Overview

• *DUCK* 6 axle housing design
• Axle housing failure mechanism
• 3D finite element modeling of axle housing stress condition
Stretch Duck Design

Separated wheel filled with red gear oil

Source: Seattle PD
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
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