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Corrosion Costs and Maintenance Strategies—A Civil/Industrial and Government Partnership

The U.S. Department of Defense is working with the civil/industrial sector and NACE International to develop and implement best corrosion control practices throughout the military.

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Corrosion and its effects have a profound impact on the infrastructure and equipment of countries worldwide. This impact is manifested in significant maintenance, repair, and replacement efforts; reduced access and availability; poor performance; and unsafe conditions associated with facilities and equipment. The primary metric reflecting this impact is cost. A recent study estimates that the annual cost of corrosion in the U.S. alone is $276 billion.[1] Corrosion costs associated with labor, material, and related factors have substantial effects on the economies of industrial nations and, more specifically, on the civil/industrial and government sectors of these economies[2] (Table 1).

Table 1
Corrosion Cost Studies in Industrial Nations

Country	Total Annual Corrosion Cost	Gross National Product (%)	Year
U.S.	$5.5 billion	2.1	1949
India	$320 million	—	1960
Finland	$54 million	—	1965
W. Germany	$6 billion	3.0	1967
U.K.	£1.365 billion*	3.5	1970
Japan	$9.2 billion	1.8	1974
U.S.	$70 billion	4.2	1975
Australia	$2 billion	1.5	1982
Kuwait	$1 billion	5.2	1987
U.S.	$276 billion	3.1	2002

*Not reported in U.S. dollars.

In the U.S., the corrosion environment, associated experience, corrosion prevention and mitigation practices, and primary decision drivers for controlling corrosion vary between these two major sectors. Until recently there has been little interaction between the civil/industrial and government sectors on the subject of corrosion prevention and control. Organizations such as NACE International have led the way in promoting corrosion control in the civil/industrial sector by developing industry consensus standards and best practices through training and educational activities. In the government sector, the military has been battling corrosion for many years, and has developed standards and corrosion methods based on unique environments and effects characteristic of each of the services.[3]

Perhaps the perceived diversity in corrosion environments and economic objectives between these two sectors has contributed to different experiences and practices. Although the military and civil/industrial corrosion environments are both severe and wide-ranging, the military objective has reliability and readiness as its primary decision drivers and the operating specifications and conditions can be much more demanding. This has led to stringent standards and processes associated with military corrosion control practices. In addition, each of the military services tended to develop different approaches to the corrosion problem based on the conditions unique to each service. At the same time, the civil/industrial sector has been driven toward more economic standards and processes because of the inherent profit motive in the competitive marketplace.

Recently, however, the military has experienced decreases in available dollar resources for corrosion-related research, while the impact of corrosion appears to be increasing. An example of this impact is severe engine strut corrosion on KC-135E aircraft and center wing box corrosion cracks on C-130 aircraft, both of which seriously affect readiness. Civil/industrial sector studies ($276 billion annual cost of corrosion) reveal that the impact of corrosion may be much greater than previously thought. The confluence of impact and motivation has brought the two sectors together and helped define mutual environments, experiences, and needs for best practices.[3]

Civil/Industrial Sector Corrosion Costs

The most recent U.S. corrosion cost study was performed in 1998 by CC Technologies Laboratories, Inc. It was conducted under the auspices of the U.S. Department of Transportation, through the Transportation Equity Act for the 21st Century, in a cooperative effort with the U.S. Department of Transportation Federal Highway Administration (FHWA) and NACE International.[1] In this study, the cost of corrosion was determined for 27 specific industry sectors. The direct cost used in this analysis was defined as the cost incurred by owners or operators of the structures, manufacturers of products, and suppliers of services. (See Sidebar 1.)

Examples of structurally deficient bridges damaged by corrosion.

Highway bridge corrosion studies provide examples of how more detailed analyses can provide significant information. In the current study, life-cycle cost analyses addressed both the direct and indirect costs of corrosion. Indirect costs are those incurred by institutions other than the owner or operator of the structure; those indirect costs incurred by the public are typically referred to as social costs. Measuring and valuing indirect costs generally requires complex assessments. For example, highway bridge indirect costs, such as traffic delays during bridge maintenance, repair, and rehabilitation, are difficult to attribute to the bridge owner or operator and become “social” costs assumed by the overall economy. In these life cycle cost analyses, indirect costs associated with lost productivity caused by traffic delays were estimated to be 10 times that of costs directly attributable to bridge corrosion.

The civil/industrial sector has been expending much energy in developing effective, economic solutions to the pervasive problem of corrosion in the U.S. infrastructure. Organizations such as NACE and SSPC—The Society for Protective Coatings are spearheading efforts to quantify the problem and standardize approaches, including the development of best practices and implementation of in-depth corrosion prevention and control training. (See Sidebar 2.) The relevance of these initiatives is not limited to the civil/industrial sector—there should be wide applicability in the government sector as well.

Corrosion in the Government Sector

The U.S. Department of Defense (DoD) maintains billions of dollars worth of equipment and infrastructure used in corrosive environments around the world. Corrosion causes these assets to deteriorate, reducing asset availability and performance capability. Required corrosion inspection, repair, and replacement actions drive up costs, and the decreased availability of critical systems reduces mission readiness. The direct cost of corrosion to the U.S. military has been estimated to be $10 billion to $20 billion annually.[1,4-5] This estimate does not include indirect costs associated with troop safety, weapon system reliability, and overall readiness of the military.

The military services have long recognized the pervasive and insidious effects of corrosion on equipment and infrastructure. Each service component has developed corrosion prevention and control programs, including research and development, training, and operations and support methodology related to corrosion and its effects. The focus and intensity of each military service has varied with mission criticality, funding availability, and command interest. However, these programs have not been standard throughout the DoD and there has been evidence of duplication, inconsistency, discontinuity, and lack of communication between service components regarding corrosion effects, methodology, standards, best practices, and results.[3]

Operating in often harsh conditions, military vehicles can suffer significant corrosion damage.

During a tour of the Pacific Rim in 2002, members of the U.S. Congress were concerned by the nature and severity of corrosion observed on facilities, material, and equipment. As a result, Congress enacted a new law requiring increased DoD emphasis on preventing and controlling corrosion. This new legislation required the DoD to appoint a top-level corrosion executive to oversee and coordinate corrosion control efforts, including design, acquisition or construction, and maintenance throughout the department.

Congress also ordered the DoD to develop a long-term DoD-wide strategy to reduce corrosion and its effects. This strategy is to include expanded emphasis on corrosion control; a uniform application of processes for testing and certifying new corrosion prevention technologies; the implementation of programs that ensure a focused and coordinated approach to corrosion-related information distribution and sharing; and a coordinated corrosion control research and development program.

Thus, the government sector, led by the military, is embarking on a major effort to standardize corrosion prevention and control strategies, policies, training, best practices, and research and development across the military services and other government agencies.

Traditional Military Corrosion Maintenance Practices

The military challenge is not much different from any large industry, although the driving force is sometimes different, especially for weapon systems. For facilities, the factors are almost identical to the civil/industrial sector, although the decision-making process is quite different.

Corrosion repairs almost always have been paid out of operating budgets as a “cost of doing business.” When a corrosion condition results in material degradation, the owner must pay to have it fixed. The longer the owner waits, the worse the problem. Separating this cost from other costs has been difficult if not impossible, as corrosion is almost always a factor in the long-term performance of any asset (either weapons system or facility). The perceived cost of corrosion has been primarily the current cost of maintaining or replacing existing assets.

Improving methods of dealing with corrosion has typically been the result of isolated instances of the application of a new technology or because of an individual leader who makes corrosion prevention a priority. Unfortunately, this is currently not seen as a career-enhancing leadership choice. In this respect, the military and private industry are not significantly different.

While maintenance organizations understood the corrosion problem and were able to characterize the severity, the extent, and its consequences, corrective actions were frequently too late to achieve the desired results in cost savings and readiness. In many cases, corrosion had grown to such an extent that the consequences were obvious, while in other cases, such as exfoliation corrosion of aluminum aircraft components, the conditions were not detected until it was too late.

In recent years, each of the military services has achieved a better realization of the true nature and impact of corrosion. Research and development efforts have focused on understanding corrosion mechanisms, finding materials that better resist corrosion, exploring coatings and other treatments that can mitigate corrosion effects and prolong service life of equipment and facilities, developing new technologies that enable improved detection and analysis, and improving existing technologies to provide better protection and maintenance of corrosion-prone facilities. But until very recently, these efforts had been somewhat fragmented and isolated within each of the services, and successes (and failures) generally had not been shared.[3]

Transcending Traditional Corrosion Control—A New Paradigm

The government sector and the civil/industrial sector are now entering a new partnership, driven not only by common problems and objectives, but also by advances in corrosion research and development in both sectors and by the U.S. Congressional mandate requiring the DoD to develop and implement corrosion prevention and mitigation strategies. This has led to a significant paradigm shift within the DoD military organizations and has spurred efforts to transcend traditional corrosion control organizations and methods in order to better identify causes for billions of dollars in annual costs of corrosion and to substantially reduce these costs.

A Unified Approach for Corrosion Control

When the DoD responded to the Congressional mandate in 2003, it designated the Principal Undersecretary of Defense for Acquisition, Technology and Logistics as the DoD Corrosion Executive. The Corrosion Executive established a Corrosion Control and Oversight Office, headed by a Special Assistant for Corrosion Control and Oversight who is responsible to the Corrosion Executive for establishing and facilitating a viable corrosion prevention and mitigation program for both defense equipment and infrastructure.

Special Assistant Daniel J. Dunmire formed and leads the Corrosion Prevention and Control Integrated Product Team (CPCIPT), which established seven Working Integrated Product Teams (WIPTs) to address important corrosion focus areas. Membership in these groups is drawn from many sources—each of the military services is represented along with staff members from the DoD, Coast Guard, NASA, NACE International, and other industrial, civil, and academic organizations. The WIPTs meet individually as required and also as a group at quarterly Corrosion Forums and targeted workshops.[6] This program is contributing to outstanding successes, enabling the DoD to begin to transcend traditional corrosion control organizations and methods.

The partnership between the civil/industrial and government sectors is already paying off. Each has contributed to an expanding body of knowledge and to the development of improved analytic methods and best maintenance methods. Mutual experiences, objectives, and approaches are replacing the former parochial and disintegrated approaches to solving the pervasive problem of corrosion and its effects.

A Model for the Future

The civil/industrial and government sectors must continue to develop effective analytic methods, pursue promising science and technology paths, and implement best practices in the most effective possible manner. That means having partnerships, shared knowledge, common objectives, and the willingness to transcend traditional organizations, methods, and limitations. We are only beginning to make significant inroads into effectively solving the problems that drive the cost of corrosion to such high levels and have such a profound impact on the safety and availability of our structures and equipment. But this significant first step should be the model for future organizations and partnerships to continue to effectively address the insidious effects of corrosion.

References

1. G.H. Koch, M.P.H. Brongers, N.G. Thompson, Y.P. Virmani, and J.H. Payer, “Corrosion Costs and Preventive Strategies in the United States,” U.S. Federal Highway Administration Report, FHWA-RD-01-156, March 2002.

2. A. Timko and G.B. Keller, Washington, D.C., focused interviews, April 2005.

3. D.J. Dunmire, “Transcending Traditional Corrosion Control,” CORROSION/2005 speech (Houston, TX: NACE, 2005).

4. “Defense Management: Opportunities Exist to Improve Implementation of DoD’s Long-Term Corrosion Strategy,” Government Accountability Office, Report GAO-04-640.

5. “Defense Management: Opportunities to Reduce Corrosion Costs and Increase Readiness,” Government Accountability Office, Report GAO-03-753.

6. “Status Update on Efforts to Reduce Corrosion and the Effects of Corrosion on the Military Equipment and Infrastructure of the Department of Defense,” Report to Congress, February 2005.

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