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Corrosion Sensors for Evaluation of Wash Intervals on Aircraft

W.H. Abbott
Battelle Columbus Operations
505 King Avenue
Columbus, Ohio 43201-2693

Owen Jett
Air Force Corrosion Program Office
Warner Robins Air Force Base
Warner Robbins, Georgia

Molly Statham and James Sawinski
Warner Robins Air Force Base
Warner Robbins, Georgia

ABSTRACT

Studies have been made involving the use of corrosion sensors to document corrosion severity on the ground and in the flight environment. They have been used to document cause and effect relationships and in this work were used to study the effects of extending wash intervals on C130 and H60 aircraft.

The results from this work in both ground and flight environments were consistent in demonstrating that there are no discernable effects of extending wash intervals above current levels. The potential impact on reduced costs and increased aircraft availability from this conclusion are large.

INTRODUCTION

Air Force aircraft are periodically washed at intervals determined by base corrosion severity/ESI. For example, wash intervals might range from 30-180 days depending on whether a base environment is rated as mild, moderate, or severe. These requirements are quite different than rinse intervals which in some cases might be as short as daily depending on locations and missions. These procedures have traditionally been assumed to be for corrosion control purposes. Washing is not only labor intensive , it is relatively expensive as applied over a large fleet of aircraft such as the C130 or H60. There are obvious economic incentives if a basis can be established for extending these intervals.

Key Words: Corrosion; Corrosion Sensors; Wash Intervals

Ground Based Studies

In recent years, considerable work has been done to evaluate the use of simple corrosion sensors to track corrosion in field environments and more recently on operational aircraft (1). Prior to the work that is the main subject of this paper, a study was done in a variety of ground environments to evaluate effects of wash intervals between 1 and 28 days on corrosion. (2) The procedures were straightforward.

Corrosion sensors were mounted on plastic panels which were mounted vertically on a chain link fence in the outdoor environment. Independent samples were washed and rinsed at specified intervals using standard aircraft wash procedures. The sensors were periodically measured to follow corrosion by their electrical output. These experiments were carried out at 3 locations – Daytona Beach (very severe), Central Ohio/Wright Patterson, AFB (moderate severity), and Robins, AFB (mild).

Several examples of the results from these studies are given in Figures 1-3. These views are somewhat difficult to interpret at first but they were designed to show the major conclusions as follows :

1) There is a benefit from washing in lower corrosion rates (Figure 1) in a severe environment but only if washing is very frequent e.g. every 2-3 days. Since no base is likely to ever wash at such short intervals, the practical consequence of these data, if verified may be for no effects of washing at intervals that would be used.
2) In a severe environment, wash intervals beyond a few days have little apparent effect
3) In locations of moderate and mild severity the data do not show any significant effects of washing.
4) Again, no conclusions are being drawn regarding any effects of rinsing.

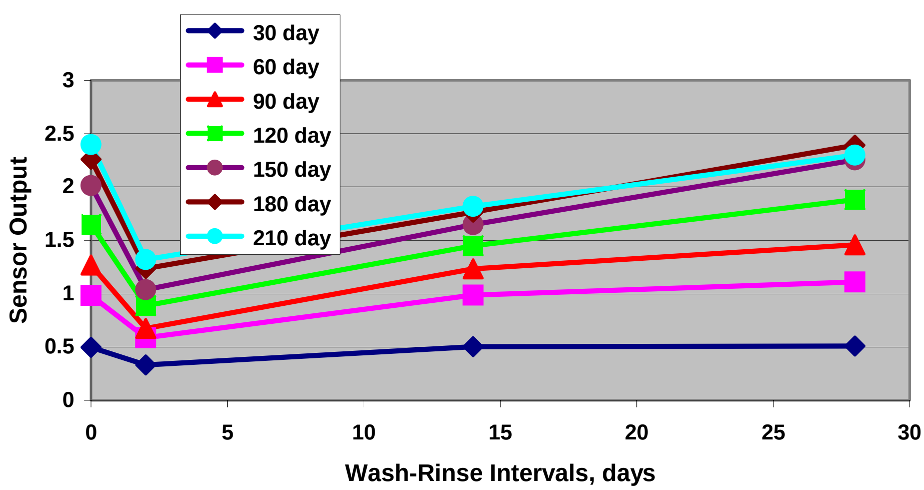

FIGURE 1 – Corrosion Sensor Output vs. Wash Intervals; Data after Various Cumulative ExposurePeriods; Exposed Outdoors at Daytona Beach (Very Severe)

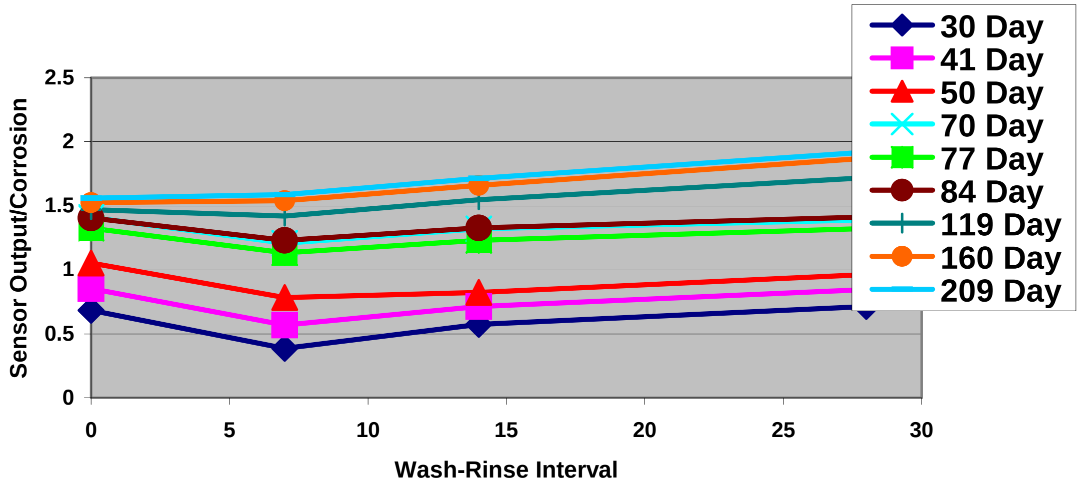

FIGURE 2 – Corrosion Sensor Output vs. Wash Intervals; Data After Various Cumulative Exposure Periods; Exposed Outdoors At Central Ohio (Moderate Severity)

It is recognized that these results are contrary to established practice and thinking. The reasons for these results are not totally understood but may be related to the very fast transport of reactants to surfaces. Whatever, the explanation, these results have been sufficiently positive to provide a basis for operational tests on aircraft.

Flight Test Studies – C130

The same corrosion sensors were installed in large numbers for this purpose on two MDS aircraft. These were the C130 and H60 at multiple bases. The C130 installations had 30+ sensors per aircraft as part of a larger study but only a few of the locations were regarded as relevant to wash effects. These were 1) Landing Gear/wheelwells, 2) Sloping Longerons (FS737), 3) Air Deflector Door, and 4) Flapwells (various wing stations). The H60 installations were unique and represented the first placement on outer skin at Left and Right sides, Belly, and in some cases Top, overhead cockpit.

The C130 base at Mansfield, Ohio was documented as a moderate ESI with a normal 120 day wash interval. Half of the fleet of 8 aircraft remained at 120 days; half were extended to an ISO wash only of about 1 year.

The H60 base was coastal, severe, and had a normal wash interval of 30 days. A similar strategy was adopted with half of the fleet extended to about 180 days. In both cases, sensors were read about every 3 months. In both cases, washings and/or rinsing were conducted per normal practices.

Figures 3-5 summarize most wash results through nearly 3 years of study. Figures 3 and 4 are from the Landing Gear areas. Figure 5 shows the statistics for all relevant areas combined. This work is ongoing but nearly 3+ years of data have now been accumulated.

Flight Test Studies – H60

Similar studies are being done on helicopters based in a severe environment on Long Island, NY. Early results are shown in Figure 6. Overall conclusions remain the same as just discussed.

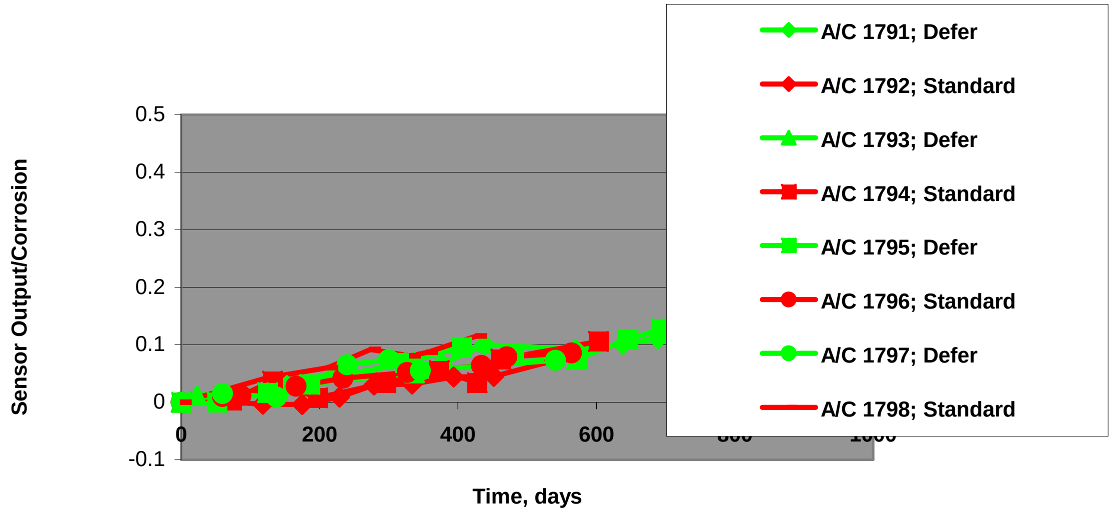

FIGURE 3 – Sensor Output on Mansfield Aircraft from Wash Deferral Studies; Rt. MLG;Green= ISO Wash Only; Red= Standard Wash

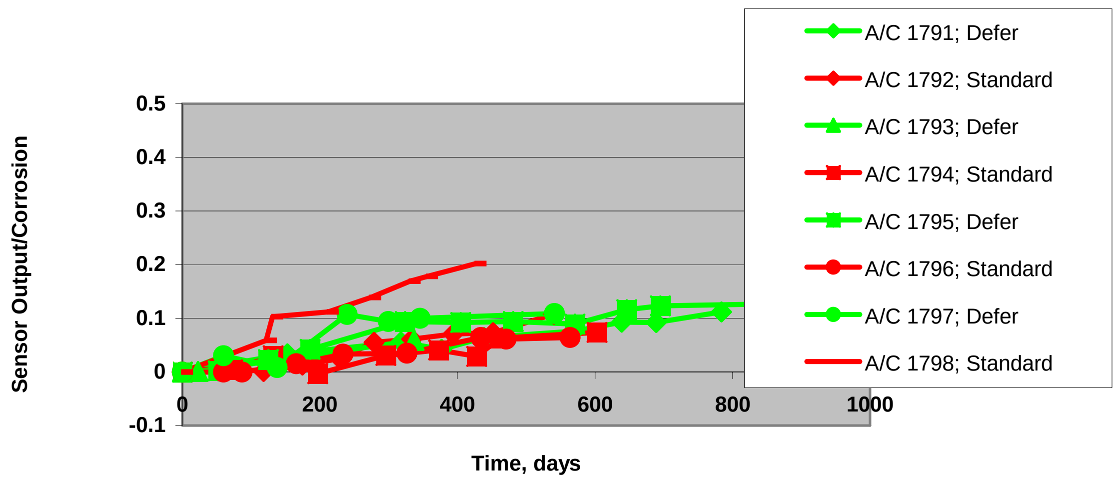

FIGURE 4 – Sensor Output on Mansfield Aircraft from Wash Deferral Studies; Lt. MLG;Green= ISO Wash Only; Red= Standard Wash

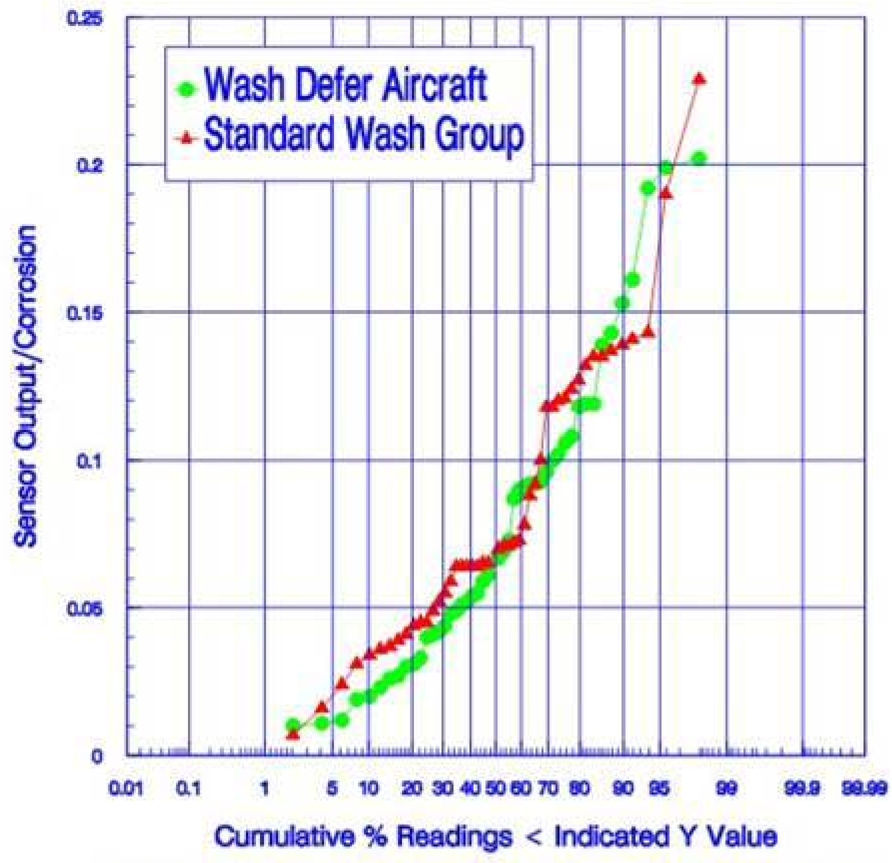

FIGURE 5 – Corrosion Sensor Output Statistics for All Areas of C130 Aircraft (MLG, Flapwells; ADD); 1 Year Data; Mansfield

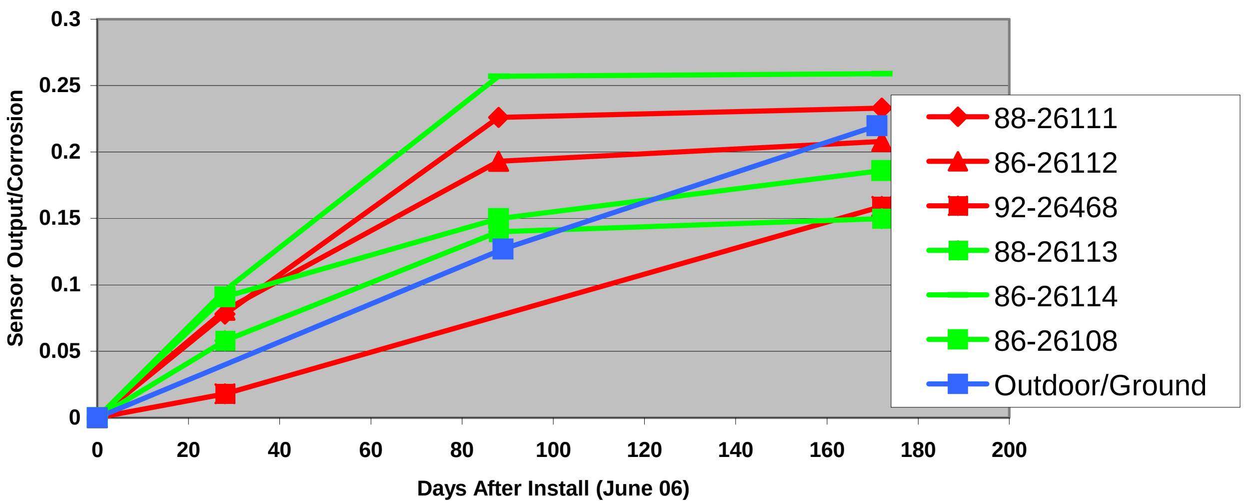

FIGURE 6 – Effects of Wash Deferral on H60 Aircraft Based WKVB (Severe ESI) Sensors on RH Outer Skin; Red = Wash Defer; Green = Normal, 30 Day

For this location data have been included on corrosion rates for sensors permanently installed on the ground. Normally on aircraft such as the C130 it is found that the rates on-aircraft are lower than found on the ground based sensors. This is due to a number of factors including sheltering effects from the structure itself. This would most likely be true on helicopters except for the missions of these particular H60s. These include low-level, rescue operations just above water. It is not surprising that rates would be higher, but even in these cases the data are showing a general conclusion reached on all aircraft including the C130s above. This is that every aircraft appears to be unique in the degree of corrosion exposure; i.e. it has its own "signature". What might at first glance in Figure 6 be regarded as scatter in the measurements is not. Instead the data represent real variations by tail number.

These data for the H60 represent the first studies in a severe environment. They are significant for their implications that wash deferrals can be done over a wide range of environmental severity levels. At the same time, caution is advised due to the radical departure from long established practice of frequent washings in severe environments.

There appears to be a growing realization that for moderate environments such as those for which the C130 results were obtained, the risks of deferred washings are small. On the other hand, the risks associated with the severe environments are higher, and for this reason, work of this type should be more extensively verified for the severe conditions.

CONCLUSIONS

The use of simple corrosion sensors for documentation of corrosion severity on operational aircraft has been demonstrated. At present over 1500 are flying successfully on various MDS aircraft worldwide.

The sensors have been used to provide "hard" metrics on cause and effect relationships. In this work they have been used to study the effects of wash deferral. It appears that a basis has been established for extending these intervals. The potential impact of this conclusion is large with respect to costs and aircraft availability. As one example for the C130 fleet, these studies were done at a basing location for which the Environmental Severity Index is at or above the indices for about 60% of the current C130 basing. If the decision were made to extend wash intervals from the current 120 days to about 180 days, one estimate shows that the increased airlift capacity would be the equivalent of adding 2-3 aircraft to the fleet!

REFERENCES

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