



**National
Transportation
Safety Board**

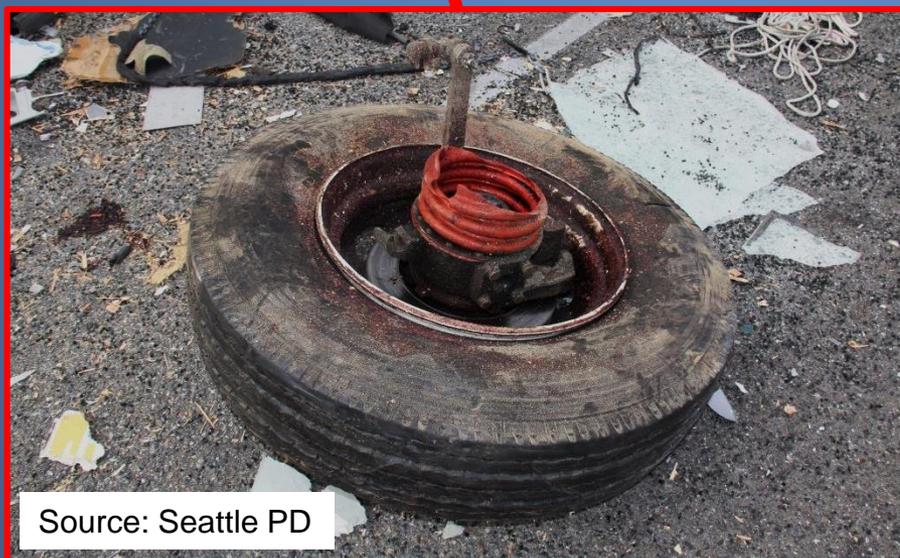
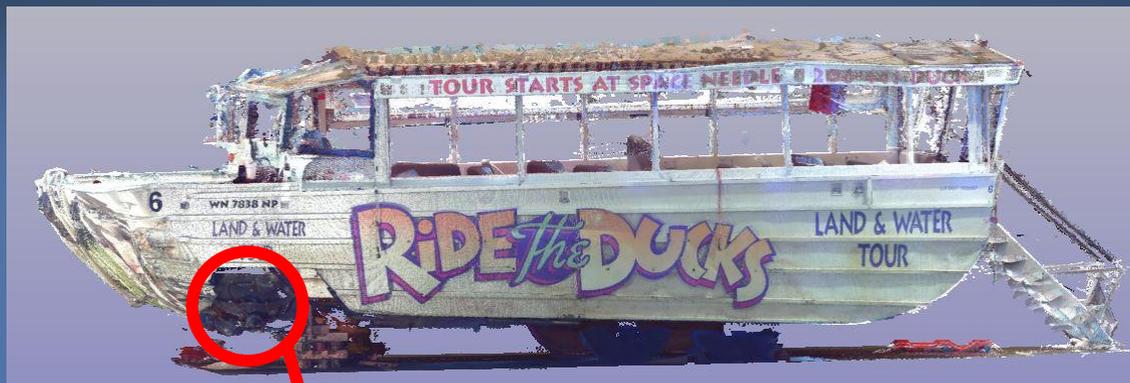
Front Axle Housing Failure Analysis

Adrienne Lamm

Overview

- *DUCK* 6 axle housing design
- Axle housing failure mechanism
- 3D finite element modeling of axle housing stress condition

Stretch Duck Design



Source: Seattle PD

Separated wheel
filled with red
gear oil

DUCK 6 Front Axle Design

VEHICLE WEIGHT



Vehicle weight distributed via the axle housing out to the wheels

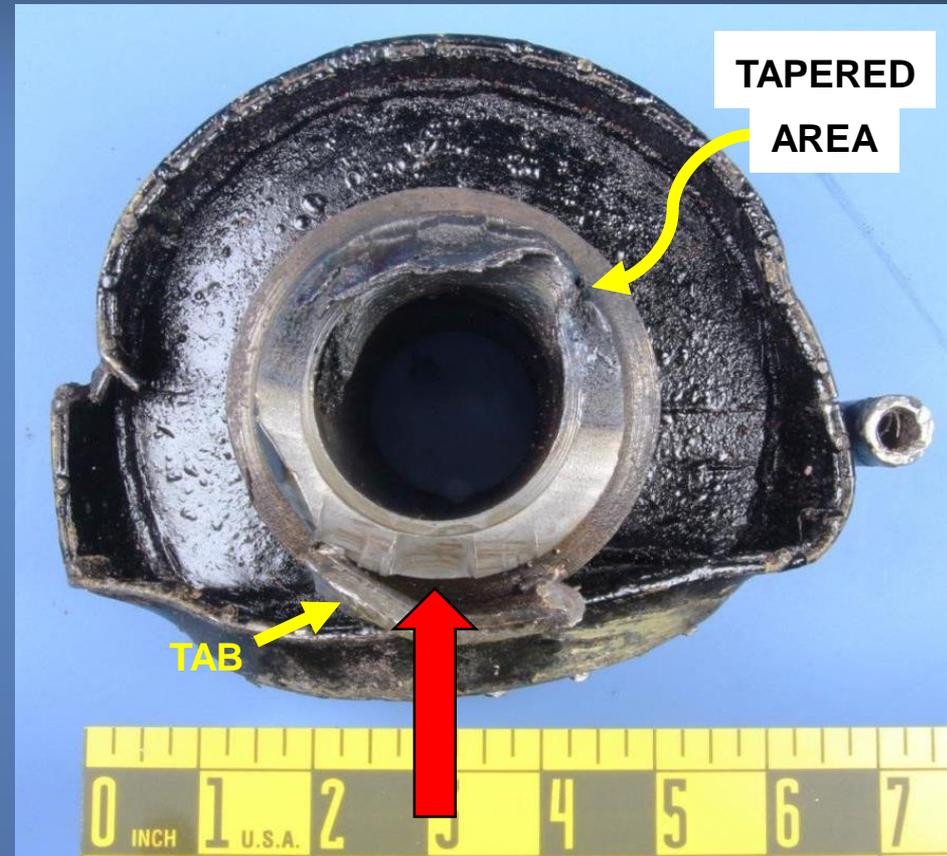
DUCK 6 Front Axle Housing Design

- Consists of:
 - Knuckle ball
 - Tapered area
 - Welded tab



Axle Housing Failure Mechanism

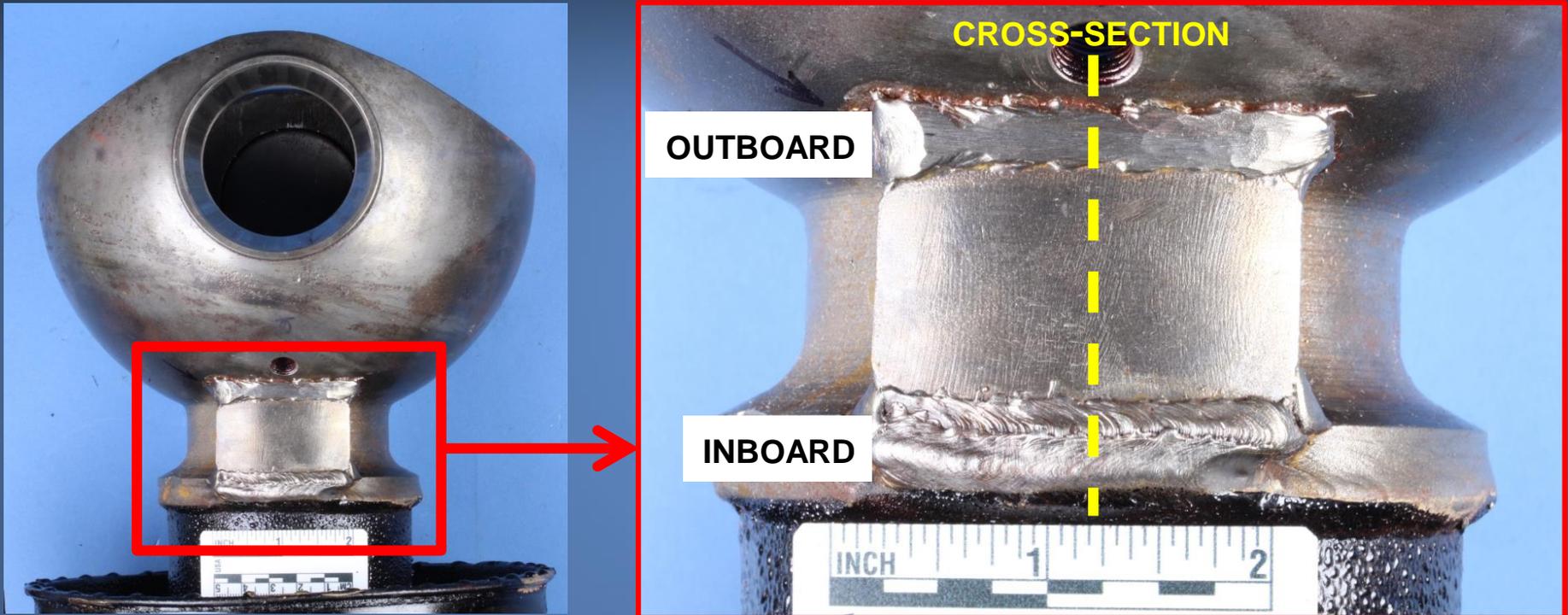
- Fractured due to fatigue cracking
- Initiation at bottom of the axle housing
- Multiple initiation fatigue cracking



Left Front Axle Housing Failure

- Multiple initiation fatigue cracking
 - Led to axle housing fracture
- Axle housing fracture caused
 - Left front wheel separation
 - Vehicle loss of control
- Tab welded at highest stress location
 - Poorly executed weld installation
 - Did not stiffen area to prevent failure

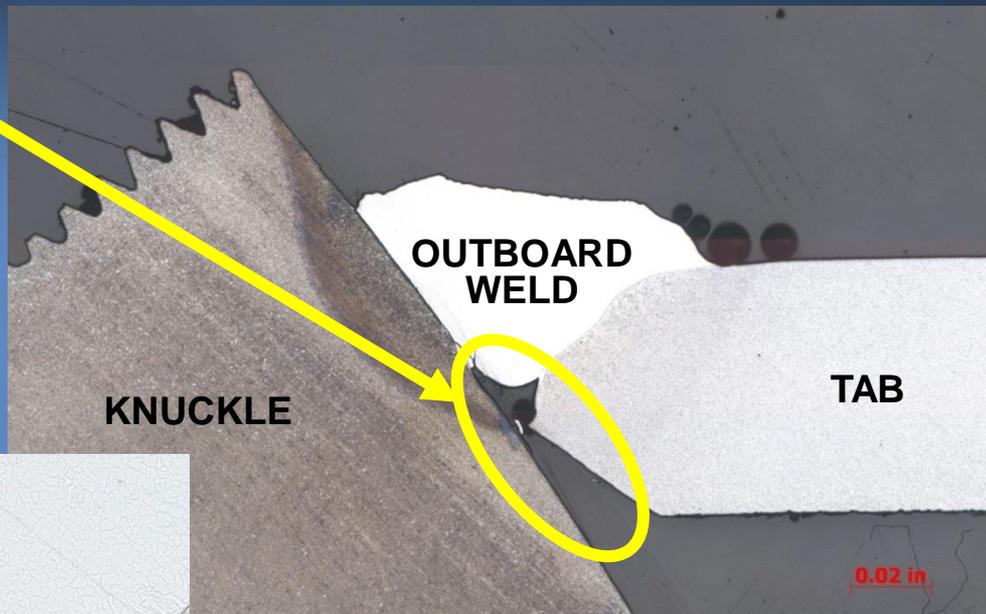
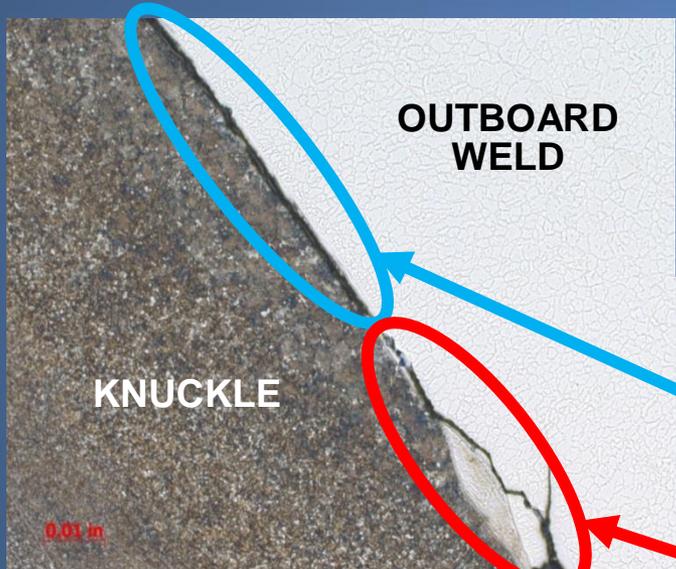
Tab Failure



Cross-section prepared through intact right knuckle, including tab.

Tab Failure

- Lack of penetration

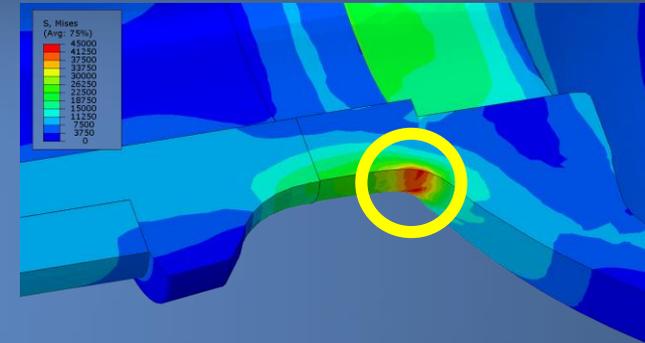
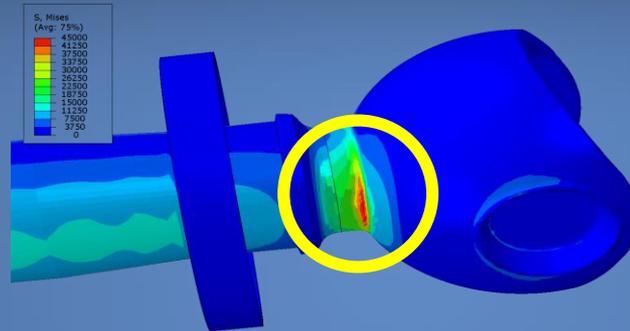


- Lack of fusion
- Cracking

3D Finite Element Modeling

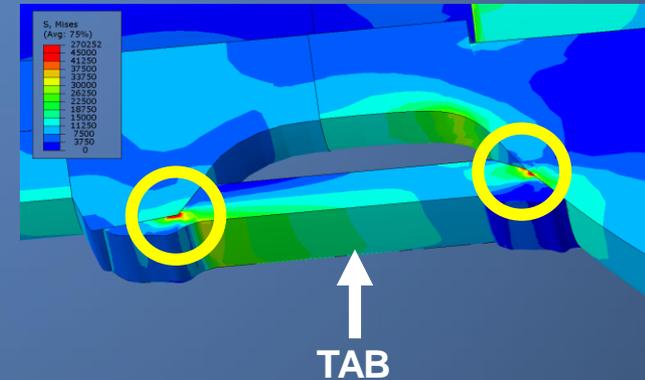
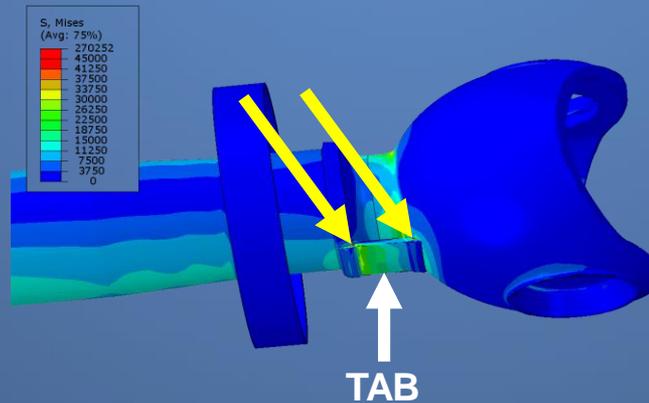
No tab

- Stress concentration in tapered area



Tab installed

- Stress concentrations at weld interfaces



Summary

- 2004 axle housing tab design was ineffective:
 - Tab stiffness inadequate
 - Weld poorly executed
 - Lack of fusion and lack of penetration
- Axle housing replacement or repair needed



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