



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LEWIS RESEARCH CENTER
CLEVELAND, OHIO 44135



Kuivinen

Corrosion reduction

May 22, 1975

REPLY TO
ATTN OF: 70112

Mr. E. J. Florestano
Adesso Corporation
P. O. Box 14311
Norfolk, VA 23518

As Literature for
ANALYTICS and
MONITORING

Dear Mr. Florestano:

First of all, I want to thank you for allowing us to test the Descal-A-Matic in our dynamic corrosion test system. We have used the system to test many water treatment corrosion inhibitors with various degrees of success (both good and bad). Our normal test program for the inhibitors is a rather severe test in that the testing period (after system equilibration) is eight consecutive days or approximately 200 hours. The water system flow rate is 10 gpm, temperature is 125°F, and saturated with air. Steel corrosion coupons are placed into the system and removed upon test completion, cleaned and reweighed. The loss in weight in grams is mathematically converted to a corrosion rate expressed in mils per year.

Chemical inhibitors have given us corrosion rates of 1 to 50 mils per year, with four mils to be considered acceptable.

In testing the Descal-A-Matic, we made no effort to pre-clean the system (as is the case with the inhibitors), however we did run the test for 14 days and at the same parameters as the other tests. Fourteen days were chosen because it normally takes between 4 to 6 days for a system to be conditioned for an inhibitor test, plus eight days for the actual run time.

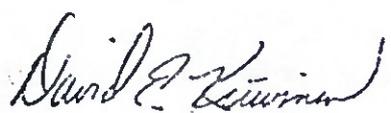
The results were excellent with corrosion rates of five and six mils per year with coupons tested on a parallel

section of the flow system and 0.0 mils on a coupon that was located downstream of the Descal-A-Matic. A sketch of the test unit is enclosed. With these excellent results, we would like to test a unit in a real application, such as a boiler system or on a heat exchanger system. Such a unit would have to be properly sized for the system. Perhaps you could make a unit available for us for a longer test program.

NASA's Langley Research Center is also interested in testing a unit of yours, perhaps with a joint effort of Lewis and Langley to try to understand the physics involved. One thought is to demagnetize at Langley the same unit that we tested at Lewis and return it to Lewis for further corrosion testing.

Enclosed we have submitted a simple flow schematic of how the Descal-A-Matic was tested at Lewis. Included are pictures of the unit and corrosion test strips. These test results do not represent the Agency's endorsement of the Descal-A-Matic as a corrosion and deposition inhibitor. It does represent data that is significant and that merits further testing and evaluation.

Sincerely,


David E. Kuivinen

3 Enclosures

cc:
Mr. Michael Cohen
Indiana University
Mr. Charles Sanderson
Superior M-Tow Inc.

CONTENT	PAGE
DESCRIPTION OF DYNAMIC CORROSION TEST.....	1 - 3
HOW THE DESCAL-A-MATIC WORKS	4
POINTS TO BE STRESSED IN CONDUCTING INVESTIGATIONS OF THE DESCAL-A-MATIC	4 - 6
TESTS BY NASA AT LEWIS RESEARCH CENTER	
FIRST TEST	7 - 8
SECOND TEST	8 - 9
THIRD TEST	10 - 11

Prepared by
Joe McPartland

Mr. David E. Kuivinen of NASA, in telephone conversations which I originated, on 10/20/77, 10/21/77 and 11/11/77, explained the Dynamic Corrosion Test which they use at their Lewis Research Center in Cleveland, Ohio. On 11/11/77, I also spoke with Mr. Joseph Yukich.

The test is used to evaluate various chemicals for their corrosion inhibition effectiveness. Their primary interest lies in the prevention of corrosion in cooling tower systems. All of the chemicals are intended to be added to the water, i.e., none are intended to be shop or field applied directly to the surfaces requiring protection.

Briefly, the test consists of filling a small tank with water, approximately ten gallons; adding the chemical inhibitor to the water in the tank; starting a pump which circulates the water from the tank through a piping system containing four steel test coupons which are weighed before the test starts and upon completion of the test (after removal of deposits). The loss in weight in the coupons is converted, mathematically into a corrosion rate expressed in "mils per year".

At the Lewis Research Center, the piping system thru which the water circulates consists of two parallel branches, each branch containing two test coupons. Each branch handles "inhibited" water, i.e., some people, unfamiliar with the test, had erroneously thought that one branch was handling "inhibited" water and the other branch was handling untreated or "control" water.

The test for chemical corrosion inhibitors is always run with the water at a temperature of 125°F - the temperature being maintained by a thermostatically controlled electrical heating element(s).

The water used in the test is always Cleveland Tap Water.

When untreated or uninhibited Cleveland Tap Water is tested in the system, the steel test coupons corrode at a rate ranging from 25 to 40 mils per year; however, if the temperature of the water be reduced to approximately 80°F, the corrosion rate drops to 6 to 7 mils per year.

The water is considered saturated with air which is continuously delivered to the water in the tank via a flexible plastic hose, with submerged discharge, connected to a source of air.

During the test, some water is lost due to evaporation from the free water surface in the open tank. From time to time makeup water is added, via another flexible plastic hose connected to Cleveland Tap Water. During the progress of the test which takes eight days, approximately 10 to 15 gallons of makeup water is added to the tank to compensate for that lost by evaporation. Thus, at the end of the eighth day, the system water is considered concentrated to 2 to 2.5 cycles of concentration.

As the test progresses, the water is periodically tested to be certain that the concentration of the chemical inhibitor is at some prescribed value, i.e., from time to time, a little more chemical may have to be added.

The water is pumped at a rate of approximately ten (10) gpm with five (5) gpm passing thru each of the two test branches.

There is no "blood-off" from the system during the test.

After completion of a given test, and before the start of a new test, the system is cleaned. We are advised the cleaning agent is either a solution of citric acid or inhibited hydrochloric acid. The solution is circulated thru the system for some period of time to remove scale deposits, including the products of corrosion, which form throughout the entire system while a test is in progress. The cleaning solution is then drained from the system. The system is then flushed with Cleveland Tap Water - until tests indicate complete neutralization of the acidity imparted by the cleaning agent. In general, it takes one day to properly clean a system.

If a test of a chemical inhibitor is to follow, the tank is filled with ten gallons of Cleveland Tap Water to which is added a SLIGHT OVERDOSE of the chemical inhibitor. The pump is started and the water is allowed to circulate throughout the system for some 3 to 5 days in what is termed an "equilibration period". For a chemical inhibitor to be effective its concentration in the water must be held at a value which insures that the metallic water-side surfaces become, and remain, covered with a film of the chemical, the film functioning to isolate the metal surface from the water environment.

I did not learn precisely the procedure followed after conclusion of the equilibration period, i.e., it would appear that one of two possibilities exist, as follows:

1. The system could be drained and then immediately refilled with fresh Cleveland Tap Water to which is added the "normal" dosage of the chemical inhibitor, or
2. Water in the tank could be tested for the concentration of chemical inhibitor and, if at the correct value be reused in the actual Dynamic Corrosion Test; if of an incorrect concentration, the concentration of inhibitor could be adjusted to the correct value by bleed-off, makeup and/or addition of more chemical inhibitor.

In either event, following the "equilibration period", steel test coupons are marked for identification, carefully weighed and inserted into the various fittings in the piping system designed to accommodate the coupons. The pump is restarted and the eight day Dynamic Corrosion Test begins. Periodically during the eight day period, the water is tested to be certain that the concentration of the inhibitor is maintained at the prescribed value. At the end of the test, the steel coupons are reweighed - after careful removal of scale including products of corrosion. The loss in weight in the coupons is converted to a corrosion rate, as previously discussed, reported as so many mils per year.

Mr. Kuivinen explained that the corrosion rate determined and reported is actually a function of the time duration of the test - an inverse function, i.e., if the test be shortened to six days, the corrosion rate would be greater than the value reported at the end of an eight day test; if the test be extended to, say, fourteen days, the corrosion rate would be lower than the value reported at the end of the eight day test. The greatest amount of corrosion occurs in the first 1/3 hours of the test. Thereafter, the loss in weight drops off rapidly. The reason for this, we are told, is that as the test progresses the deposition of scale, including prod-

ucts of corrosion, on the metal surfaces functions to isolate the metal from the water environment - much like the inhibitor film. If the tests were conducted for 48 hours, instead of eight days, the large loss of weight in those 48 hours would be reported as a very much larger corrosion rate (mils per year) than would be reported if the test ran for eight days, i.e., the loss of weight in the coupons in the six days following the first 48 hours, is a small percentage of that lost in the first 48 hours.

Mr. Kuivinen emphasized that in advising that, as the test progresses, scale is accumulated on the test specimen - he does not limit that to products of corrosion, i.e., in addition to products of corrosion, e.g., ferric hydroxide and, perhaps, ferrous hydroxide and, perhaps, iron oxide ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$), normal calcium and magnesium carbonates are evident on the test coupons.

It is my understanding that the corrosion rates of the four test coupons used in any given test are reasonably consistent, i.e., within, approximately, 2 mils per year, when testing a chemical corrosion inhibitor.

As of this writing, I do not understand what is meant by the advice that untreated Cleveland Tap Water causes corrosion at some rate ranging between 25 to 40 mils per year. In a given test, would we expect the four coupons to give corrosion rates of, say, 25, 30, 35 and 40 mils per year? In a given test, should we expect the four corrosion rates to be, say, 24, 24.7, 25.3 and 26.0 mils per year - and, in another test, some time later to be 39.0, 38.7, 39.3 and 40.0 mils per year? Is there some correlation between the corrosion rates for untreated Cleveland Tap Water and variations in its analysis - daily, weekly, monthly, seasonal variations in the analysis of Cleveland Water?

Mr. Yukich explained that the steel test coupons which they use were supplied to them by one of the suppliers of corrosion inhibitors located in Cleveland. The supplier provided a carton full of test coupons. Each coupon is packaged in a plastic envelope, presumably sealed, which is inserted in a paper envelope containing a desiccant. Each coupon is stamped with its weight and, perhaps, with some identification number. Mr. Yukich believed the test coupons were actually prepared, by the supplier, through another Cleveland Laboratory Supply House. In any event, we believe it can be said that the coupons are of some standard quality, i.e., they are identical in composition, size and finish. Presumably a technique is used to preclude their becoming contaminated between the time the envelopes are opened and the test begins, i.e., that they are not "handled".

Mr. Yukich explained that on occasions "used" coupons may be "re-used" in another test.

While there may be some valid reason for using parallel test branches in the Dynamic Corrosion Test, it would appear that use of a single branch would insure that all test coupons would be subjected to exactly the same quantity of water during the test period.

Valid studies of the Descal-A-Matic in the laboratory should take into account what happens in using the Descal-A-Matic. This is illustrated in Figures 1 and 2. Two new boilers are placed "on the line"; Boiler No. 1 uses untreated water; Boiler No. 2 uses water treated by the Descal-A-Matic.

Shortly after the boilers are placed on the line, deposits will be observed on the tubes of each boiler.

As time progresses, the deposits on the tubes of Boiler No. 1 will build up, i.e., a conventional scale forms.

As time progresses, the deposits on the tubes of Boiler No. 2 remain essentially unchanged in amount, i.e., the deposits do not build-up. The substance deposited is not "scale"; the substance is a powdery deposit.

The powdery substance forms on the metal surfaces throughout the entire water system and provides a thin layer which, once formed, inhibits or prevents corrosion.

It is in the light of the foregoing that investigations should be undertaken to establish the validity of Descal-A-Matic to prevent scale and corrosion in a water system.

Two additional points should be stressed upon those contemplating laboratory investigations into the validity of the Descal-A-Matic:

1. The flow rate of the water should approximate closely the rated capacity of the particular Model Descal-A-Matic being tested, i.e., a unit rated at 15 gpm should not be tested at 1 gpm; instead, a unit rated at 1 gpm should be used.
2. The Descal-A-Matic and the system should be grounded, i.e., we are dealing with the effect of a magnetic field upon the many charged particles located in the water, i.e., ions, charged colloidal particles, acidic compounds, dipoles, etc., and the tendency for water formed precipitates to deposit and build upon a grounded metal surface under the influence of turbulent flow, in the piping portion of the system, and/or the currents established in the heat exchanger portion of the system.

In the three Dynamic Corrosion Tests conducted at the Lewis Research Center, the Model A-275 Descal-A-Matic was used. A photograph of that unit is enclosed. It is shipped with a plug in the inlet connection and a cap on the discharge pipe. The Model A-275 is intended to be connected into a 3/4" ip pipe. The inlet connection is a 3/4" to 1" enlarger. The magnets are housed in the 1" length of pipe in the length upon which the Name Plate is applied. The outlet is a 3/4" nipple.

In testing this unit at the Lewis Research Center, the "inlet enlarger" was not used, i.e., as can be seen in the photograph of the Dynamic Corrosion System illustrating the way the Descal-A-Matic was installed, the 1" magnet housing was screwed into the

UNTREATED WATER

TREATED WATER

FIRE TUBE

FIRE TUBE

TIME

Start-up

Short time after start-up

After year of operation Annual Inspection

ARAGONITE TALC

ARAGONITE TALC

SCALE

SCALE

FIGURE 1. FORMATION OF SCALE ON TUBE OF FIRE TUBE BOILER USING UNTREATED WATER

FIGURE 2. ABSENCE OF SCALE ON TUBE OF FIRE TUBE BOILER USING WATER TREATED BY A "Descal-A-Matic"

"tee" - from which the Descal-A-Matic branch originated. The 3/4" discharge from the Descal-A-Matic is connected to the 1" "tee" (housing coupon #12) via a bushing. It is my understanding that the 3/4" Descal-A-Matic (Model A-275) is "equivalent" to its own length of 3/4" pipe - insofar as its effect upon flow rate and friction loss in head is concerned.

On the other hand, the parallel branch (housing coupons #41 and #43) consists of 1" pipe.

We can consider the pressure in the header, from which each of the two branches originates, to be constant. Thus, the pressure drop across each branch is identical. The question arises: what is the flow in each branch?

The flow in each branch can be calculated or can be determined from appropriate flow charts. For example: if each of the branches were 100' long and the pressure drop across the branch were 1 psi, the flow in each branch could be determined from the enclosed Flow Chart (for Fairly Rough Pipe) to be: 2.1 gpm in the 3/4" pipe and 4.4 gpm in the 1" pipe.

Under the assumed conditions, the 1" branch would handle more than twice the quantity of water handled by the Descal-A-Matic branch.

We believe the foregoing emphasizes the need, when parallel branches are used, to accurately determine the flow rate in each branch - not only before the test starts, but periodically during progress of the test.

The results of the three tests of the Descal-A-Matic are summarized in the Table, below. It should be noted that only three test coupons were used in the tests; one was located in the Descal-A-Matic branch - at the exit from the Descal-A-Matic; the other two coupons were located in the Parallel branch.

LOCATION OF COUPON	CORROSION RATE, MILS PER YEAR					
	FIRST TEST		SECOND TEST		THIRD TEST	
	14 days w mag #1	8 days wo mag #2A	8 days w mag #2B	30 days wo mag #3A	30 days w mag #3B	
Descal-A-Matic	0.0	21.5	23.3	5.6	7.3	
Parallel	6.0	30.4	38.1	8.0	7.8	
Parallel	5.4	21.0	18.0	5.5	9.2	

THE FIRST TEST OF THE DESCAL-A-MATIC was conducted in May, 1975 in a system which had not been cleaned following the completion of the test of a corrosion inhibitor conducted in February or March of 1975, i.e., the system was contaminated with a certain amount of scale, products of corrosion and the chemical inhibitor - a sodium phosphate and sodium chromate mixture which, when tested, resulted in a corrosion rate of, approximately, 3 mils per year.

The system was not operated to allow for "equilibration". The test was conducted with new steel test coupons and was run for fourteen days instead of eight days.

In discussions of this test, it has been generally assumed that the flow rate in the two branches, the Descal-A-Matic branch and the parallel branch, was approximately 5 gpm. Unless the flow rates were actually checked, we tend to believe that the flow rate in the Descal-A-Matic branch could have been 3.33 gpm and the flow rate in the parallel branch could have been 6.66 gpm.

The unique result of this test, never before encountered in Mr. Kuivinen's experience with Dynamic Corrosion Testing, was the complete absence of corrosion on any of the steel test coupons, e.g., the coupon installed in the Descal-A-Matic branch.

It would appear that there would be some justification in one ascribing the "unique" result to the fact that a "unique" device was tested, i.e., never before had a "magnetic water conditioner" been tested in the Dynamic Corrosion Test System.

While ADESSO expected favorable test results, the complete absence of corrosion on the one coupon came as a pleasant surprise, i.e., with respect to this particular coupon, it would appear that the powdery substance - upon which we depend to prevent corrosion - formed almost immediately on the coupon in question, at the start of the test. Ordinarily we expect the substance to form after a passage of time. Perhaps the proximity of the coupon to the Descal-A-Matic may account for the startling result. In any event, it would appear that this amazing result was due to the "treatment" imparted by the Descal-A-Matic for the particular flow rate that existed under the other test conditions which prevailed.

Can we account for the fact that the coupons located in the parallel branch corroded at rates of 5.4 and 6.0 mils per year? First of all, the water passing over these coupons could never be considered "treated" to more than 50% of the "treatment" imparted to the water passing over the coupon which showed no corrosion. Secondly, we now suspect the flow rate in the parallel branch could have been twice that in the Descal-A-Matic branch. Both of these factors would work to delay the deposition of the powdery substance upon which we rely for corrosion prevention. Further, if in the course of the test, the parallel branch handled twice as much water as the Descal-A-Matic branch, it would appear that the coupons in the parallel branch were subjected to a test twice as severe as that to which the uncorroded coupon was exposed - insofar as the quantity of water handled affects the results.

It has occurred to me that someone may suggest that the very favorable results of the first test may be ascribed to some residual benefit in the system - imparted thereto by the chemical inhibitor tested before the Descal-A-Matic, i.e., to the chromate-phosphate inhibitor, referred to earlier. I am certainly no authority in this matter. Nevertheless, I suggest that there would be some tendency for the chromate-phosphate to dissolve in the ten gallons of fresh Cleveland Tap Water being circulated. - with opportunity for a chromate-phosphate film to form on the steel test coupons, particularly if a saturated solution of chromate-phosphate results in the presence of yet undissolved chromate-phosphate "film". In any event, the thickness of the chromate-phosphate film which may form on the coupons during the Descal-A-Matic Test would be less than the thickness of the same protective film which formed on the coupons used in the actual test of the chromate-phosphate.

We may concede that the presence of the chromate-phosphate could have had some bearing on the results of the test but IN NO WAY COULD ITS PRESENCE HAVE RESULTED IN A COMPLETE ABSENCE OF CORROSION ON THE COUPON INSTALLED IN THE DESCAL-A-MATIC BRANCH.

THE SECOND TEST OF THE DESCAL-A-MATIC actually consisted of two tests which we refer to as TEST 2A and TEST 2B.

TEST 2A was run first, from 10/6/75 to 10/14/75.

The Test System, we are told, was cleaned with either citric acid or inhibited hydrochloric acid.

TEST 2A was conducted on a Descal-A-Matic from which the magnets had been removed. I am not certain if the Descal-A-Matic was the same one used in TEST 1 or if AEDSSO provided NASA with another Descal-A-Matic without magnets. In either event, it is my understanding that the cylinder inside the unit, into which the magnets are inserted, was plugged - so as to insure that the water passages in the unit being tested were identical to those encountered in a Descal-A-Matic containing its magnets.

The system was not "equilibrated". Mr. Kuivinen saw no need to "equilibrate" the system - nor do I believe we would have seen any such need, inasmuch as there were no magnets in the Descal-A-Matic.

The test was run for eight days at a reported flow rate of approximately 5 gpm thru the Descal-A-Matic. Unless the flow rate was actually checked, we tend to believe the parallel branch could have been handling water at as much as twice the flow rate of that in the Descal-A-Matic branch - for reason previously discussed.

The results of this test are recorded in the Table of Corrosion Rates.

TEST 2B followed TEST 2A and was conducted in the same Test System used in Test 2A. TEST 2B was run from 10/14/75 to 10/22/75 with magnets installed in the Dascal-A-Matic.

Again, we believe the flow rates could have been different in each branch and quite different from the approximated values reported in the Test Report, for reasons previously discussed.

There are two points we would like to make:

1. The Test System was not cleaned following TEST 2A - this was confirmed by Mr. Kuivinen. We believe the system should have been cleaned. TEST 2B was conducted in a contaminated system - contaminated with scale and the products of corrosion which formed in the system during TEST 2A.
2. The Test System was not operated to allow for "equilibration" of the system before the actual Corrosion Test began. We believe the system should have been operated in an "equilibration" period - for the same reason that chemical inhibitors are "equilibrated" before start of their test.

We believe both of the foregoing points accounts for the unsatisfactory corrosion rates reported for TEST 2B in comparison to those reported in TEST 2A.

We also believe that Point 1, above, accounts for the difference between the results of TEST 1 and TEST 2B. TEST 1 was conducted in a system which was also contaminated with chromate-phosphate, scale and products of corrosion. The products of corrosion present at the start of TEST 1 were those remaining in the system after the test of the chromate-phosphate which had resulted in a corrosion rate of 3 mils per year, i.e., the system had experienced comparable corrosion or the products of corrosion present bore some relation to the factor 3. On the other hand, TEST 2B immediately followed TEST 2A which had resulted in a corrosion rate of 21.0 to 30.4 mils per year, i.e., TEST 2B was conducted in a system contaminated with products of corrosion seven to ten times more extensive than existed in the system at the start of TEST 1. The results of TEST 2B were influenced by the fact that it started in a system in which active corrosion, completely uninhibited, was in progress.

NOTE: EACH OF THE TESTS 2A AND 2B WERE CONDUCTED WITH "USED" STEEL TEST COUPONS.

THE THIRD TEST OF THE DESCAL-A-MATIC also consisted of two tests which we refer to as TEST 3A and TEST 3B. The tests were conducted over a thirty day test period - from 6/1/76 to 7/1/76. The tests were simultaneously conducted - one in one Test SYSTEM; the other, in a second Test System.

These tests were conducted with "new" steel test coupons.

Each system we are told was cleaned before the tests began.

It should be noted that the flow rate in each of the two branches, in each of the Tests 3A and 3B, was reported at "about three gpm". Again, for reasons previously discussed, we question the accuracy of the reported flow rates. We believe the flow rate thru the Descal-A-Matic branches in each of those tests could have been 2 gpm and the flow rate in the parallel branches could have been 4 gpm, i.e., the Descal-A-Matic was being operated at 2/5ths of its rated capacity and, as noted on page 4, we would have preferred the flow rate to have more closely approximated the rated capacity of the Descal-A-Matic.

It should be noted that Mr. Yukich of NASA confirmed that each of the two Test Systems were equipped with identical pumps - JABSCO-ITT, 30PUPPY, Model #12520-0001. He also advised that the reported flow rates were assumed essentially equal in both the Descal-A-Matic branch and the parallel branch of each of the two test systems and equal to one-half the pump capacity in gpm - as determined from a head-capacity curve provided with the pump by the manufacturer, i.e., the difference in the corrosion rates between TEST 3A and TEST 3B could not be attributed to any major difference in the characteristics of the pumps which were used.

NASA's report of the Third Test to ADESSO, a letter dated 9/27/76, advised, in part, as follows:

"...We ran the tests at about three cycles of concentration after a few days of testing...."

We interpreted the reference to "a few days of testing" to mean that the systems were "equilibrated" before the actual thirty day test began. On 10/21/77, in a telephone conversation, I questioned Mr. Kuivinen concerning this point. He could not recall specifically if the systems had or had not been equilibrated. His data sheets were not readily available but his copy of the report of the Third Test was. He referred to the report and advised that he believed my interpretation of the report was correct, i.e., he believed the systems had been "equilibrated".

In time, following additional thought, I concluded that the systems could not have been "equilibrated". I called Mr. Kuivinen again, on 11/11/77, and he referred me to Mr. Yukich who had actually conducted the Third Tests and prepared the report of same. Mr. Yukich quickly clarified the matter, i.e., THE SYSTEMS HAD NOT BEEN "EQUILIBRATED" BEFORE TESTS 3A OR 3B were started.

A more complete description of the procedure followed at the start of the Third Tests would be as follows:

The systems were cleaned, new test coupons were installed and each system was filled with ten gallons of Cleveland Tap Water. The tests were started. During the first few days of testing, the input to the electrical heating elements, controlling water temperature, was so controlled that approximately 20 gallons of water were evaporated from the system - requiring the addition of some 20 gallons of "make-up" water. In this manner, three cycles of concentration were achieved in the first few days of the test. Thereafter, the water was maintained at "about three cycles of concentration" for the duration of the test.

Mr. Yukich explained that maintenance of the three cycles of concentration required periodic "bleedoff" and "make-up". This can be appreciated when one recalls that in a regular eight day test approximately ten to fifteen gallons of water are lost from the system due to evaporation from the open tank - requiring the addition of an equal amount of makeup water and resulting in the water being at 2 to 2.5 cycles of concentration at the end of eight days. In the Third Tests, depending on how many days were necessary to achieve the three cycles of concentration, some 35 to 50 gallons of makeup water would be required to compensate for that lost due to evaporation over the balance of the thirty day test period. Without "bleedoff" the three cycles of concentration could not have been maintained. Additional "make-up" water was necessary to compensate for that wasted by "bleedoff". The total amount of "make-up" water added each of the test systems used in the THIRD TESTS could have exceeded 70 to 100 gallons.

When Descal-A-Matics are installed to protect Cooling Tower Systems, one is installed in the "makeup" water line - sized to treat "makeup" water at its flow rate.

A second Descal-A-Matic is installed to treat the circulating water - at such a rate that all of the water in the system is "treated" once every two hours.

In all of the tests conducted at NASA, but particularly the third test, ADESSO would have preferred the initial fill of the systems as well as all makeup water to have been "treated" magnetically.

With reference to Test 3B, it is ADESSO's contention that THE SYSTEM SHOULD HAVE BEEN "EQUILIBRATED" before the test started.

COMMENT: The history of the Dascal-A-Matics used in Test 2A and Test 3A should be checked by NASA and ADESSO. NASA could help by advising if the units used in either, or both, tests were, in fact, disassembled to remove the magnets - or did they use "blank" devices provided by ADESSO, i.e., devices without magnets. Is it possible that magnets were removed from the Dascal-A-Matic used in Test 1 and inadvertently, or deliberately, (we would have no argument either way) inserted in the blank device provided by ADESSO for Test 2A and 3A?

The point is this: if the history of the units, at NASA or ADESSO, confirms that magnets had been installed at any time in the device prior to its use in Test 2A or 3A, it would suggest that ADESSO determine if any "residual" magnetism is exhibited in such devices upon removal of its magnets and, if so, the flux density of the residual field.

Is it possible that the corrosion rates reported for Test 2A and Test 3A were actually more favorable rates, due to the effect of residual magnetism, than would have been encountered without "residual" magnetism? It should be noted that in Test 2A, two of the three test coupons had corrosion rates lower than anticipated - based on the information that uninhibited Cleveland Tap Water results in corrosion rates ranging from 25 to 40 mils per year, approximately.

There is a tendency to assume that - had the Cleveland Tap Water which flowed during Test 2A been flowing in a system without the blank Dascal-A-Matic - the corrosion rates would have been essentially the same as those reported after Test 2A. This could be a valid assumption ONLY IF NO RESIDUAL MAGNETISM WERE PRESENT.

GENERAL OFFICES:
7460 Tidewater Drive
Norfolk, VA. 23505

November 30, 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
Cleveland, Ohio 44135

Attn: Mr. David E. Kuivinen
Chemical Services

My dear Mr. Kuivinen

First of all, I want to thank you for all the courtesies extended to me in our many telephone conversations over the past several years, for the interest you have shown in the Descal-A-Matic, for the work you undertook in testing the Descal-A-Matic, on three different occasions, in your Dynamic Corrosion Test System and for your reports covering each of those tests.

Following the First Descal-A-Matic Test, you discovered that the steel test coupon installed in the Descal-A-Matic branch suffered no loss of weight during the fourteen day test period - did not corrode at all - a unique result, never before encountered in all of your experience in Dynamic Corrosion Testing and indicating great potential for the Descal-A-Matic as a corrosion preventative device. The results of the Second Test were not impressive and prompted your advising that, at that time, you were less optimistic about the Descal-A-Matic. The results of the Third Test were not impressive either and were reported without "comment".

We are encouraged by your admission that you have been unable to understand why there is a difference between the results of the three tests. It indicates that you remain objective in this matter - for which we are most grateful - and that a logical explanation could well rekindle your enthusiasm to proceed with your research.

With that in mind, we have prepared Enclosure 1, a discussion of the Three Tests of the Descal-A-Matic in your Dynamic Corrosion Test System(s). We are confident that, following its study, you will agree that additional testing is merited.

We would like to make two points:

1. Neither NASA nor ADESSO should have expected correlation in the results of the three tests conducted because each test differed from either of the other two, i.e., the Descal-A-Matic was not tested three times following one Test Procedure; rather, it was tested once in each of three different tests.
2. None of the tests, not even the first one, truthfully, allowed for "system equilibration" - the term you use to describe the

three to five day preliminary test procedure followed when you are testing a chemical corrosion inhibitor. During this period, the corrosion inhibitor is added to the water and then circulated throughout the system until you are satisfied, by some testing, that the metal surfaces are coated with a film of the inhibitor - the film being necessary to isolate the metal surfaces from the water environment. It is only then that the eight day Dynamic Corrosion Test begins.

Corrosion prevention by the Descal-A-Matic is dependent upon the formation of what we describe to be aragonite talc - a protective film, too, or coating, that forms on the metal surfaces and which also isolates the metal from the water.

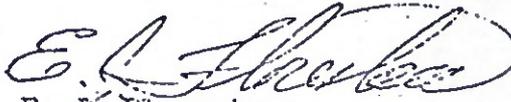
An "equilibration period" should be allowed in testing the Descal-A-Matic - for the same reason one is allowed in testing a chemical corrosion inhibitor.

Please convey my appreciation to Mr. Joseph A Yukich whom I understand has played a most important role in the testing of the Descal-A-Matic.

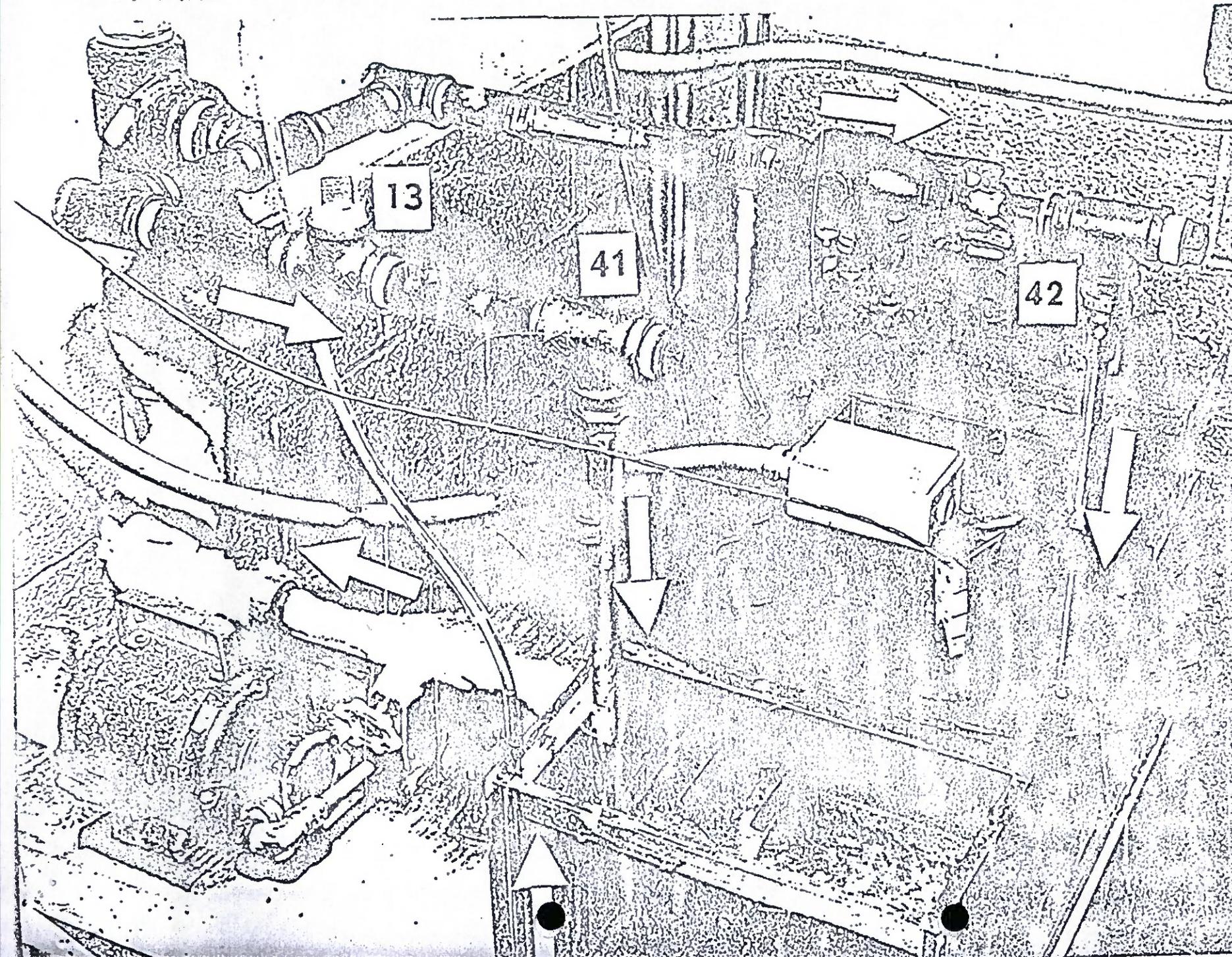
Your comments concerning the above points and the Enclosure will be appreciated.

Very truly yours,

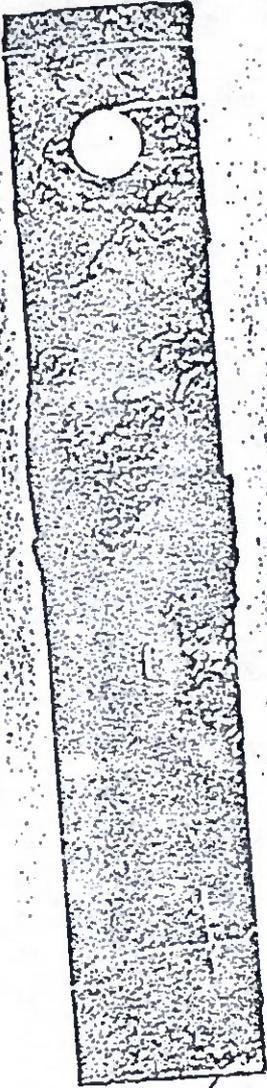
ADESSO CORPORATION


E. J. Florestano
President

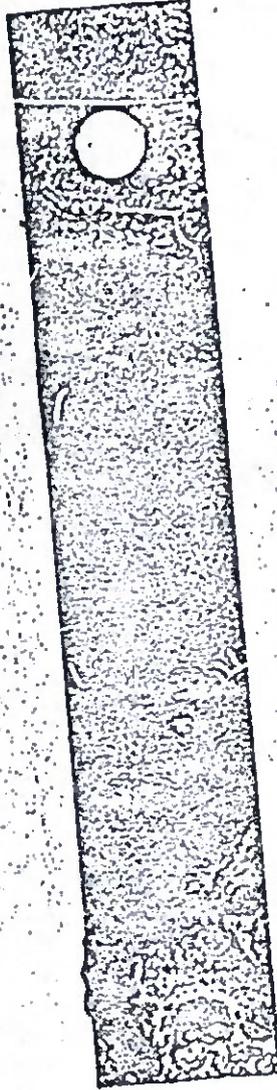
TEST COUPONS



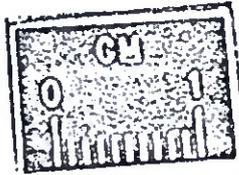
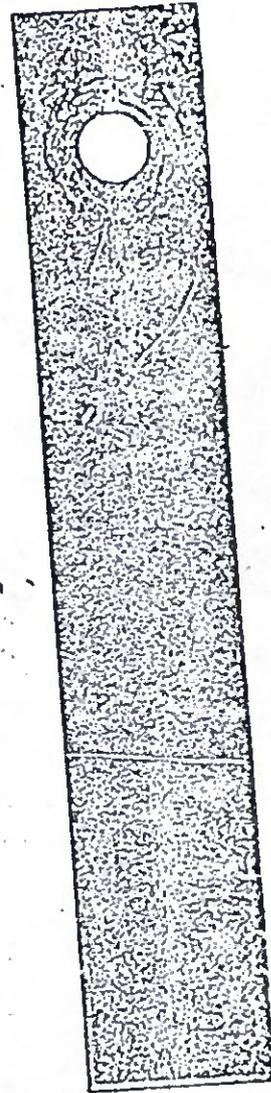
41



43



42



DYNAMIC CORROSION TEST SYSTEM