



**Hazardous Materials Accident
Failure of an Anhydrous Ammonia
Nurse Tank**

Calamus, Iowa, April 15, 2003

DCA-03-MZ-001



Iowa

Des Moines ★

Calamus ●



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Parties

- Federal Motor Carrier Safety Administration
- Research and Special Programs Administration
- River Valley Cooperative
- Iowa Department of Agriculture and Land Stewardship
- Trinity Industries, Inc.
- Continental NH₃ Products







River Valley
AMMONIA



ANHYDROUS AMMONIA
INHALATION
HAZARD



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0005

VALLEY

APR 17 2003



APR 17 2003





Safety Issues

- Initial Qualification and Periodic Testing of Nurse Tanks
- River Valley's Emergency Procedures for Anhydrous Ammonia Nurse Tank Loaders

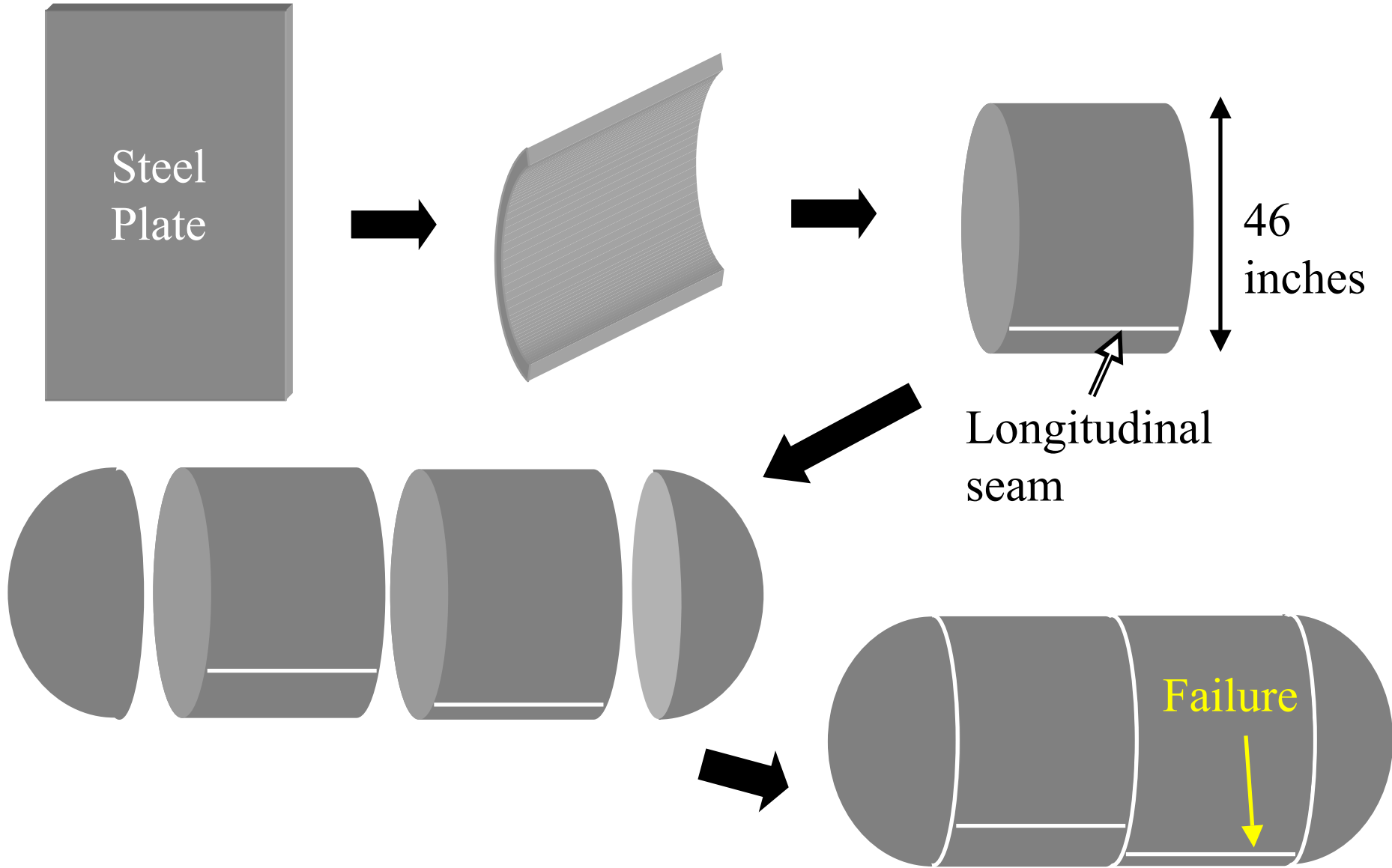




Nurse Tank Failure



Tank Construction

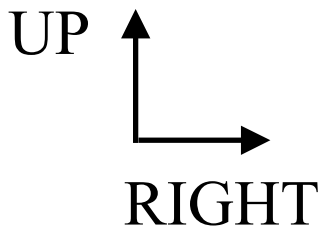




Longitudinal
weld (seam)

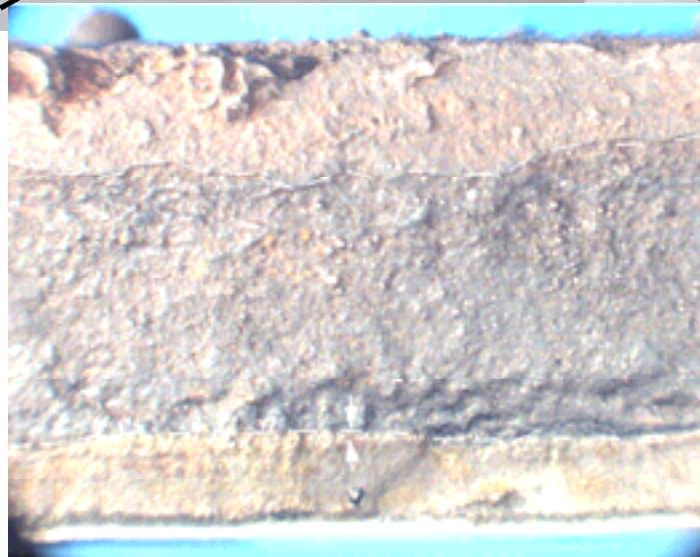
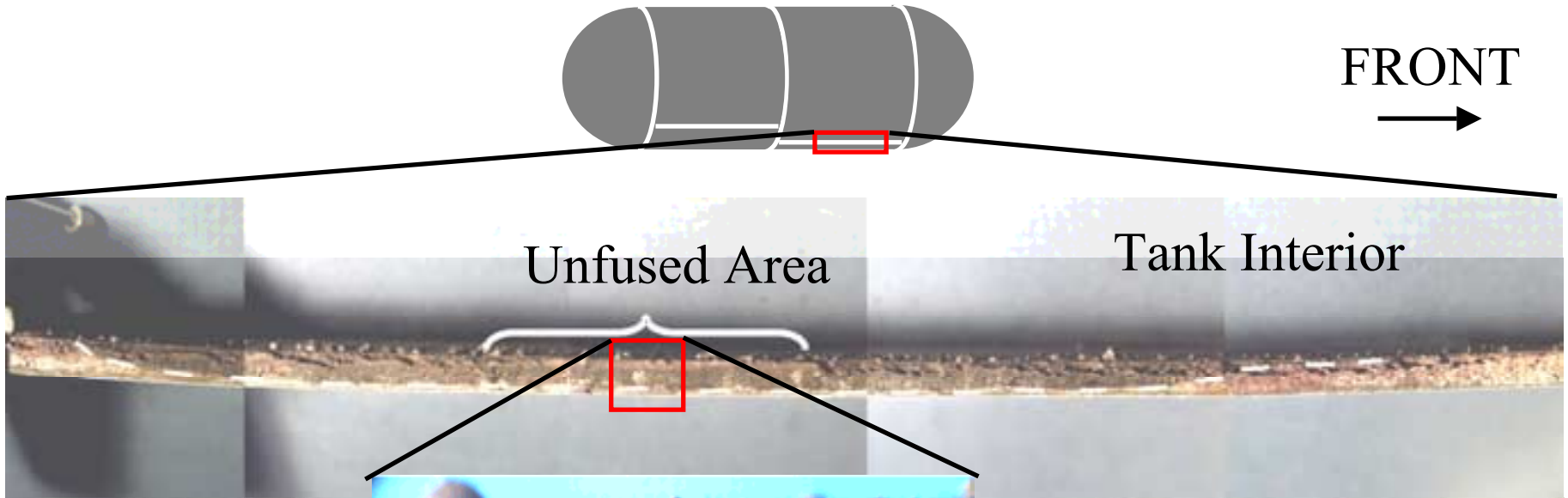


Underside of
the nurse tank



Trailer

Fracture Surface

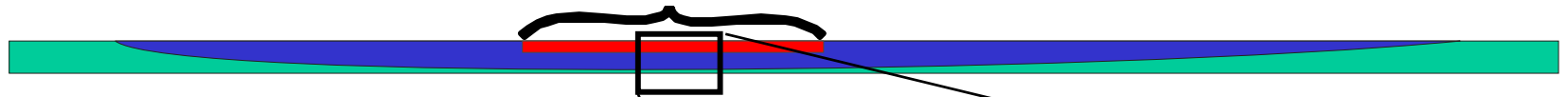


2 mm \longleftrightarrow





Fracture Surface Schematic Drawing

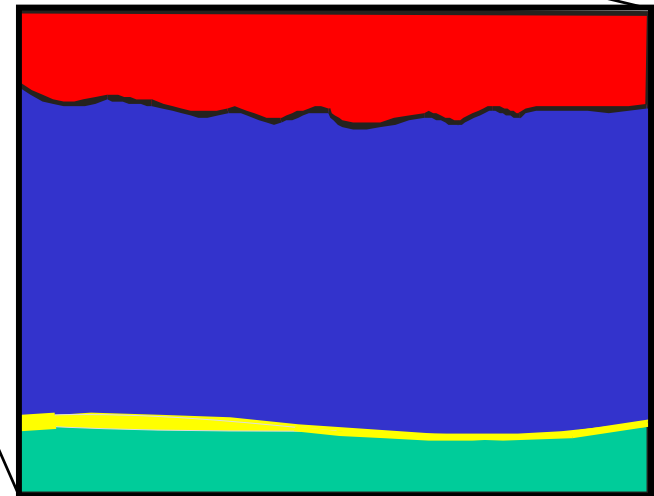
Unfused area

Interior of Nurse Tank



Key

Unfused region	
Black region (rough)	
Black region (fatigue)	
Overstress region	

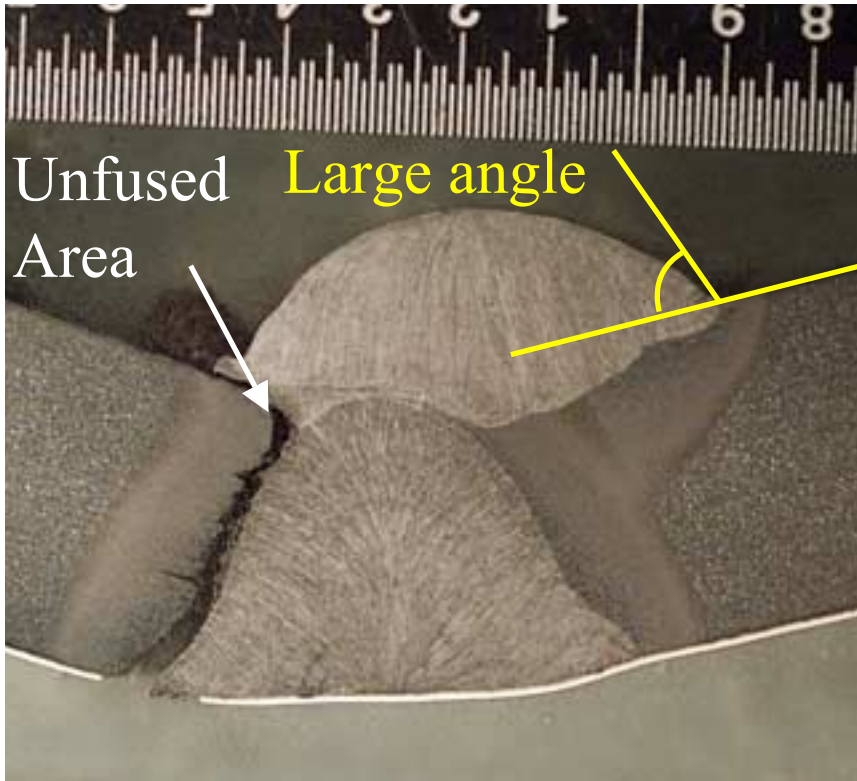
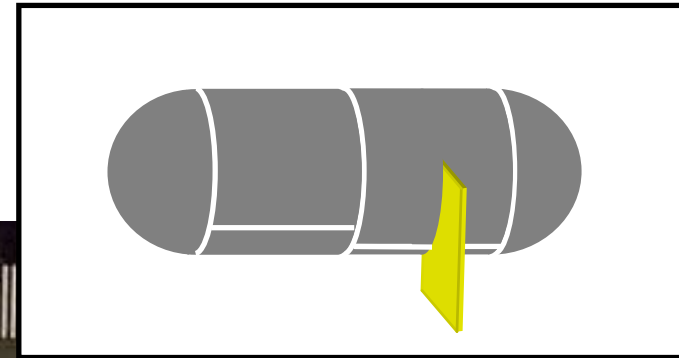


Fracture Interpretation

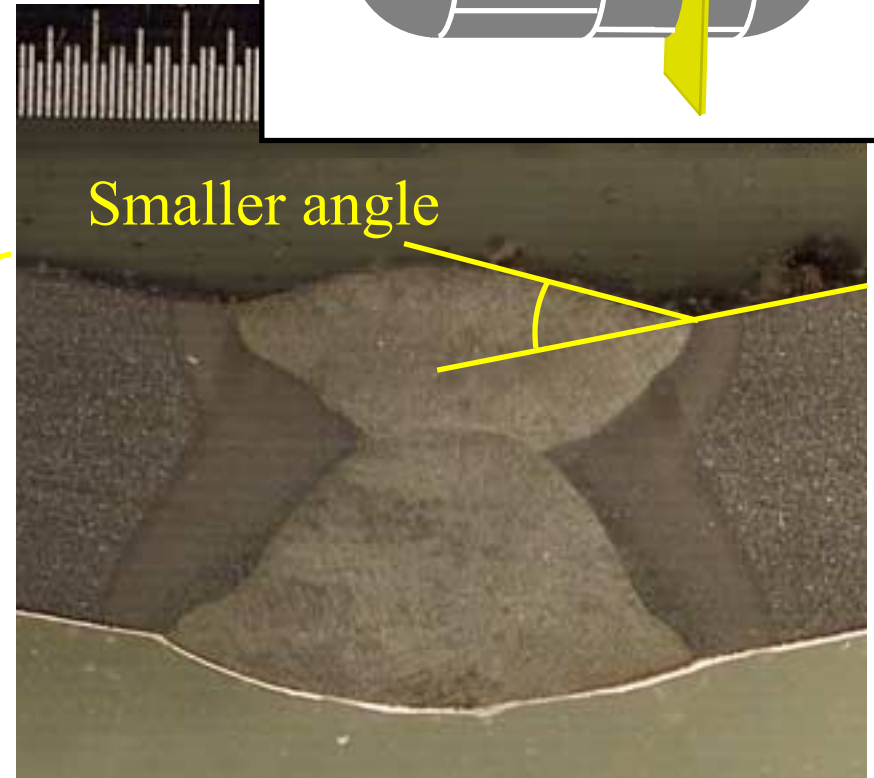
- Black region indicates long-term existence of crack.
- Rough features of majority of black region indicative of relatively high stress – most likely the 1976 proof pressure test.
- Fatigue region indicative of growth under lower cyclic (operational) loads over time.



Fracture and Weld Cross-Sections

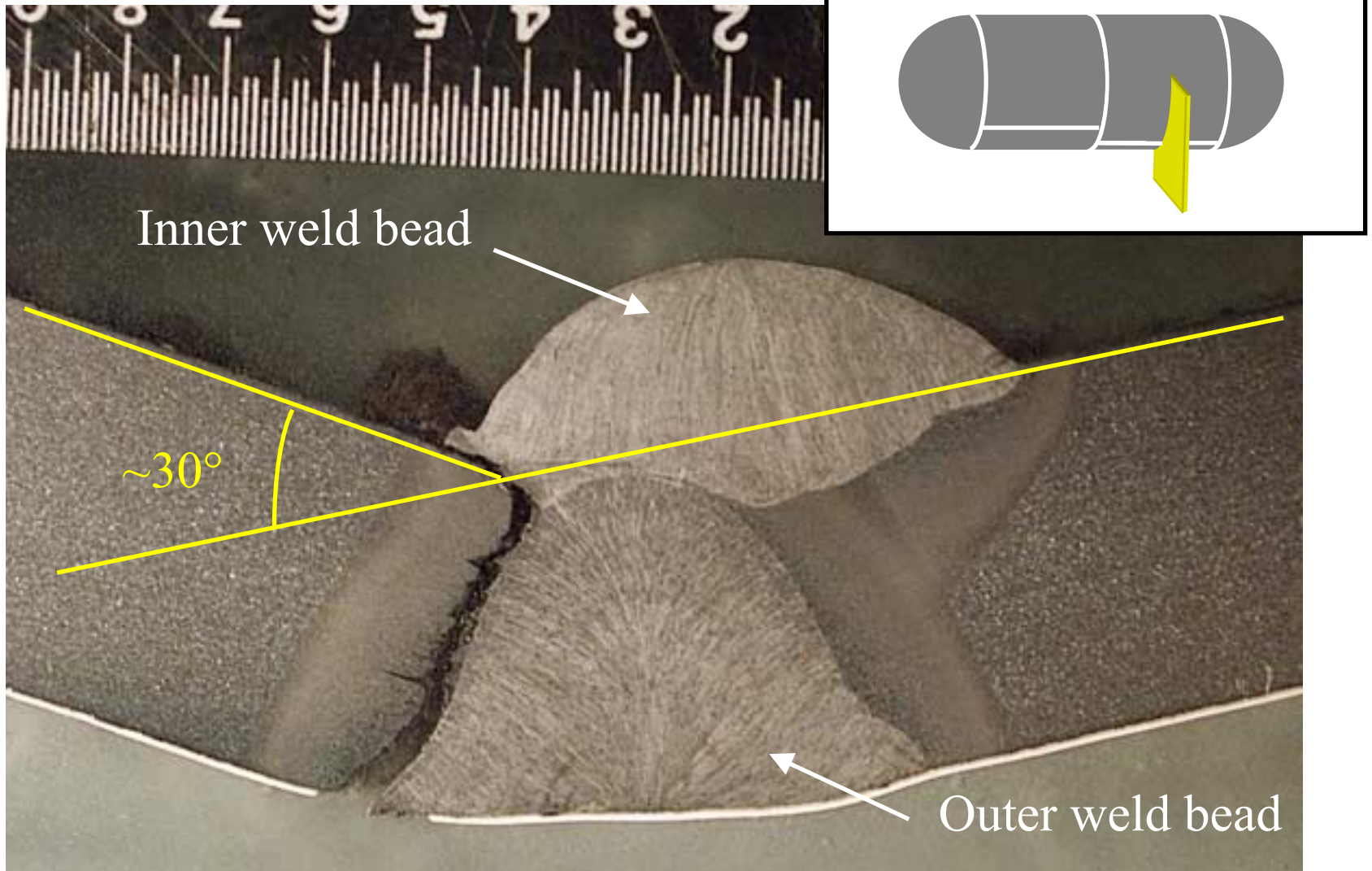


Fractured region



Uncracked region

Fracture Cross-Section



- The unfused area and offset weld bead weakened the tank wall.
- Misalignment of the shell surfaces and the large angle weld bead increased the stresses in this area.



- A crack extended from the unfused area of the weld, probably during the manufacturing proof pressure test.
- The crack grew by fatigue under normal operating loads until the tank failed.





Initial Qualification and Periodic Testing



DOT and OSHA Regulations

- Nurse tank must be built to the standards of the *ASME Boiler and Pressure Vessel Code*.



ASME

Boiler and Pressure Vessel Code

- Manufacturing standards
- Pressure vessels – tanks & boilers
- Weld qualification



ASME Weld Qualification

- Radiographic examination of the tank welds for defects
- 3 Options
 - Full radiography – entire weld length
 - Spot radiography – 6 inches in 50 feet
 - No radiography



Spot Radiography

- Used by manufacturers until mid-1980's
- Accident tank was built in 1976
- 12–15 feet of longitudinal weld / tank
- **One 6-inch radiograph for every 3 or 4 nurse tanks**



Radioscopy

- New procedure - mid 1980s
- Examines the full length of welds
- Now used by all tank manufacturers



Periodic Testing

- Only compressed gas container that is not required to have periodic testing and inspection.
- NDT could have detected the weld defect and internal crack



Minnesota Program

- 1996 – Inspection and testing to recertify unmarked nurse tanks
- 1,500 – 2,000 nurse tanks tested
- Tanks allowed to be repaired and retested



Nurse Tank Failures

- 10 nurse tanks could not be repaired and were removed from service
 - Inadequate wall thickness
 - Unreparable head damage



Nurse Tank Failures

- 2 catastrophic nurse tank failures in 1995
- Split open at the circumferential weld
- Released anhydrous ammonia





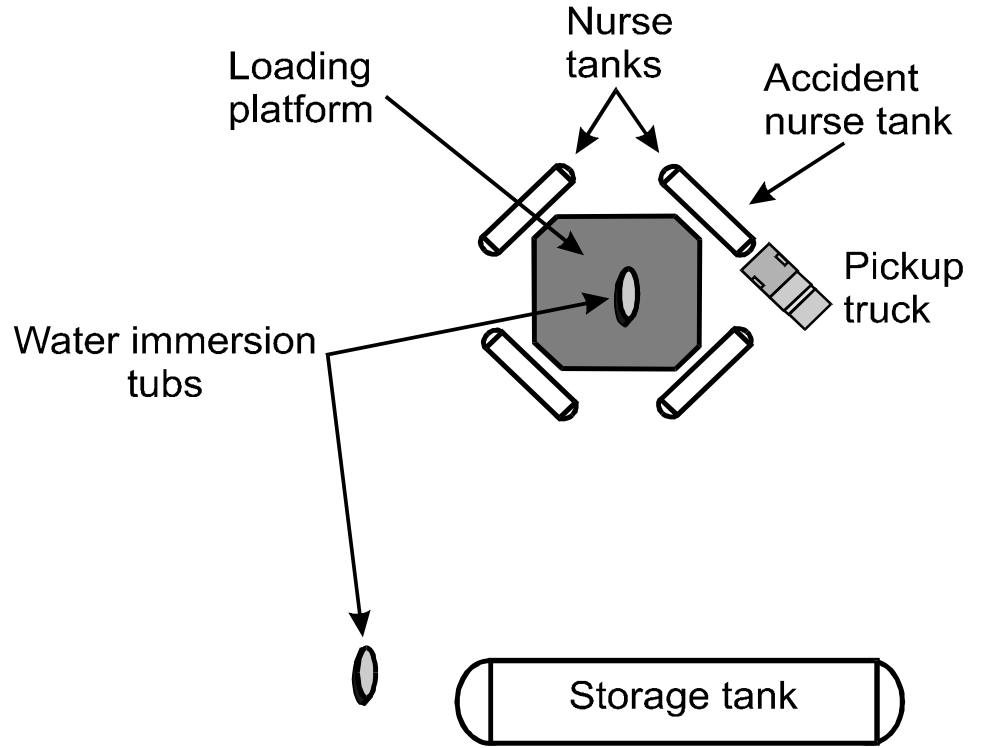
River Valley Cooperative Emergency Procedures







Not to scale



Water Immersion

- Water dilutes the anhydrous ammonia
- Reduces the corrosive injuries to the skin and soft tissues
- Does not provide any protection from, or first aid for, inhalation injuries



Inhalation Injuries

- MSDS – Immediately move victim from the exposure site to fresh air
- NIOSH – Immediately vacate the area heading upwind
- 2000 ERG – Move at least 200 feet away from the source



River Valley Emergency Procedures

- Did not direct the loaders to evacuate the area
- Instructed to get into a tub which kept them in the area of the release



