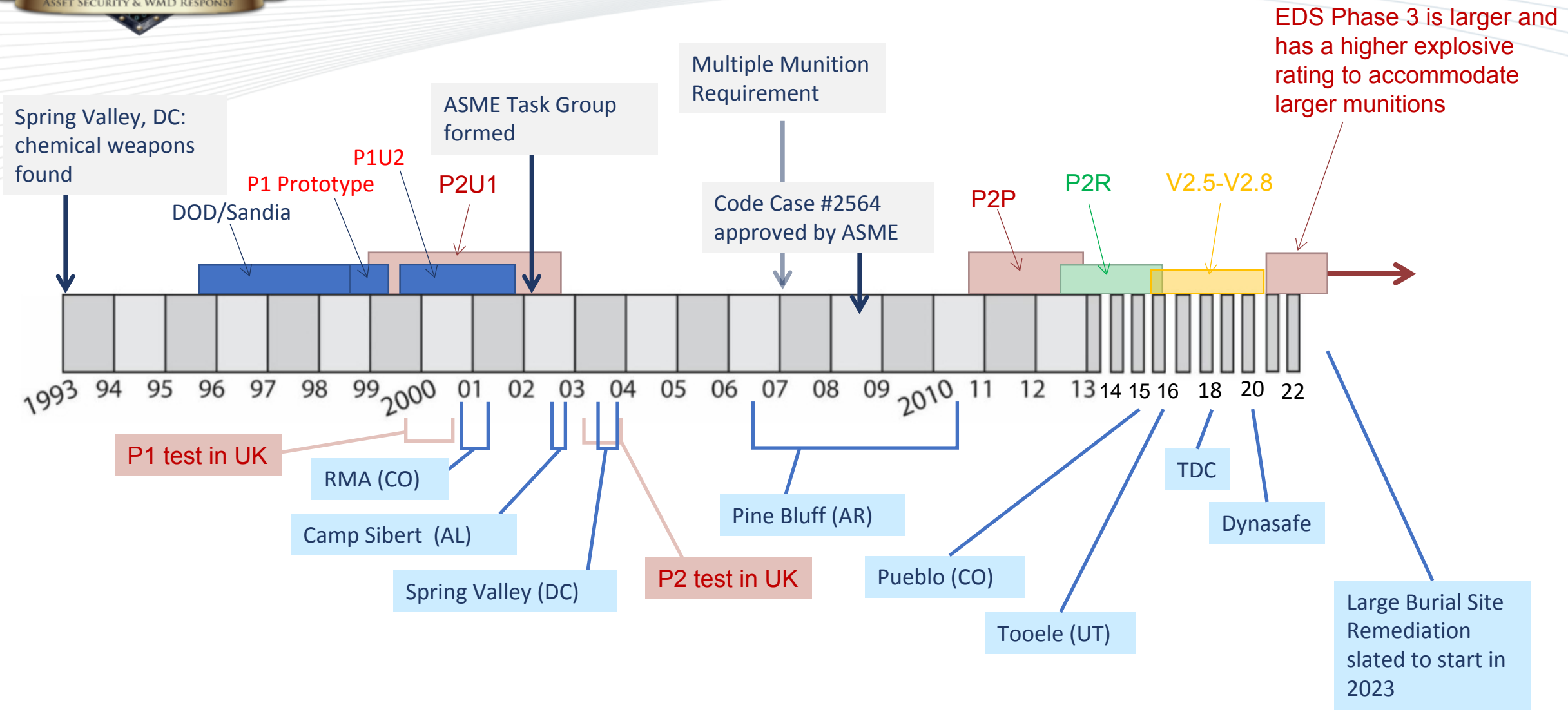
EDS Operating Procedure

1. The EDS system uses an explosive shape charge to split open a chemical munition inside of an explosive containment vessel.
2. This exposes the chemical agents which are then neutralized with other chemicals.
3. The vessel is rotated like a front load washing machine to insure all of the chemical agents are mixed and neutralized.
4. When sampling confirms that the chemical agent is neutralized, the liquid waste is drained, the vessel opened, and the metal scrap is disposed.



EDS was developed and is operated by the US Army Chemical Materials Activity.

30 Year History of the EDS Program



Sometimes the Munitions are in Rough Shape

EDS has destroyed thousands of chemical munitions

- 75 mm projectile
- 4.2 inch mortar
- Liven projectile
- 4 inch Stokes mortar
- 4.5 inch projectile
- M139 bomblet
- 4 inch mortar
- E123 bomblet
- M60 105 mm projectile
- M125 bomblet
- 8 inch artillery
- 155 mm artillery
- 25 pounder
- German Traktor Rocket
- M70 bomb

Munition split open with a linear shape charge

P1 Design Parameters

EDS P1 vessel as shown here weighs about 5,200 pounds.

Overall length	47.00 inches
Inside length	38.00 inches
Outside diameter	24.00 inches
Inside diameter	20.00 inches
Door thickness	5.00 inches
Cylinder wall thickness	2.00 inches
Aft end thickness	4.00 inches

The P1 vessel was rated for 4.5 pounds TNT

P2 Design Parameters

EDS P2 vessel as shown here weighs about 18,000 pounds.

Overall length	71.89 inches
Inside length	56.58 inches
Outside diameter	36.53 inches
Inside diameter	29.22 inches
Door thickness	9.00 inches
Cylinder wall thickness	3.65 inches
Aft end thickness	6.30 inches

The P2 vessel was rated for 9 pounds TNT

P3 Design Parameters

EDS P3 vessel as shown here weighs about 44,000 pounds.

Overall length	126.125 inches
Inside length	108.125 inches
Outside diameter	40.5 inches
Inside diameter	29.25 inches
Door thickness	9.0 inches
Cylinder wall thickness	5.625 inches

The P2 vessel was rated for 24 pounds TNT

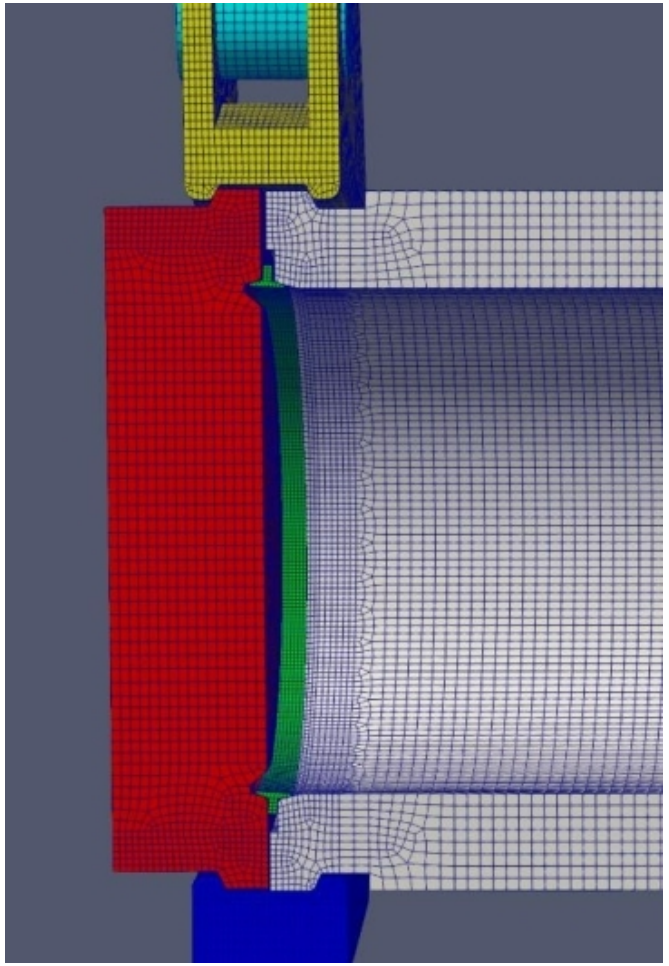
Evolution of the EDS Vessels

The P1 and P2 vessels with the two piece door clamping system

The P3 vessel with two doors and the three piece door clamping system

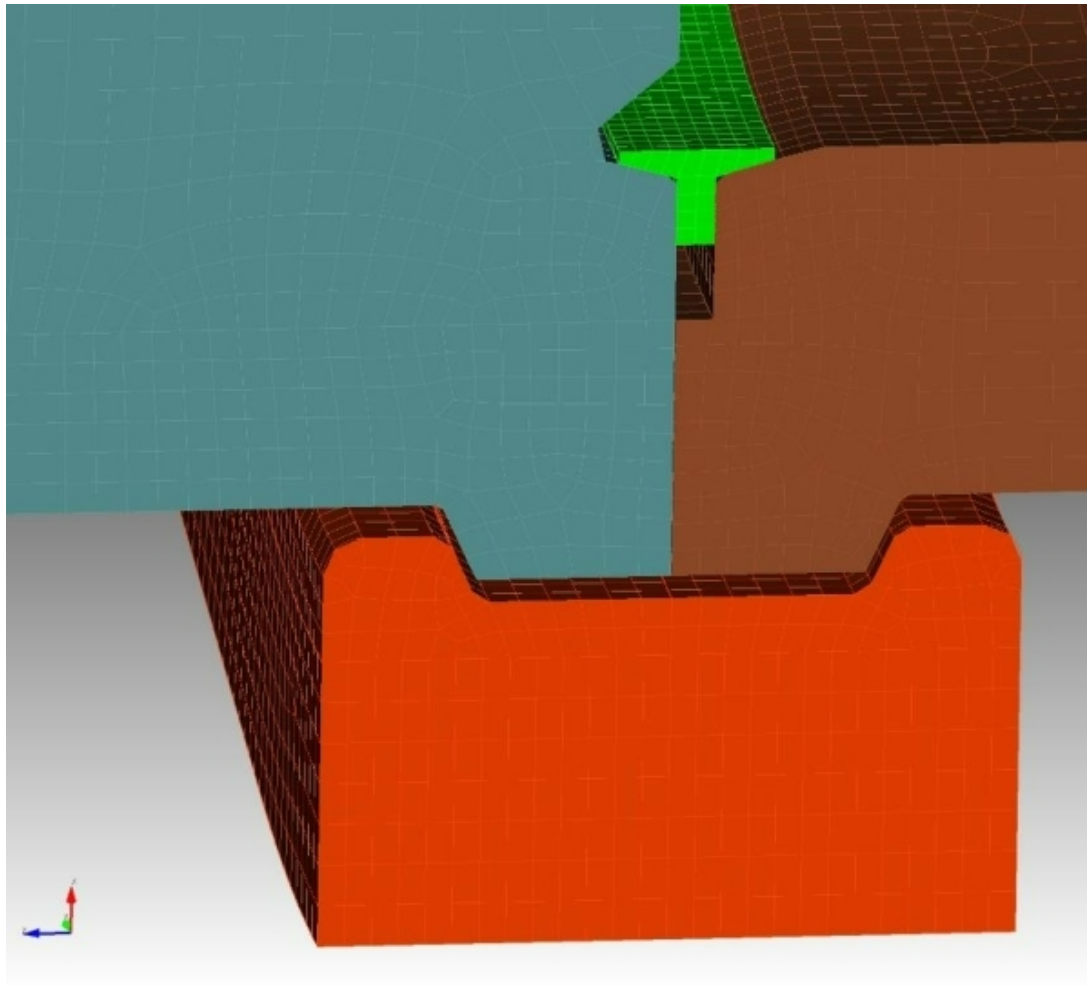
Opening Between The Door and Body Can Be Large

- During testing of the P2 vessel, a transient opening between the door and body of 5 or more millimeters has been measured.
- Initial analysis of the P3 vessel with the larger explosive loads and using the clamp design carried over from the P2 vessel predicted a large gap opening.
- This opening was on the order of 9 millimeters between the flanges when containing the largest explosive loads.
- An investigation into reducing the gap while not impacting the operation or basic design of the P3 vessel design was initiated.



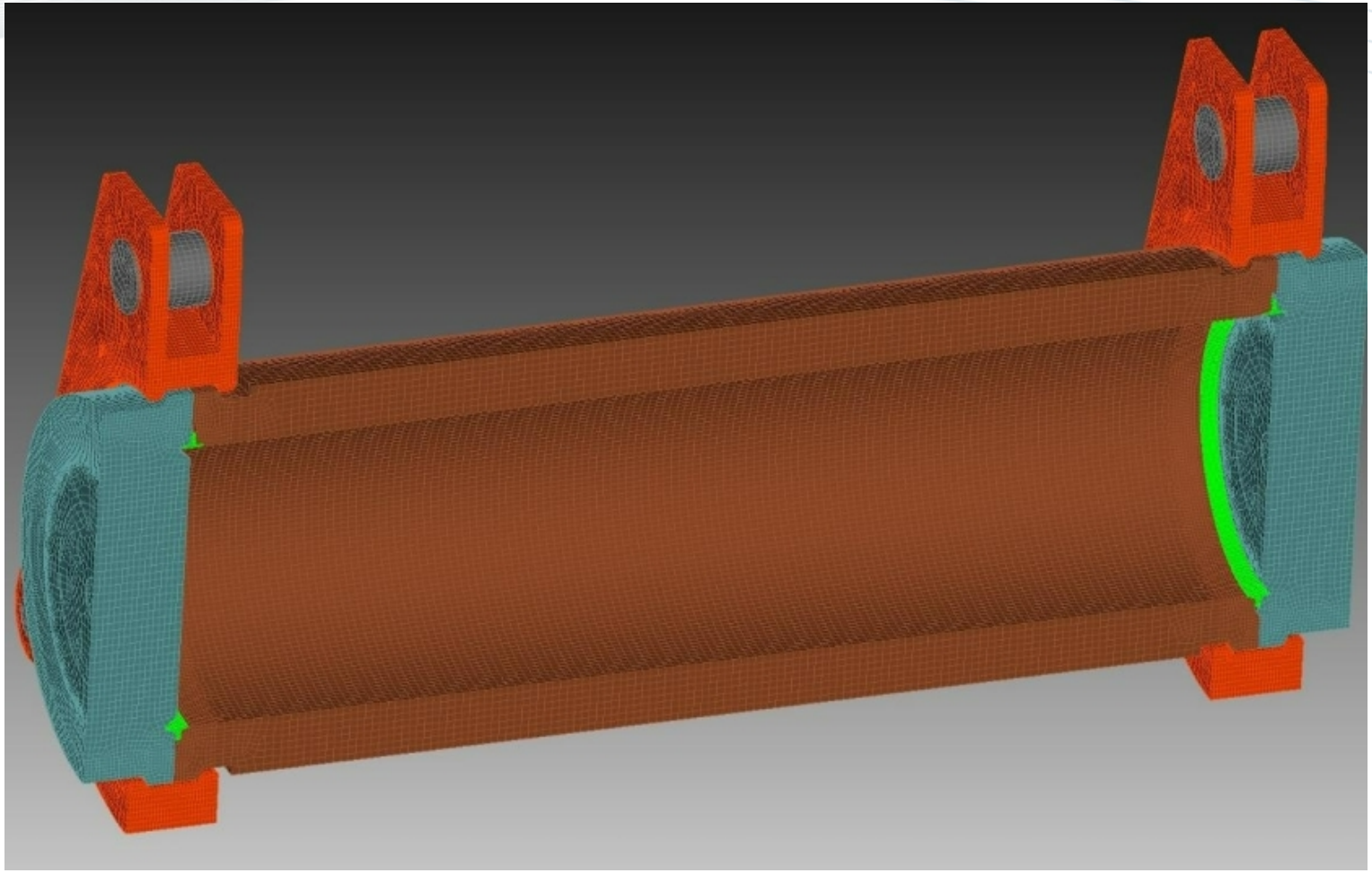
P2 Clamp Design

- The P2 clamp uses short and shallow angled flanges on both the door and vessel body.
- The door and the and flanges are forced together during closure of the clamp.
- The clamp holds the door and body together during explosive loading



P3 With Legacy Clamp Design Analysis

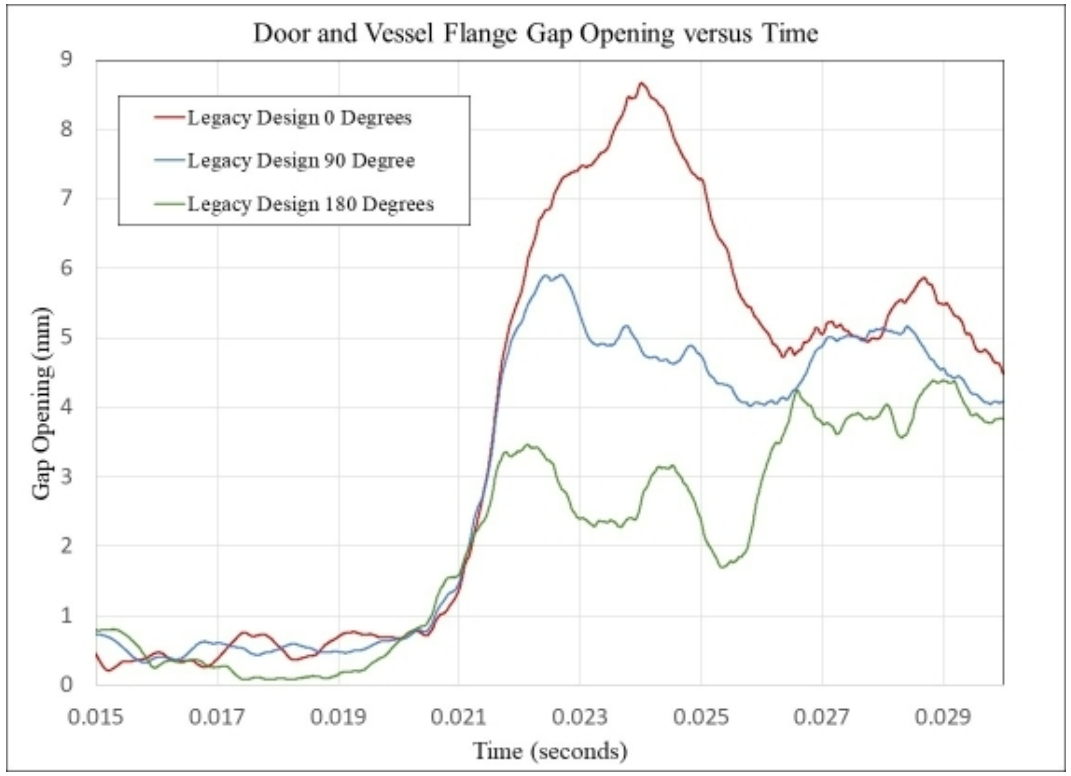
- Mesh contained 404,750 8-noded under integrated hex elements.
- Body and Door were made from 316 stainless steel.
- Clamps were made from 4140 alloy steel.
- The analysis was performed with an Eulerian/Lagrangian Sandia National Laboratories developed code Zapotec.
- All contact surfaces were included.
- The clamps were prestressed in the analysis
- 31 pounds of TNT were modeled.



EDS P3 vessel showing the three piece clamps on each end.

P3 Original Clamp Design Analysis

- The analysis modeled 30 milliseconds of simulated time.
- The first 15 milliseconds were used to close the clamps.
- The explosives were detonated at 15 milliseconds in the analysis.
- The zero degree location is near the tightening mechanism.



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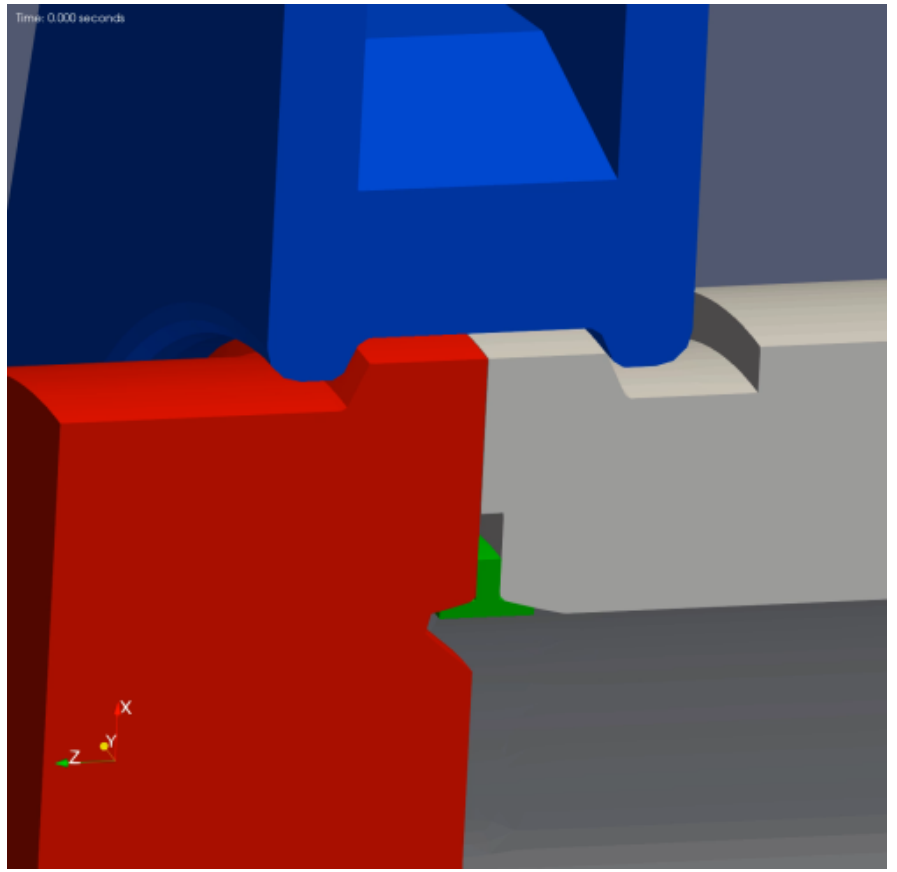
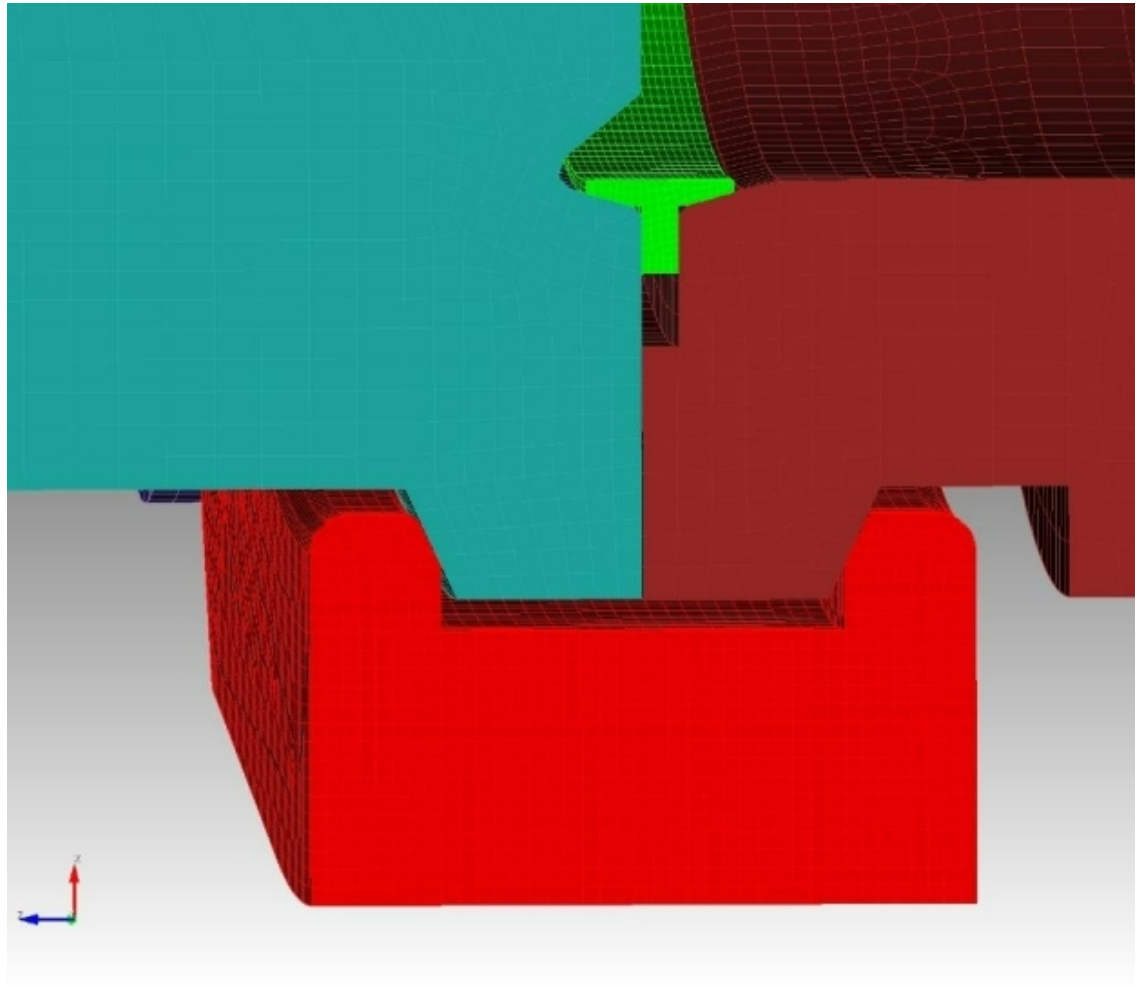


P3 New Clamp Design Analysis

- Flanges are longer and at a slightly steeper angle.
- To get longer flanges some material had to be removed from the diameter of the vessel body.
- The clamps have a step design forcing the contact away from the body and door outer corners.
- In the full model analysis, 858,836 8 -noded under-integrated hex elements were used the new design.
- No changes to the operating procedures are required.



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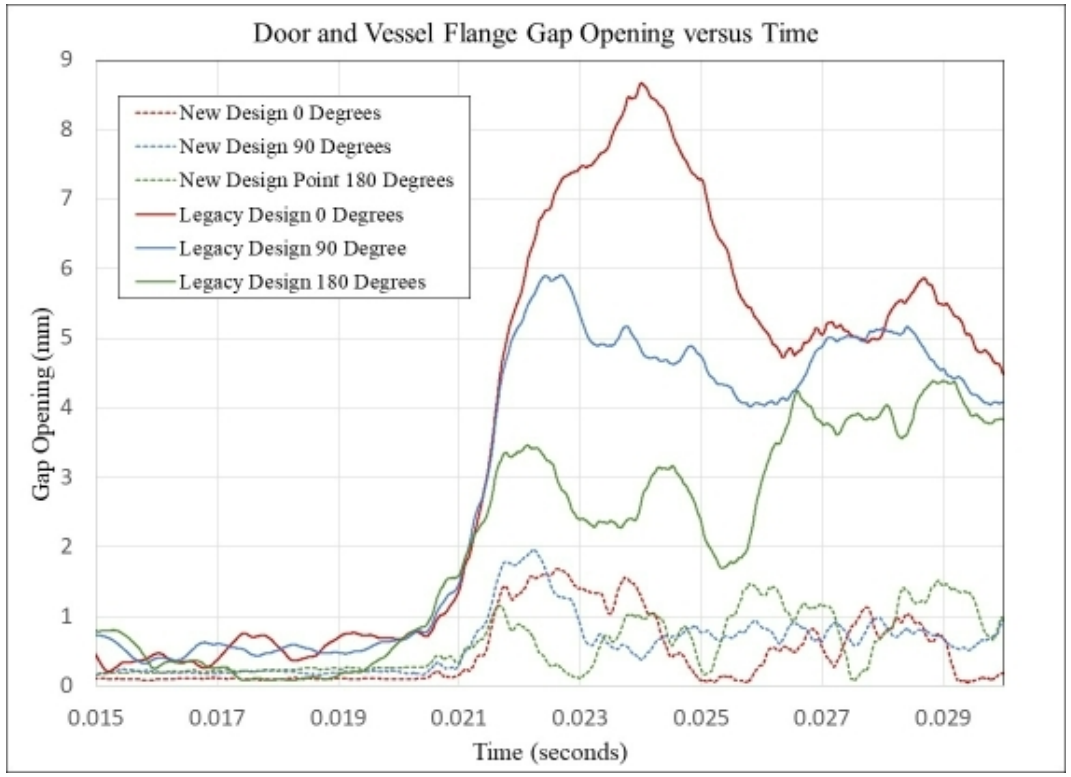

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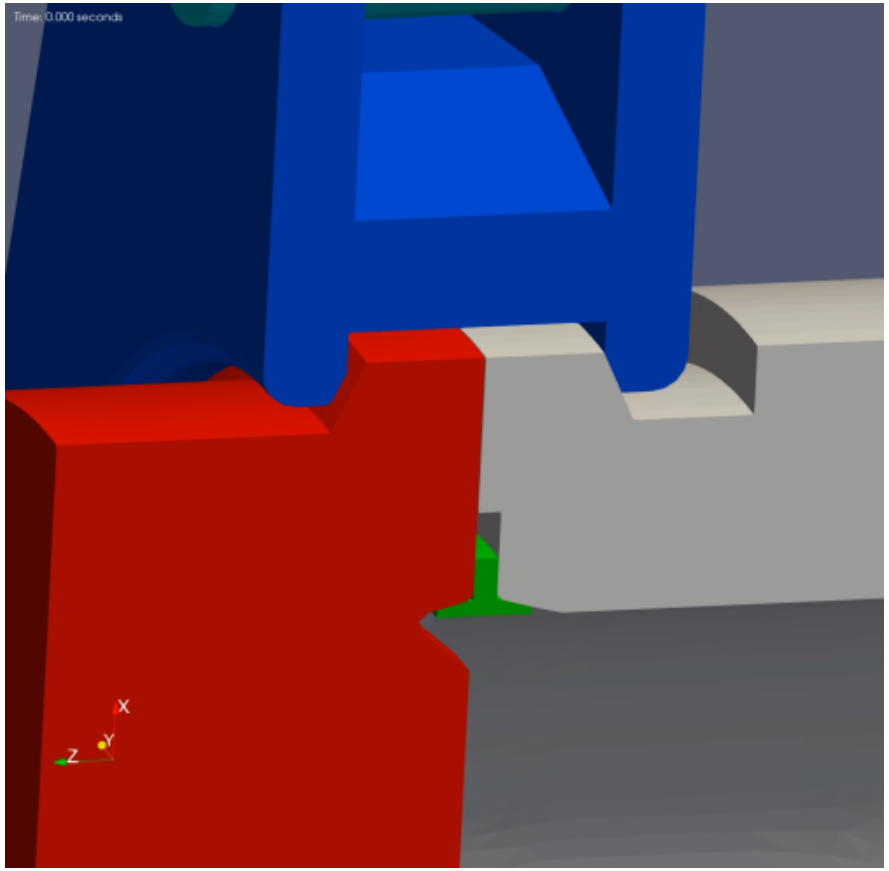
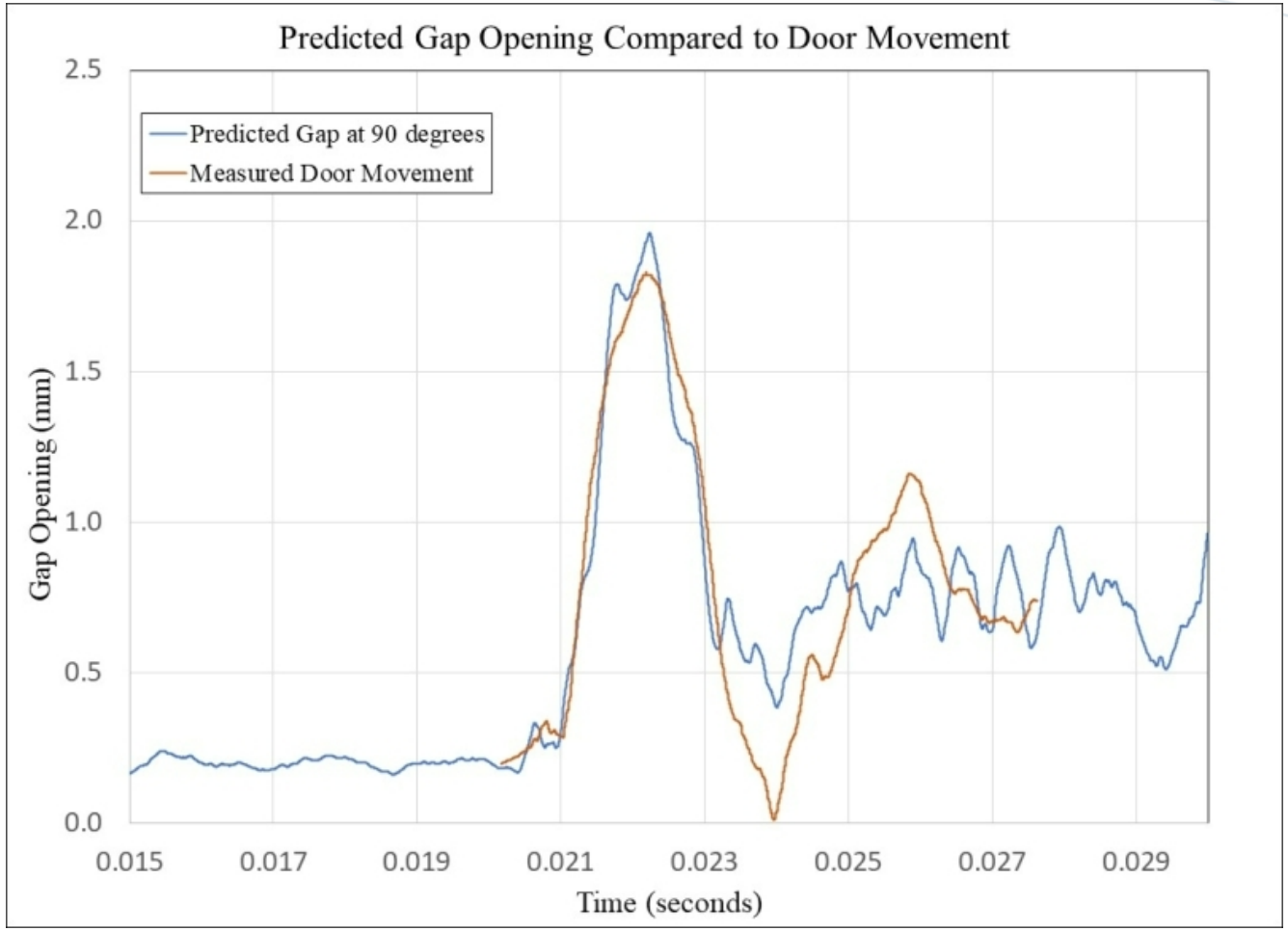


P3 New Clamp Design Analysis and Test Results

- The P3 vessel was tested with 24 pounds of C4 explosive which is roughly equivalent to 30 pounds of TNT.
- The gap was not measured in certification test, but the movement of the door was measured.
- The door movement should be very close to the gap opening as the vessel body is not expected to move very much.
- The correlation between the predicted door movement and the predicted gap is excellent.



Conclusions

- The gap opening from the explosive load was reduced from a predicted 9 mm to under 2 mm.
- The predicted displacements agreed very well with the measured door movement.
- No changes to the vessel operating procedure were required.
- No additional expense was added to the project.

Acknowledgments

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