MTL TR 87-8

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THE REAL COST OF CORROSION: ACCOUNTING FOR DOWNTIME, IMPLICATIONS AND METHODOLOGY

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ABSTRACT

The cost of corrosion uses the five-ton truck, Series 800, as the sample product in this pilot study because of its availability of historical maintenance data. It is the first study that attempts to account for the cost of downtime, due to corrosion, of an Army end item. Costing included parts, components, the three levels of maintenance labor, and supply and administrative time. The latter are the basic dollars spent for a system or end item that is out of commision due to some form of degradation. The methodology used to account for downtime is flexible enough to enable its use in estimating the monies spent on a variety of systems or end items where material degradation is a critical factor. The estimated results can be included in total life cycle support calculations. While corrosion is a multimillion dollar expense, material degradation is also a pervasive problem that can seriously undermine the Army's readiness posture.

CONTENTS

INTRODUCTION

In late 1985, Commanding General, Richard T. Thompson, Army Materiel Command (AMC), issued Guidance Statement Number 94 which established the Center of Excellence (CTX) for the Prevention of Corrosion/Degradation at the Army Materials Technology Laboratory (MTL), Watertown, Massachusetts.

In an effort to support the work of CTX, a study of the cost of corrosion was begun January, 1986, by MTL's Directorate for Technology, Planning and Management (DTP&M). Five-ton trucks in the 800 Series were used to establish a methodology for the pilot cost study on corrosion; the availability of data determined the use of this particular system for the cost study. During the period 4 April 1986 to 6 August 1986, in a cooperative effort with CTX, the study was continued and completed by DTP&M at CTX, housed in the Metals and Ceramics Laboratory at MTL.

Without the cooperation and expertise of key personnel at the Tank-Automotive Command (TACOM, Warren, Michigan), Headquarters, AMC (Alexandria, Virginia), Materiel Readiness Support Activity (MRSA, Lexington, Kentucky), and several Army Field Support Groups (e.g., 43rd, 83rd, and 183rd), this study would not have been possible nor the implications regarding readiness mission capability been realized (see Appendix A for list of personnel).

METHODOLOGY

The Data Collection

Historical maintenance data on the five-ton truck, 800 Series, was collected for 1983 through 1985, a two-and-one-half-year period. Among other data requested for inclusion in the study were, though scarce, early procurement and maintenance plans; procurement and replacement truck costs; parts, labor costs, and hours for both military and civilians for the three levels of maintenance (organizational, intermediate, and depot); operation and maintenance Army, and Operation and Procurement Army indexes (OMA and OPA, respectively); and, downtime hours and readiness mission capable factors. Scheduled or normal maintenance was reviewed and disregarded for inclusion in the study where no obvious correlation to corrosion existed. Whereever possible, information for all three levels of maintenance was sought for all costing categories. Where no data existed or was available, extrapolation from existing or comparitive material was made (see Appendix B for truck descriptions).

Data Calculation

Using sample data collection (SDC) of truck repairs for the 800 Series trucks (1983-1985), it was determined that of 243 trucks reported, 147 trucks related to corrosion; that is, 60 percent of all trucks in the SDC had a part or related operational problem involving corrosion. Total procurement for the 800 Series trucks is $17,396. The first procurement occurred in 1970 and the last known contract for procurement was 1985. A ten percent incident ratio for corrosion part replacement is calculated for the entire fleet, overtime, based on mission capability downtime factors.

Costs of parts both directly and indirectly related to incidents of corrosion were calculated from the two-and-one-half-year SDC into a one-year base (1985). OPA inflation indexes were applied to determine historical data from the first year of procurement through 1986. Five-year incremental indexes were then applied to calculate outyears, 1986 through 2001. Both OPA and OMA (used for labor calculations) use the same inflation rates for outyears (see Table 1).

Labor was calculated from the SDC in a similar manner as parts and further broken down into the three levels of maintenance. Labor cost indexes for military specialities and skill for organization and intermediate levels of maintenance were multiplied by maintenance level hours. For expediency, the total cost of military labor for each of the two levels were individually averaged. Labor costs were then inflated for outyears, 1986 through 2001.

After determining a one-year base, OMA inflation indexes were then applied to calculate the depot maintenance labor of civilians for the same years as military labor. Both military and civilian rates were multiplied by the average number of hours for the base year 1985 and, subsequently, calculated for historical cost data through 1970, and for five-year increments, 1986 through 2001, for the entire fleet (see Table 1).

Replacement costs for the 800 Series five-ton trucks were gained from three sources: contractual costs (TACOM), those cited in the Army Master Data File (AMDF), and the extrapolation made from OPA indexes. Four basic models were used to calculate and correlate an average base cost for 1985 (see Table 2).

Two alternative five-ton truck models were used for comparison to the 800 Series truck and to provide hypothetical historical cost data, which are not specifically cited in this study. The models used were the 900 Series five-ton truck and the medium tactical vehicle (MTV). The cost for the MTV was quoted by TACOM (see Table 2). The same methodology was used for these models as in the 800 Series, as described above, for parts, labor, and replacement costs. Exceptions were the reduction of the OPA 1985 index by 0.0500 for parts in the 900 Series; the assumption was that a new generation of truck exhibits a degree of improvement in either commonly known corrodable parts (i.e., battery casings) or in protective outer frame coating.

The MTV model was costed and, as with the 900 Series, hypothetical historical data calculated. Parts inflation index for 1985 was reduced by 0.1000. Rationale used for this reduction assumed planned corrosion prevention of extra coatings applied to the frame and undercarriage of the MTV. Also, cost savings should be gained due to new corrosion policy, coding and procedure, improved maintenance and inspection, and materials improvements planned to be in place over the next two-to-five years.

Downtime is the time a system is out of service due to supply or administrative delays. It is the time counted from when supplies are ordered to when actual maintenance begins, or that time after maintenance has been completed and before actual shipment to its point of origin. Little or no labor, per se, is involved (see Appendix C for rationale and methodology). Table 3 details the hours, and Table 4 details the costs for downtime due to corrosion.

Methodology application is represented in the following manner:

$$C_2 = \Sigma \text{ parts} + \text{labor} + \text{replacement costs} + \text{downtime}$$

where C_2 = cost of corrosion. The cost of corrosion is made up of the cost of some portion of parts, labor, replacement costs and downtime.

IMPLICATIONS

While downtime has not traditionally been accounted for within the Army, or for that matter DoD-wide, it is a very high cost when coupled with corrosion. In these days of budget reductions and our current emphasis on the use of state-of-the-art technology, the reduction of corrosion and its attendant cost makes sense. "Business sense" makes it imperative that this be counted as a cost to Government; private industry could not survive the cost of having primary machinery and related equipment out of commision for reasons of productivity. Even if the cost of replacement is excluded, the price tag for the two-year period, 1985 through 1986, is significant for the estimated total of currently fielded tactical wheeled vehicles ($35.2 million dollars, see Table 5c). As a further example, for the period 1983 through 1986, the cost of a minimum amount of corrosion for the one fleet studied was $17.2 million dollars (see Table 6).

Further, readiness mission capability is a critical issue and one that can be countered by emphatic support of materials' improvement. Not only would more aggressive action in materials' improvement reduce the factors of failure of systems and components vulnerable to corrosion, but failures that cause loss of life and injury to the men and women dependent upon those systems are an expense we cannot afford or easily replace. Safety is a direct recipient of reliability and maintainability, without which jeopardy of the primary mission is further undermined.

It is argued that a rotted door does not stop a truck performing its mission. There are other similar examples that support this claim. However, when even small or inexpensive components such as battery cables corrode and necessary fluids as lubricants and the like leak out of engines, the entire system is unusable (the "weakest link"). Projected corrosion improvements, such as the corrosion prevention coatings planned for the MTV will only protect the frame and undercarriage of the truck. It will not protect leakage, dry rot, moisture accumulation, and a myriad of geographic and environmental damage to the "innards" of the system.

Materials' improvement through research would seem to be the least expensive means of combating corrosion in both the short and long term. For example, only one fleet of trucks has been the focal point of this pilot cost of corrosion study and the cost of corrosion, including replacements, for a four-year period (1983-1986) amounted to $31.55 million dollars (see Table 6). When these costs are applied as a measure for all ground vehicles, including tanks, motorcycles, and other items such as missile carriers, bridges, marine and signal systems, and personnel equipment, the cost of corrosion to the Army can be estimated to be a far greater percentage of the $2 billion dollars cited by the National Bureau of Standards Report to Congress (May, 1978). If one considers the Army's fleet of helicopters and fixed wing aircraft in addition to ground vehicles, overtime, the cost of corrosion is beyond any dollar conceived in any previous study.

SUMMARY

In conclusion, the pilot study on the cost of corrosion may be conservative in its calculation. The reasons for considering the cost conservative are as follows: only one fleet of trucks was calculated for the cost of corrosion; and, availability of detailed data on all maintenance incidents are either incomplete or are not recorded. Related to the latter are problems such as wear of materials, tensile strength or cracking, and the use of incorrect or incompatible coatings and metals that hasten corrosion. These problems are unsolvable until such time cognizance of corrosion factors occur through training, which is now being instituted through MTL efforts.

Therefore, due to these considered stipulations and, in particular, the latter problems of maintenance records, downtime hours and the attendant costs would tend to be far greater in magnitude. Downtime, itself, as it is presented in this pilot study, is a new cost concept. Because of the initial findings for the costs of downtime due to corrosion, downtime needs to be seriously considered as an outset cost in acquisition planning and in logistical support.

Table 1. COST SUMMARY: PARTS AND LABOR

a. Cost Summary, 1986-2001:

Year	Org Parts	Org Labor	Int Parts	Int Labor	Depot Parts	Depot Labor
1986	347,486	695,834	234,554	531,249	54,555	191,203
1991	393,588	819,205	276,140	625,439	64,228	225,104
1996	440,960	917,805	309,377	700,717	71,958	252,197
2001	494,083	1,028,373	346,647	785,133	80,627	282,580
Total	1,676,117	3,461,217	1,166,718	2,642,538	271,368	951,084

Total Cost: $10,169,042
Total Parts: $ 3,114,203
Total Labor: $ 7,054,839

b. Cost Summary, 1983-1985:

Year	Org Parts	Org Labor	Int Parts	Int Labor	Depot Parts	Depot Labor
1983	297,372	645,656	200,727	493,267	46,687	170,846
1984	321,142	664,791	216,772	507,886	50,419	177,228
1985	334,314	668,628	225,663	512,103	52,487	183,727
Total	952,828	1,979,075	643,162	1,513,256	149,593	531,801

Total Cost: $5,769,715
Total Parts: $1,745,583
Total Labor: $4,024,132

c. Historical Cost Summary, 1970-1982:

Year	Org Parts	Org Labor	Int Parts	Int Labor	Depot Parts	Depot Labor
1982	272,800	620,313	184,141	473,906	42,829	162,884
1981	238,700	551,007	161,123	420,957	37,476	151,350
1980	213,894	471,118	144,379	359,924	33,581	136,858
1979	191,328	439,552	129,147	335,807	30,038	123,714
1978	175,582	413,911	118,518	316,219	27,566	113,410
1977	163,881	387,609	110,620	296,125	25,729	105,915
1976	154,654	366,756	104,392	280,194	24,280	99,709
1975	139,476	348,732	94,147	266,423	21,898	92,039
1974	125,234	327,387	84,533	250,716	19,662	76,114
1973	115,472	305,926	77,944	232,721	18,129	67,624
1972	110,156	274,566	74,356	209,566	17,294	66,043
1971	105,667	240,198	71,332	183,505	16,591	63,467
1970	100,996	223,807	70,429	170,984	15,856	61,008
Total	2,107,541	4,970,882	1,425,061	3,797,047	330,929	1,320,106

Total Cost: $13,951,566
Total Parts: $ 3,863,531
Total Labor: $10,088,035

Table 2. REPLACEMENT COST BY MODEL AND YEAR*

a. Average Cost by Model and Year, and Four-Year Average Per Model:

Model	Year 1983	1984	1985	1986	1983-1986
M813	58,696.00	65,987.00	68,694.00	71,401.00 :	66,195.00
M813A1	60,013.00	67,468.00	70,236.00	73,003.00 :	67,680.00
M817	80,706.00	84,016.00	87,462.00	90,908.00 :	85,773.00
M818	66,981.00	69,728.00	72,588.00	75,448.00 :	71,186.00

b. Average Dollar Total by Year:

1983	1984	1985	1986	1983-1986
66.981.00	71,800.00	74,745.00	77,690.00 :	72,709.00

*Four models calculated for representation of average replacement costs; constant dollars used.

c. Procurement Cost Comparison: 900 and medium tactical vehicle (MTV) Series:

Year	Model	Replacement Cost
1986	800 Series	77,690.00
1986	900 Series	76,101.00†
1986	MTV Series	67,908.00†

†Costs have been indexed based on year of planned procurement.

Table 3. DOWNTIME HOURS*

a. Downtime Hours, 1970-1982, 1983-1985, and 1986-2001:

	Administration			Supply		
Year	Org	Int	Depot	Org	Int	Depot
1970-1982	1,697,685	5,915,844	2,538,853	4,300,763	4,823,595	3,041,874
1983-1985	450,000	1,568,904	672,966	1,140,000	1,279,494	806,499
1986-2001	600,000	2,091,872	897,288	1,520,000	1,705,992	1,075,332

b. Historical Downtime Hours, 1970-1986:

	Administration			Supply		
Year	Org	Int	Depot	Org	Int	Depot
1986	150,000	522,968	224,322	380,000	426,498	268,833
1985	150,000	522,968	224,322	380,000	426,498	268,833
1984	150,000	522,968	224,322	380,000	426,498	268,833
1983	150,000	522,968	224,322	380,000	426,498	268,833
1982	147,000	512,244	219,836	372,400	417,668	263,456
1981	144,060	501,999	215,439	364,952	409,315	258,187
1980	141,179	491,959	211,130	357,653	401,129	253,023
1979	138,355	482,120	206,907	350,500	393,106	247,963
1978	135,588	472,478	202,769	343,490	385,244	242,004
1977	132,876	463,028	198,714	336,620	337,539	238,144
1976	130,219	453,767	194,740	329,888	369,988	233,381
1975	127,614	444,692	190,845	323,290	362,588	228,713
1974	125,062	435,798	187,028	316,824	355,336	224,139
1973	122,561	427,082	183,287	310,448	348,229	219,565
1972	120,110	418,541	179,621	304,278	341,264	215,174
1971	117,708	410,170	176,029	298,192	334,439	210,871
1970	115,353	401,966	172,508	292,228	327,750	206,254
Total	2,297,685	8,007,716	3,436,141	5,820,763	6,529,587	4,117,206

Total Administration: 13,741,542 Total Supply: 16,467,556

*Two percent reduction per year, 1982 back through 1970. The percent reduction is based on a rationale that the closer to original production, the newer and less number of trucks fielded, the fewer the incidents of corrosion there should be. Hours maintained steady from 1983-2001. Calculation based upon readiness factor.

Table 4. DOWNTIME COST SUMMARY

a. Cost, 1986-2001:

Year	Administration Org	Administration Int	Administration Depot	Supply Org	Supply Int	Supply Depot
1986	322,734	1,125,195	486,800	940,033	1,055,059	665,032
1991	379,955	1,274,478	551,385	1,064,750	1,192,036	753,264
1996	425,686	1,427,874	617,750	1,192,904	1,338,871	843,927
2001	476,969	1,599,890	692,170	1,336,613	1,500,165	945,823
Total	1,605,344	5,427,437	2,348,105	4,534,300	5,089,131	3,208,046

Total Administration: $9,380,886.00 : Total Supply: $12,831,477
Total, 1986-2001: $22,212,363

b. Downtime Costs, 1983-1985:

Year	Administration Org	Administration Int	Administration Depot	Supply Org	Supply Int	Supply Depot
1983	276,190	962,922	400,181	804,464	902,900	569,123
1984	298,266	1,039,891	449,894	868,767	975,071	614,614
1985	310,500	1,082,543	468,347	904,400	1,015,065	639,823
Total	884,956	3,085,356	1,318,422	2,577,631	2,893,036	1,823,560

Total Administration: $5,288,734 : Total Supply: $7,294,227
Total, 1983 - 1985: $12,582,961

c. Downtime Costs, 1970-1982:

Year	Administration Org	Administration Int	Administration Depot	Supply Org	Supply Int	Supply Depot
1982	253,368	883,355	382,171	737,990	828,293	522,096
1981	221,697	772,936	334,400	645,742	724,756	456,834
1980	198,658	692,611	299,648	578,635	649,439	409,359
1979	177,699	619,539	268,035	517,588	580,922	366,171
1978	163,075	568,552	245,976	474,991	533,112	336,035
1977	152,207	530,663	229,584	443,337	497,585	313,641
1976	143,637	500,784	216,257	418,375	469,570	295,982
1975	129,541	451,637	195,394	377,316	423,485	266,934
1974	116,313	405,521	175,443	338,788	380,243	239,823
1973	107,247	373,910	161,767	312,380	350,603	220,995
1972	102,310	356,698	154,320	298,000	334,464	210,822
1971	98,149	342,192	148,044	285,881	320,862	202,248
1970	93,802	327,036	141,488	273,219	306,651	193,291
Total	1,957,703	6,825,434	2,952,527	5,702,242	6,065,382	4,034,231

Total Administration: $11,735,664 : Total Supply: $15,801,855
Total, 1970 - 1982: $27,537,5196.

Table 5. ONE FIVE-TON TRUCK COST*

a. Annual Average Cost: One (1) Truck, 800 Series, 1983-1986:

Year:	Truck Cost	Parts	Labor	Downtime	: Total
1986:	77,690	36.65	81.53	264.13	: 78,072.31
1985:	74,745	35.21	78.44	254.12	: 74,972.05

b. 1970 and 1978 Cost Increase Comparison:

Year:	Truck Cost	Parts	Labor	Downtime	: Total
1978:	39,256	18.49	55.01	133.46	: 39,432.00
1970:	22,580	10.77	26.20	76.77	: 22,705.59

c. Total Corrosion Cost: One Truck Multiplied by All Models of Five-Ton Trucks Estimated as Currently Fielded, Excluding Replacement:

Year	Parts/Labor/ Downtime	Estimated # Fielded Five-Ton Truck	Total
1986	382.31	47,000	17,968,570.00
1985	367.77	47,000	17,285,190.00

*Annual averaged costs for one truck. Annual averaged cost for parts, labor, and downtime are derived from totals of maintenance levels divided into number of trucks produced.

Table 6. COST OF CORROSION SUMMARY

a. 1983-1986:*

Year	Parts†	Labor	Replacement‡	Downtime**
1983	544,786.00	1,309,769.00	1,498,474.00	3,915,780.00
1984	588,333.00	1,349,905.00	1,615,498.00	4,246,503.00
1985	612,464.00	1,364,458.00	1,681,763.00	4,420,678.00
1986	636,595.00	1,418,286.00	1,748,021.00	4,594,853.00
Total:	2,382,178.00	5,442,418.00	6,543,756.00	17,177,814.00

b. Cost of Corrosion Averaged Over Four Years (Constant Dollars):

Item	Total
Parts:	595,545.00
Labor:	1,360,605.00
Downtime:	4,294,454.00
Total:	6,250,604.00

*For three levels of maintenance: organization, intermediate, and depot. In constant dollars.

†Difference in 1986 total from those in Table 1 and 6, above, reflects the result of three levels rather than individual maintenance levels inflation process.

‡Based on 22.5 trucks per year at averaged procurement cost. Since only four (4) models (two [2] variations each) were calculated, replacement costs may be somewhat conservative. Averaged four-year cost of replacement is $1,635,939.00.

**For three levels of maintenance, as above, and combines both Administrative and Supply costs.

APPENDIX A. PRIMARY INFORMATION SOURCES

The people and organizations cited below are thanked for their close cooperation, support, and patience in providing the information necessary to undertake the pilot cost of corrosion study. They are deserving of special mention.

Tank Automotive Command, Warren, Michigan:
- Mike Merlo, AMSTA-VCW
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- R. Fitzpatrick, SLCMT-TP

APPENDIX B. FIVE-TON TRUCK 800 SERIES DESCRIPTION

1. Number procured, 1970-1985: 17,396

2. Description:

Model*	End Item Number	Nomenclature
M813*	2320000508902	Cargo Truck, Fixed Long Wheel Base (LWB), Without Winch (W/O)
M813WW*	2320000508890	Cargo Truck, Fixed LWB, With Winch (W/W) M813A1*
M813A1*	2320000508913	Cargo Truck, Fixed Dropside, LWB, W/O
M813A1WW*	2320000508905	Cargo Truck, Fixed Dropside, LWB, W/W
M814	2320000508988	Cargo Truck, Extra Long Wheel Base (XLWB), W/O
M814WW	2320000508987	Cargo Truck, Fixed XLWB, W/W
M817*	2320000508970	Dump Truck, W/O
M817WW*	2320000510589	Dump Truck, W/W
M818*	2320000508984	Tractor Truck, W/O
M818WW*	2320000508978	Tractor Truck, W/W
Other: †		
-	2320000508927	Bolster Truck
-	2320000509006	Van
-	2320000509010	Van
-	2320000510489	Wrecker Truck
M816WW	-	-
M819WW	-	-
M8120	-	-

*The four models costed for procurement/replacement purposes in study. These same models provided the most detailed data.

†A dash signifies that information was unavailable. Some models/end numbers may, therefore, be repeated inadvertantly in "Others".

APPENDIX C. RATIONALE FOR DOWNTIME DEFINITION AND METHODOLOGY

SDC for the 800 Series Truck only cited supply and administration hours for organization and direct support levels. No other maintenance level hours were clarified. Inquiries into the specifics of downtime resulted in the following methodology.

From a comparable fleet of Five-Ton Trucks, mission capability was quoted at 81 percent and 19 percent down. Of the 19 percent down, eight percent was due to administrative delay and 11 percent was due to supply delay [mission capable administration (MCA) and mission capable supply (MCS), respectively]. These statistics were for active and reserve Army, CONUS and OCONUS, as was the 800 Series.

Statistically, the percentage of downtime due to administration and supply closely corresponded to the number of hours cited in SDC for administration and supply downtime for the 800 Series trucks. This ratio/percent was applied to the 800 Series total fleet and a total of 3305 trucks were calculated to have been down at any one time. When calculated by the percent known to be down due to corrosion, we estimated that an addition of 337 trucks were necessary to make the fleet mission capable over the life of the fleet. Fleet life, or life expectancy, had been estimated at 20 years in 1970; from the calculations, a 15-year life tended to be more realistic. Using a 15-year life expectancy, this calculated into 22.5 trucks per year needed to maintain readiness capability (337 divided by 15). This number was then multiplied by the average cost of the truck, the result of which is the cost of downtime due to corrosion for administration and supply.

Hours for downtime were extrapolated for the three levels of maintenance based upon the total hours expressed in SDC. These hours were then multiplied for the total fleet according to the number of maintenance incidents and, then, calculated for the percentage down due to corrosion (ten percent).

Further note is necessary at this point on how downtime hours were determined. Within SDC, organization and direct support contained like number of hours in downtime as was found for parts and labor -- that is, a two-to-one ratio. Therefore, the assumption was made that downtime was similar in trend for all maintenance levels in downtime as it had been for parts and labor. Differences in either supply of administration downtime at the general and depot levels were not supported by any concrete evidence; it was, therefore, reasonably assumed a like ratio of hours could exist at all levels. Further logic dictates that delays for supplies at one level can be countered by delays in administration at another level.

Thus, the methodology for calculating hours was as follows: 50 percent of the total for organization and direct support was assigned as general support. Next, direct support and general support were summed and the result assigned as intermediate level hours. General support hours were then assigned as depot level hours. The underlying assumption, too, is that the least amount of hours is at the organizational level, the most at the intermediate level, and the depot level having more than organization, but less then intermediate hours in downtime. This is a reality of current maintenance level disbursement; intermediate level maintenance has steadily increased the complexity of the work once reserved exclusively for the depot.

Total costs for administration and supply downtime were divided by their respective total hours. An average per-hour cost for both supply and administration was calculated in this manner. Level hours were then calculated by this average cost per hour for 1985 and, using OPA indexes, inflated from 1970 through 1986, and for the outyears, 1986 through 2001, for the total fleet.

However, further assumptions were made. Assuming improvements in policy procedure, maintenance practices, and materials, the downtime hours from 1983 to 2001 were held steady. Likewise, a reduction of two percent per year was applied for 1982 back to 1970, assuming a lesser degree of corrosion incidents the closer to first fielding; this reduction of two percent still accounts for geographic and environmental variations that would have encouraged corrosion.

BIBLIOGRAPHY

1. Sample Data Collection, TACOM (AMSTA-VCW), Warren, MI, June 1983 - December 1985.

2. Army Master Data File (AMDF), 1985.

3. Revised Inflation Indices, Headquarters, Army Materiel Command (AMCRM-ER), Alexandria, VA, March 1986.

4. Economic Effects of Metallic Corrosion in the United States, National Bureau of Standards, Special Publication #511-1, May 1978, U.S. Department of Commerce, Washington, D.C.

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