

The Impact of Corrosion on Storage Tanks and Piping

Gerry Koch
CC Technologies
Freshwater Spills Symposium
April 6-8, 2004



NACE International – The Corrosion Society

1. NACE International Overview
2. Cost of Corrosion
3. Aboveground, Underground Storage Tanks, and Associated Piping Systems
4. NACE Resources



NACE International – Overview

Our Vision

NACE International will be recognized as a world-class corrosion society by contributing significantly to the enhancement of global corrosion efforts.

Our Mission

To reduce the impact of corrosion.



NACE International – Overview

- Global Forum for Corrosion Technology
- Global Source for Corrosion Education & Training
- Internationally Recognized Standards



NACE International – Overview

- 60th Anniversary
- Not-for-Profit Organization
- 15,000 Individual Members in 91 Countries
- 275 Corporate Members
- Organized in 82 Sections



NACE International – Overview

- Education Programs
- Professional Recognition
- Coating Inspector Training
- Cathodic Protection Certification



NACE International – Overview

- NACE Standards
- Conferences/Expos
 - CORROSION/2004 – New Orleans, LA, March 2004
 - Corrosion Technology Week 2004 – Phoenix, AZ, Sept. 2004
 - Topical
- Periodicals
- Publications & Software



NACE International – Education & Certification

NACE Education Classes Designed To:

- Introduce fundamentals of corrosion control
- Expand existing knowledge
- Provide professional recognition & certification



NACE International – Education & Certification

10 Certification Categories

- Coating Inspector Program
 - Three Courses
 - 5,500 recognized individuals – worldwide
- Cathodic Protection Certification



NACE International – Education & Certification

- NACE Certification Specified Worldwide
- Qualified Personnel
- Ensure Safe Operations
- Extend Asset Life
- Reduce Downtime
- Improved Quality Assurance



NACE International – Standard & Reports

Standards Recognized Worldwide

- 118 NACE Standards
 - 19 Material Requirements
 - 69 Recommended Practices
 - 30 Test Methods
- 60 Technical Committee Reports



What is the Cost of Corrosion?



\$276 Billion

The United States Cost of Corrosion Study



Cost of Corrosion – Study Goals

- Determine the cost of corrosion control methods and services
- Determine the cost of corrosion for specific industry sectors
- Extrapolate individual sector costs to a national total corrosion cost
- Assess the barriers to progress and effective implementation
- Develop strategies for realizing cost savings



Cost of Corrosion

- All costs are direct corrosion costs
 - Cost of labor attributed to corrosion management activities
 - Cost of the equipment required because of corrosion related activities
 - Loss of revenue due to disruption in supply of product
 - Cost of loss of reliability
 - Cost of lost capital due to corrosion deterioration



Methods & Services

- All costs are direct corrosion costs
- Disadvantage: many costs are missed
 - Cost of labor attributed to corrosion management activities.
 - Cost of the equipment required because of corrosion-related activities.
 - Loss of revenue due to disruption in supply of product.
 - Cost of loss of reliability.



Methods and Services

•Protective Coatings	B\$ 108.6
•Corrosion Resistant Alloys	B\$ 7.7
•Corrosion Inhibitors	B\$ 1.1
•Engineering Plastics/Polymers	B\$ 1.8
•Cathodic and Anodic Protection	B\$ 1.0
•Corrosion Control Services	B\$ 1.2
•Research and Development	-
•Education and Training	-
	TOTAL: B\$ 121.41



Cost of Corrosion – Industry Sector Analysis

For each sector, details of analysis are different

- Government Reports
- Publicly Available Documents
- Industry Experts
- U.S. Department of Commerce Bureau Census
- Existing Industrial Surveys
- Trade Organizations
- Industry Groups
- Individual Companies



Cost of Corrosion – Industry Sector Analysis

26 Sectors in 5 Categories

- Infrastructure
- Utilities
- Transportation
- Production & Manufacturing
- Government



Cost of Corrosion – Industry Sector Analysis



Cost of Corrosion – Category: Infrastructure

Highway Bridges	B\$	8.3
Gas & Liquid Transmission Pipelines	B\$	7.0
Waterways & Ports	B\$	0.3
Hazardous Materials Storage	B\$	7.0
Airports	B\$	-
Railroads	B\$	-
TOTAL: B\$		22.6







Cost of Corrosion – Category: Utilities

Gas Distribution	B\$	5.0
Drinking Water & Sewer Systems	B\$	36.0
Electrical Utilities	B\$	6.9
Telecommunications	B\$	-
TOTAL: B\$		47.9



Cost of Corrosion – Category: Transportation

Motor Vehicles	B\$	23.4
Ships	B\$	2.7
Aircraft	B\$	2.2
Railroad Cars	B\$	0.5
Hazardous Materials Transport	B\$	0.9
TOTAL: B\$		29.7





AIRCRAFT ACCIDENT REPORT
ALOHA AIRLINES, FLIGHT 243
BOEING 737-200, N73711,
NEAR MAUI, HAWAII
APRIL 28, 1988



Cost of Corrosion – Category: Production & Manufacturing

Oil & Gas Exploration & Production	B\$	1.4
Mining	B\$	0.1
Petroleum Refining	B\$	3.7
Chemical, Petrochemical, & Pharmaceutical	B\$	1.7
Pulp & Paper	B\$	6.0
Agriculture Production	B\$	1.1
Food Processing	B\$	1.1
Electronics	B\$	-
Home Appliances	B\$	1.5

TOTAL: B\$ 17.6



Cost of Corrosion – Category: Government

Defense	B\$	20.0
Nuclear Waste Storage	B\$	0.1
TOTAL: B\$		20.1

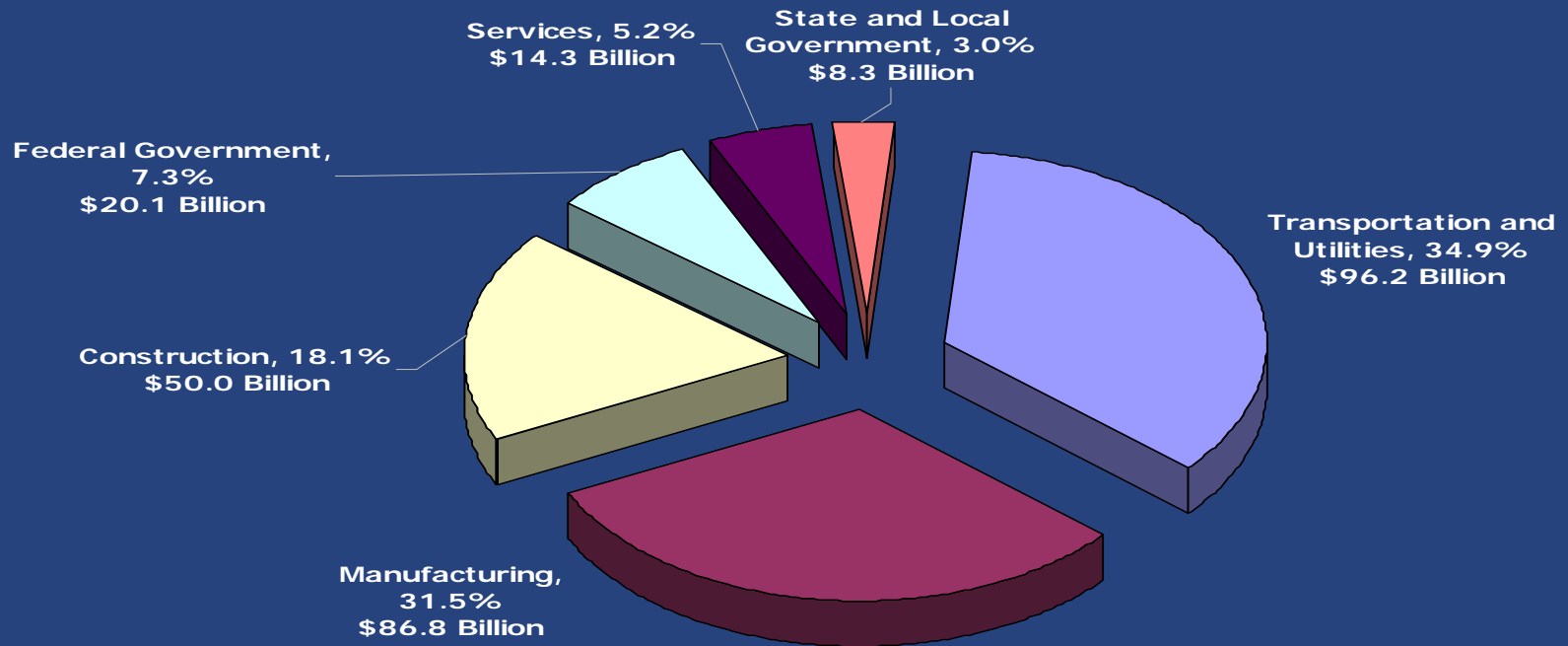


Cost of Corrosion – Summary of Sector Analyses

Infrastructure	B\$	22.6
Utilities	B\$	47.9
Transportation	B\$	29.7
Production & Manufacturing	B\$	17.6
Government	B\$	20.1
TOTAL: B\$		137.9



Extrapolated Corrosion Costs: \$276 Billion, 3.1% of GDP



Non-Technical Preventive Strategies

- Increase awareness of the widespread effects of corrosion
- Build awareness of the huge cost associated with corrosion
- Build awareness of potential savings
- Change the misconception that nothing can be done about corrosion
- Change policies, regulations, standards, and management practices to increase corrosion savings
- Improve education and training of staff



Technical Preventive Strategies

- Advance design practices for better corrosion management
- Advance life prediction and performance assessment methods
- Advance corrosion technology through:
 - Research
 - Development
 - Implementation

Recognize the commonality of the problem throughout all branches of the military; but also that corrosion may manifest itself differently in each branch.



Further Information

- FHWA – RD-01-156 – Full Report
- FHWA – RD-01-157 – Tech Brief

Contact:

- Federal Highway Administration
- Y. Paul Virmani (202) 493-3052

Web Site:

- <http://www.corrosioncost.com>



Aboveground and Underground Storage Tanks and Associated Piping Systems



Impact of Corrosion

8.5 million tanks in the U.S. (regulated and non-regulated)

\$ 4.5 Billion Cost to AST

\$ 2.5 Billion Cost to UST

Total Cost of \$7 Billion annual cost

Corrosion is one of the leading causes of storage tank and piping failures



Corrosion Control Regulations

- By the Oil Pollution Act of 1990:
 - The owner must have a Spill Response Plan
 - The owner must put in place measures, practices, etc. to limit the possibility of releases based upon industry accepted sound engineering practice in design, operation, and maintenance of the facility
 - The reg. does not regulate corrosion control, but does say prevent release.
- 1998 EPA Regulation for UST – Requires that all tanks to have corrosion control, as well as overflow and spill protection



Corrosion Control Regulations

Spill Prevention Control and Countermeasure (SPCC) Regulation
(Implementation Required by 2/18/05)

- *Provide buried piping that is installed or replaced after August 16th, 2002 with a protective coating and cathodic protection.*
- *Should a section of line be exposed for any reason it must be inspected for deterioration. If corrosion damage is found you must take additional examination and corrective action.*



NACE Standards

NACE has either developed or is in the process of developing standards to address Tank and Pipeline integrity:

- RP0169-2002, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- TM0101-2001, Measurement Techniques Related to Criteria for Cathodic Protection
- RP0193-2001, External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms



NACE Standards (con.)

- RP0285-2002, Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
- TM0497-2002, Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems



API Standards

- API 570 Piping Inspection Code
- API 651 Cathodic Protection of Aboveground Petroleum Storage Tanks
- API 652 Lining of Aboveground Petroleum Storage Tanks Bottoms
- API 653 Tank Inspection, Repair, Alteration, and Reconstruction
- API 1632 Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems



NACE International – The Corrosion Society

Thank You!

