From: "Paul Gunter" <pgunter@nirs.org>
To: <hga@nrc.gov>
Date: 07/26/2006 4:19:11 PM
Subject: RE: letter on Oyster Creek embedded drywell liner

Gentlemen:

The email that I sent you earlier attached a letter of 07/26/2006 that incorrectly listed Senator Robert Menendez as still a member of the House of Representatives. I am attaching the above letter with the correction along with the original affidavit. If you would not mind please regard this attached version as the intended correspondence.

Thanks,

Paul Gunter, NIRS

CC: <DJA1@nrc.gov>, <fpg@nrc.gov>

Mail Envelope Properties (44C7CE2D.C3A : 5 : 7226)

Subject: RE: letter on Oyster Creek embedded drywell liner
Creation Date 07/26/2006 4:24:39 PM
From: "Paul Gunter" <pgunter@nirs.org>

Created By: pgunter@nirs.org

Recipients
nrc.gov
HGA (Hansraj Ashar)
DJA1 CC (D. Ashley)

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FPG CC (Frank Gillespie)

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NUCLEAR INFORMATION AND RESOURCE SERVICE

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July 26, 2006

Dr. Hansraj Ashar, Senior Civil Engineer
Division of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Mail Stop 9 D3
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Dr. Ashar:

I am writing on behalf of Nuclear Information and Resource Service (NIRS) and the coalition of New Jersey citizen groups who have intervened in the Oyster Creek License Renewal Application.

Please find the attached memorandum dated July 26, 2006 from Dr. Rudolf Hausler of Corro-Consulta. It regards the age management review of inaccessible and embedded regions of the Oyster Creek drywell liner and other General Electric Mark I Boiling Water Reactors. Dr. Hausler is identified as our corrosion expert in support of an Atomic Safety Licensing Board (ASLB) hearing on the contention regarding the age management review of severe corrosion of the all important containment component at Oyster Creek nuclear generating station in Lacey Township, New Jersey.

We are providing this memorandum recognizing that the current ASLB has denied interveners' efforts to introduce the corrosion of the inaccessible and embedded region of the drywell liner into the current licensing proceeding. Therefore, this issue is not addressed in the current adjudicatory process now before the NRC licensing board to consider the twenty-year license extension.

However, we do understand that the NRC staff is engaged in developing interim guidance for the age management of inaccessible and embedded regions of the General Electric Mark I Boiling Water Reactor containment component, such as Oyster Creek. With this common concern, we are submitting Dr. Hausler's analysis for incorporation into your interim guidance review.

Dr. Hausler raises a number of significant questions. We respectfully request an answer to the following questions:

1) Dr. Hausler points out in the attached memo of July 26, 2006 to Paul Gunter (NIRS) that Oyster Creek's operators following the removal of the sandbed in 1992 identified that deteriorated concrete floor conditions of the sandbed floor contributed to inadequate drainage of water from the sand bed region of the drywell liner. He further notes that the concrete floor adjacent to the embedded drywell liner was cratered with large chunks of missing concrete and channels 12 to 13 feet long, 12 to 20 inches deep and 8 to12 inches wide exposing the steel rebar. Additionally, drainage channels were missing and the drain pipes, 6 to 8 inches above the sandbed floor, were clogged Dr. Hausler asks why the concrete floor deteriorated in the first place further identifying that this damage has never been satisfactorily explained. **Has NRC determined whether or not this damage to the concrete floor was the result of corrosion of the embedded steel rebar generating internal pressures powerful enough to break up the concrete floor?**

2) **What are the safety implications for corrosion of the inaccessible steel drywell liner immediately adjacent to and embedded below the damaged and subsequently repaired concrete floor?**

3) **With regard to AmerGen assumptions that water seepage into the former sandbed region came from above, has NRC confirmed whether or not ground water has intruded from below into the Oyster Creek drywell liner region to contribute as a potential driver of crevice corrosion in the inaccessible and embedded regions of the drywell liner containment component?**

4) With regard to NRC Information Request Form dated January 24, 2006[1], it identifies at (8c) the "blistering" of coatings in the torus (or "wetwell") and the downcomers (or "vent pipes") components of the Oyster Creek primary containment structure and states that "While blistering is considered a deficiency, it is significant only when it is fractured and exposes the base metal to corrosion attack. The majority of blisters remains intact and continues to protect the base metal; consequently the corrosion rates are low."[2] It concluded that that corrosion at the "cracked" blisters was substantial, but was "contained" at the blisters that had not cracked.

Dr. Hausler raises the concern that the blistering of the containment coating on the interior of these components is, in fact, formed as a result of corrosion of the base metal underneath the coating.

Given that the torus and the downcomers are as equally important to containment integrity as the drywell liner and hence an effective aging management program, what are the corrosion rates that NRC has determined as "low" for the base metal of these additional areas of Oyster Creek's containment structure?

5) **If corrosion rates of the torus / downcomers as evidenced by coating blistering have been observed and verified by quantitative measurement can you please provide a public copy of these measurements?**

[1] NRC Information Request Form, Aging Management Program, Topic: IWE, Rich Morante/NRC to Joh Hufnagel/AmerGen, January 24, 2006 [Petitioners' Exhibit NC 1, NIRS et al Motion for Leave to Supplement Contention, June 23, 2006]
[2] Ibid

In closing, we thank you for the transparency and clarity that staff can bring to these containment integrity and public safety concerns in light of the Oyster Creek's application to extend its operating license for the additional 20-years. We look forward to your response.

Sincerely,

Paul Gunter, Director
Reactor Watchdog Project

Enclosure:
Memorandum of Dr. Rudolf Hausler, Corro-Consulta, July 26, 2006

Cc:
Mr. Frank Gillespie, NRR/NRC
Mr. Donnie Ashley, NRR/NRC
Dr. Mario Bonaca, NRC/ACRS
The Honorable Richard Lautenberg, United States Senate
The Honorable Robert Menendez, United States Senate
The Honorable Frank Pallone, United States House of Representatives
Governor Jon Corzine, State of New Jersey
Lisa Jackson, New Jersey Department of Environmental Protection
Jill Lipoti, New Jersey Bureau of Nuclear Protection

CORRO-CONSULTA

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Memorandum

July 26, 2006

To: Paul Gunter, Nuclear Information Resource Service

From: Rudolf H. Hausler

Subject: **Oyster Creek, Drywell Liner Embedded Region Issues**

I. Background

In its June 20, 2006 submission (Ref. 10), AmerGen includes extensive discussion of the mechanism for corrosion in the embedded region of the drywell liner. Because I understand that this is not a subject that can be raised at this stage before the licensing board, but is vitally important, I would like to draw the NRC's attention to various deficiencies in the analysis.

II. Discussion of the Corrosion Mechanism

AmerGen submitted extensive discussion relating to the corrosion mechanism in the drywell area for the purpose of demonstrating by theoretical arguments as to why corrosion in the drywell area and in particular the embedded portion is of no concern. Since possible damage and corrosion in the embedded area is, however, an ongoing concern and intricately linked to the aging management program in the sandbed area, the arguments proffered by AmerGen need detailed review at this point.
AmerGen relies on an EPRI document, which purports to show that corrosion of embedded steel is not significant if certain conditions are fulfilled (Ref. 10). Among others:

- *If the concrete is monitored to ensure that it is free of cracks that provide a path for water seepage to the surface of the containment shell or liner, and*
- *If the moisture barrier at the junction where the steel becomes embedded is subject to aging management activities, and*
- *If water ponding on the containment concrete floor is not common, and when detected, is cleaned up in a timely manner.*

AmerGen provides assurances that these conditions are satisfied for Oyster Creek, because the *external moisture barrier and seal are now accessible for visual inspection, and that visual inspection is conducted at a four-year interval.*

However, it is well established that upon sandbed removal (Ref. 11)

- *The sand bed floor was found to be unfinished in all bays*
- *The drainage channel was missing*
- *The drainpipes were 6 to 8 inches above the floor (hence ponding)*
- *The floor was cratered with some craters adjacent to the shell. A few craters were big, about* ***12 to 13 feet long and 12 to 20 inches deep and 8 to 12 inches wide.***
- *And concrete reinforcement bars could be seen bare in many bays.*

GPUNuclear concluded that the concrete floor conditions prevented proper drainage of water, which in turn aggravated the corrosion of the drywell shell. Clearly the EPRI conditions were not fulfilled prior to sandbed removal.

Furthermore, subsequent to the repair of the concrete floor, it was assumed, but not verified, that water ponding was eliminated. It was also assumed that the seal installed to prevent water seepage into the crevice between the floor and the shell was effective. However, verification was only visual and not verified by proper inspection.

Figures 1 and 2 are sketches of the location of the sandbed area and its dimensions (Fig. 2). In view of the small access hole (20" diameter) and the even smaller sandbed dimensions (15" wide) and the resulting very confined work area one needs to wonder just how effective the repairs of the concrete floor and subsequent coating and sealing of the crevice might have been. Similarly, considering the extension of the sandbed area of 5 to 7 feet either side of the access hole, and its narrowness, one needs to ask just how thorough visual inspection can really be.

Furthermore, it was also assumed that water on concrete floor would come from above. The question of water seepage from below has never been considered or verified, another EPRI requirement, which was disregarded. As an aside, the possibility of groundwater affecting the embedded region also prompts the concern that water leaks could have reached the groundwater. If the leaking water were radioactive, this would be a major concern.

Responding to concerns about possible corrosion in the embedded region, AmerGen has discussed the corrosion mechanism, and has argued that there is no need to further consider damage which might have been caused over the period from 1968 to 1992 (24 years) due to the poor conditions of the concrete floor. It is noted that the discussion is framed in general statements and little to no quantitative information is being offered.

For instance, chemical tests in 1986 indicated that the water drained from the sandbed had a pH of 8.46 and a chloride content of 45 ppb. Based on an EPRI report AmerGen concludes that *such water is not "aggressive" to concrete since the pH is greater than 5.5 and the chlorides are less than 500 ppm. This means that the wetted concrete environment will provide a high pH environment that will protect the embedded shell from corrosion.* No doubt the logic of this statement will not escape the NRC staff. The EPRI statement means that for concrete to deteriorate the pH of the water has to be below 5.5 and chlorides higher than 500 ppm. However, the corrosion literature indicates that the corrosion rate of steel is roughly constant at 10 mpy over a pH range from 4 to 10, and only dependent on the rate at which oxygen can diffuse to the surface (see for instance Ref. 12). It is well known that rebar can corrode in concrete when cracks in the concrete allow water to come in contact with the steel surface. The presence of chloride will aggravate the corrosion rate [1)].

AmerGen assures us that *impurities in the water, such as chloride or sulfate are not fundamentally involved in the corrosion anodic and cathodic reactions.* This is a highly misleading statement in that it is true that chloride does not act as a depolarizer (such as oxygen does), but is heavily involved in the anodic reaction in that it modifies the corrosion product layer (iron oxide) and makes it less protective. Chloride ions furthermore accumulate in pits and render the environment in the pit more acidic, thus stimulating pit growth.

AmerGen then goes on to state that it is reasonable to assume that the corrosion rate of steel in the embedded region is significantly less than the shell in contact with the sand bed for two primary reasons:

- *The concrete generates a high pH environment, pH 12 to 13,* (albeit not substantiated*) and thermodynamic calculations reveal no corrosion of iron above pH 10 at room temperature.* This latter statement is patently wrong. Thermodynamics clearly demonstrate that iron can react with water over the entire pH range even more so in the presence of oxygen (Ref. 13). The rate of the reaction is governed by the protectiveness of the corrosion product layer.
- The second argument is based on the notion that the steel in the sandbed corroded in preference to the embedded steel due to the establishment of a differential aeration cell. This is a very difficult argument to verify. The differential aeration cell theory basically states that the steel in an oxygen-starved environment becomes more anodic vs. steel in an aerated environment (For detailed explanation see Appendix I), and the anodic region then corrodes preferentially to the cathodic (aerated) region. While this is generally correct, the problem is that when the sand was there, the oxygen concentration would decrease deeper down in the sandbed and would be lowest at the embedded region. Hence, the embedded region should have corroded the most. There are, however, mitigating circumstances having to do with the conductivity of the water in the sand bed which might be used as

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[1)] It is for this very reason that rebar in concrete structures close to the ground are often coated and critical concrete structures, such as bridge decks or runways, more over, are cathodically protected.

> an explanation for the perhaps lower corrosion rates deeper down in the sandbed. Under no circumstances could it be argued that the corrosion observed in the bathtub ring "*cathodically protected the imbedded region*". Furthermore, now that the sand has been removed, the embedded region, which is oxygen-depleted, would now corrode preferentially if the coating and the seal were in anyway deficient..

The question of course remains as to why the concrete floor deteriorated in the first place. This has never been satisfactorily explained. For large pieces of concrete to be removed to the point where large craters are formed and the rebar is exposed, it is necessary that:

- Cracks where formed in the concrete for water to come in contact with the rebar
- Water seeped through the cracks either from above or below
- And the rebar corroded.

If the rebar embedded in concrete corrodes the corrosion product fills a larger volume than the steel from which it is formed. Therefore internal pressures are generated powerful enough to break the concrete. The phenomenon is well known to corrosion engineers. If this model were correct then it would demonstrate that steel in contact with the particular concrete can in fact corrode, and this in turn would raise serious questions with respect to the state of corrosion of the drywell liner immediately adjacent and below to the concrete floor (of the previous sandbed), particularly in those places where the large crevices had been observed in 1992. In fact such crevices where observed in all the bays, not just those where the most intensive "bathtub ring" corrosion had been described. Of course, other explanations for the state of deterioration of the concrete floor in the sandbed area are possible, but it must be pointed out that the phenomenon was never satisfactorily explained. **Therefore the state of corrosion in the embedded area needs to be established unequivocally (and not on the basis of questionable corrosion theories) prior to licensing the plant for another 20 years of operation.**

Subsequently it will be imperative to verify that the silicon seal is impervious to water, because now, after removal of the sandbed, water penetrating into the crevice between the concrete floor and the drywell liner will be much more corrosive than it was when the sandbed was still in place. Such verification cannot be carried out visually but must be done with methods well known to coatings engineers, suitable to detect holidays and/or pinholes (Ref. 6, 7, 8, 9). Visual inspection will likely reveal the formation of rust, blisters, and or the lifting of the seal. But by the time such observations are made it may well be too late and the damage may already be done. Furthermore, such inspection must be done more often than every 4 years (every second RO), simply because both coating and silicon seal are already past their specified useful life period. The rate of deterioration of the coating and seal cannot be assumed to be linear with time. Rather, as coatings engineers are well aware of, once it starts, it progresses rather exponentially, helped by the corrosion, which can now take place underneath the coating. (The same thinking should be applied as well to the blistering observed in the coating of the inside of the torus and the vent lines).

III. Further discussion of AmerGen's Aging Management Program

AmerGen states that on the basis of their interpretation of the corrosion mechanism, which has been demonstrated above to be lacking in understanding, *the corrosion rate for the embedded drywell shell is less than the corrosion rate of the sandbed region of the drywell shell. Also, direct monitoring of the drywell shell in the sandbed region adequately bounds any corrosion in the drywell embedded shell.* This argument is flawed because:

- Removal of the sand bed would tend to move the most severe corrosion into the area where water can accumulate, i.e. below the sandbed floor in the embedded region.
- If the coating and the seal have not been fully effective, severe corrosion could be ongoing in the embedded region..
- Direct monitoring of the drywell shell at the top of the sandbed area by UT is not predictive of the corrosion, which could occur in the embedded region. UT measurements from the outside cannot be made without removing the coating. Hence, AmerGen has not proposed direct monitoring of the areas most prone to corrosion.

AmerGen further states that *historical data show that the environment in the sandbed region is not aggressive, and thus water in contact with the embedded shell is not corrosive. The data also show that corrosion of the drywell shell in the sandbed region is due to galvanic corrosion and impurities such as chlorides and sulfates are not fundamentally involved in the corrosion anodic and cathodic reactions. Thus only limited corrosion would be anticipated for the drywell embedded steel.* (Ref. 10 at 11-12). These statements are rather serious distortions of the facts as known.

- Historical data do in fact show that the environment in the sandbed region was corrosive (up to 33 mpy). If left unprotected, the vessel would have had to be condemned in the mid 1990's.
- There are no data that show that corrosion is due to "galvanic" corrosion, because there is no situation that has been identified where dissimilar metal occur. Rather, the observed corrosion phenomena have been explained on the basis of differential aeration, i.e. an oxygen concentration gradient. Removal of the sandbed may have simply moved the differential aeration situation, if one existed, to lower elevations, i.e. into the embedded region. If the seal installed in 1992 was not fully effective, the crevice is the location where the oxygen concentration cell would be established and crevice corrosion would continue with the same rates observed previously at the higher elevations.
- Hence, the final conclusion, that corrosion of the embedded drywell steel

would be bounded by the corrosion observed in the sand bed cannot possibly be sustained. Nor can it be stated with any confidence that corrosion in this area would be limited. If in fact the seal were to have failed, the corrosion rates would rapidly approach those observed previously on top of the sandbed. If on the other hand water were to penetrate from below, differential corrosion would still occur in the embedded region, because organic coatings are permeable to gases, in particular oxygen.

IV. Conclusions

In conclusion we find AmerGen's proposed drywell liner aging management program flawed in several respects.

- First, we contend that the integrity of the drywell liner needs to be established on a much broader basis than has been done to date. This should include detailed UT or other investigations to determine the current thickness of the steel within the embedded area. If any corrosion has occurred, the structural impact of that corrosion should be assessed.
- Second, the first priority of monitoring needs to be focused on the presence of water.
  - It needs to be established that the water does not come from below, but is in fact linked to water leakage from penetration at higher elevations
  - It needs to be established that no water puddles exist anywhere on the sandbed floor and that the drains work properly. (It does not make any sense to monitor the drains quarterly if in fact standing water prevails on the sandbed floor). Hence, quarterly monitoring of the drains from the sandbed area is not frequent enough. Rather we contend that moisture sensors ought to be installed in the embedded region as well as on the sandbed floor and in the sandbed region in order to definitely establish that the water originates only from the higher elevations.
- Third, if the continued presence of water is observed anywhere in the embedded region, then further thickness measurements must be taken. The frequency of monitoring is yet to be determined, but because the metal in parts of the embedded region is only 0.676 inches thick, and the worst corrosion rates observed are over 0.33 inches per year, it appears that a frequency of at least once per year would be required.

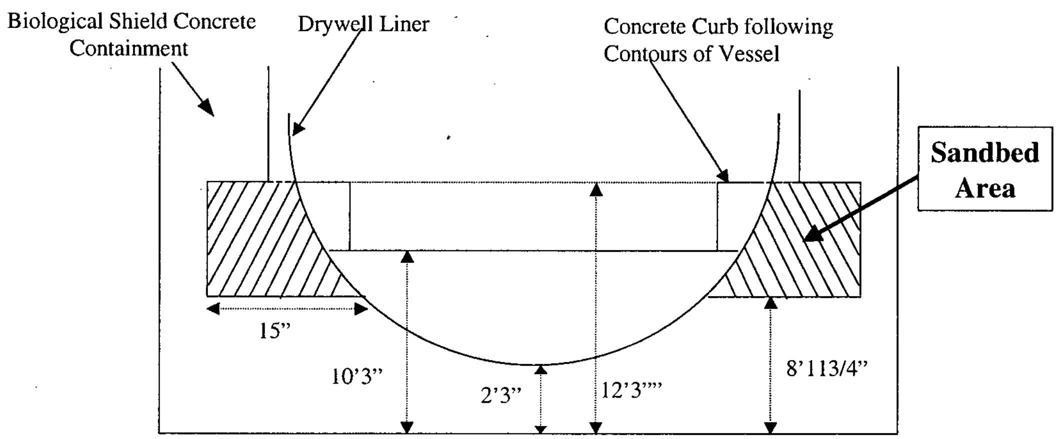
Rudolf H. Hausler

References

1. US NRC IE Information Notice No 86-99, Dec. 8, 1986; *Degradation of Steel Containments*
2. GPU Nuclear Calculation Sheet No. C-1302-187-5300-019 (4/15/92)
3. GPU Nuclear Calculation Sheet No. C-1302-187-5320-024 (4/16/93)
4. Corro-Consulta Memorandum to Richard Webster, Esq., June 22, 2006; *Discussion of Monitoring Methodologies At Oyster Creek Nuclear Plant Dry Well.*
5. AmerGen Letter to US NRC April 4 2006 (2130-06-20284)
6. National Association of Corrosion Engineers, International, Standard Test Method **TM-00384**: *"Holiday Detection of Internal Tubular Coatings of 250 μm (10 mils) dry Film Thickness"*
7. National Association of Corrosion Engineers, International, Standard Recommended Practice, **RP-0188-90**, *"Discontinuity Testing of Protective Coatings"*
8. National Association of Corrosion Engineers, International, Standard Test Method **TM-0186-94**: *Holiday Detection of Internal Tubular Coatings of 250 to 760 μm (10 to 30 mils) Dry Film Thickness*
9. National Association of Corrosion Engineers, International, Test Method **TM-0183**, *"Evaluation of Internal Plastic Coating for Corrosion Control of Tubular Goods in Aqueous flowing Environment"*
10. AmerGen Letter to US NRC June 20, 2006
11. GPU Nuclear Letter to US NRC September 15, 1995
12. H. H. Uhlig, Corrosion and Corrosion Control, John Wiley and Sons, 1963, page 85.
13. M. Pourbaix, Atlas of Electrochemical Equilibria in Aqueous Solutions, NACE, 1974, pg. 307 – 321.
14. GPU Nuclear Calculation Sheet No. C-1302-187-5300-020 (49/15/92)

Figure 3

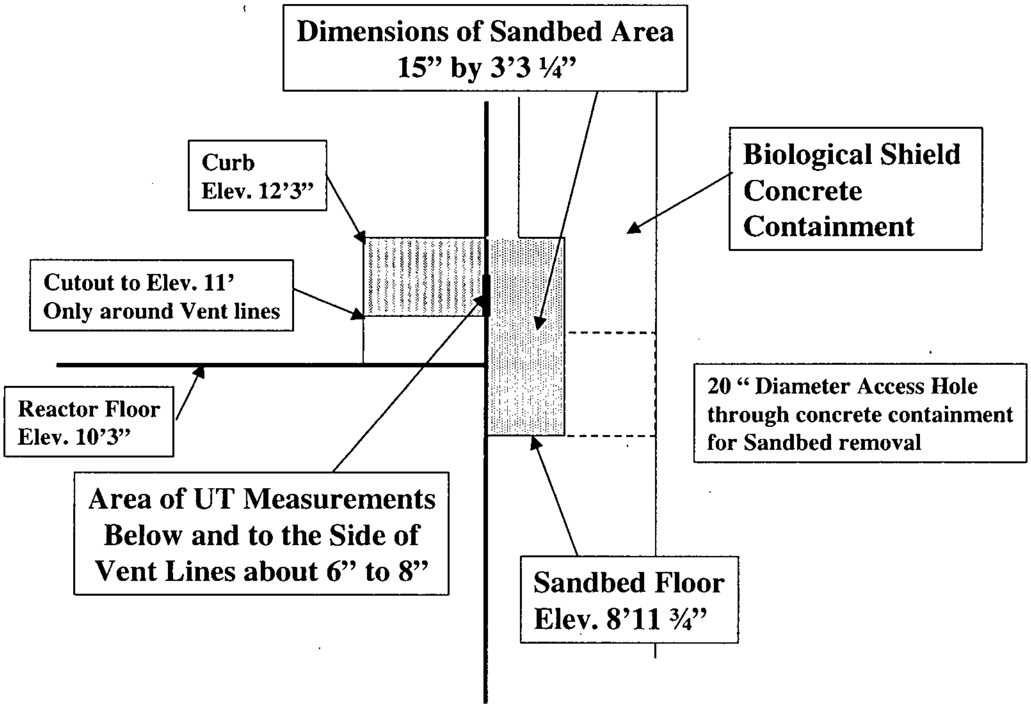
Schematic Drawing of Lower Spherical Section of Drywell Liner
(not to size)



Schematic Cross Section through Sandbed Area

(not to size)

Figure 4



Appendix I

Discussion of Differential Aeration Cell by Means of Evans Diagram

The differential aeration cell consists of a piece of iron of which one part is in contact with aerated water (or solution) while the other part is in contact with deaerated water. This situation can occur in various ways. For instance a bolt screwed into a piece of iron (Fig. AI-1) can create a crevice underneath the bolt head or in the threads were water can seep in. Another example might be a ground rod sticking into mud or indeed a metal plate in contact with wetted sand. In all these instances part of the metal is in contact with water containing oxygen (fully aerated) and metal where oxygen has difficulties to get to.

Such situations can be theoretically discussed by means of polarization diagrams presented in the form of an Evans diagram as in Fig. A I-2. The diagram describes separately the polarization behaviors of the two parts of the iron piece as if they were disconnected and then defines a mixed potential as well as the resulting anodic and cathodic corrosion rates at the mixed potential.

The steel immersed in aerated solution will assume a fairly positive potential (depending on pH perhaps about + 200 mV vs. SCE). The cathodic reaction will be the reduction of oxygen to hydroxyl ions while the anodic reaction is the oxidation of iron to iron ions. The current potential relationships describe the rate of the respective reactions when the potential is moved (for instance by external means) in the negative or positive direction. At the point where anodic and cathodic reactions (currents) are equal is the corrosion potential and the associated corrosion current (corrosion rate). For the part of the steel immersed in the deaerated solution the potential is more negative (depending on pH perhaps on the order of -400 mV vs. SEC). The anodic reaction is the same while in the absence of oxygen water is reduced to hydrogen and hydroxyl ions.

In reality, however, the two pieces of metal are in electrical contact and are furthermore wetted by the same solution (i.e. in electrolytic contact as well). Under these conditions the metal must assume one potential and one potential only, namely the mixed potential. As can be seen from Fig. A I-2 this is only possible if the cathodic reaction rate of the aerated side increases which then forces the anodic reaction of the deaerated side to increase as well. To a certain extent this result may be counter intuitive in that now the area that is starved in oxygen is corroding while the oxygen rich side is, as is often said as well, cathodically protected by the corroding side.

However, physical observations are quite in tune with the above explanation. Crevice corrosion, as for instance in bolt threads, under washers, etc. is commonly observed. Ground rods corrode a few inches below the surface of earth or mud in which they are embedded. Applied to the sandbed it is indeed observed that corrosion does not occur on top of the sandbed where aeration is greatest, but in fact in an area below that surface. The question then arises as to why the corrosion rate should not be greatest at the very bottom of the sandbed. This is a very difficult question to answer. Its resolution must focus on the conductivity of the electrolyte. Basically, in order for the aerated metal part to force corrosion of the oxygen starved metal area an electrolytic current must flow through the aqueous medium. The higher the resistivity of medium the greater the potential drop from the cathodic to the anodic area, hence the lower the "throwing power". In other words, high resistivity will move the anodic area closer to the cathode, i.e. closer to the surface. The observation, therefore, that the highest corrosion rates on the drywell liner were observed a few inches below the sand bed surface in a so called "bathtub ring" could be explained if the water leaking into the sand bed had always had low conductivity. It is also assumed that the height of the sandbed was uniform. Furthermore, the sand bed was removed in stages, which would have moved corrosion to lower elevations for at least a year after the first 60% of the sand had been removed.

The actual observations from the outside of the drywell show a surface described as "pimpled" and "resembling the surface of a golf ball" with alternating corroded and less corroded areas. The "bathtub ring" model of the corrosion may have actually been a sampling artifact, although it does appear that the cathodic and the anodic areas were relatively close together. Because of the lack of extensive observations, it remains unclear whether the golf ball pattern extended to the embedded region. After the sandbed was totally removed, the area with the highest corrosion rate would have probably shifted to the crevices formed between the sandbed floor and the drywell liner, i.e. the embedded area, if the crevices had not been sealed. The obvious concerns now are the integrity of those seals, the extent to which groundwater can seep into the embedded region, and the extent of the corrosion in this region. The higher elevations on the liner above the floor are probably corroding at a lower rate because they are coated and even if the coating had failed sometime in the past 14 to 15 years, these areas would probably not have been immersed in standing water. The areas near the floor and below, however, could have been immersed in standing water and could therefore be experiencing the highest corrosion rate.

Rudolf H. Hausler

Figure A I-1

Formation of Crevice underneath Screw-head

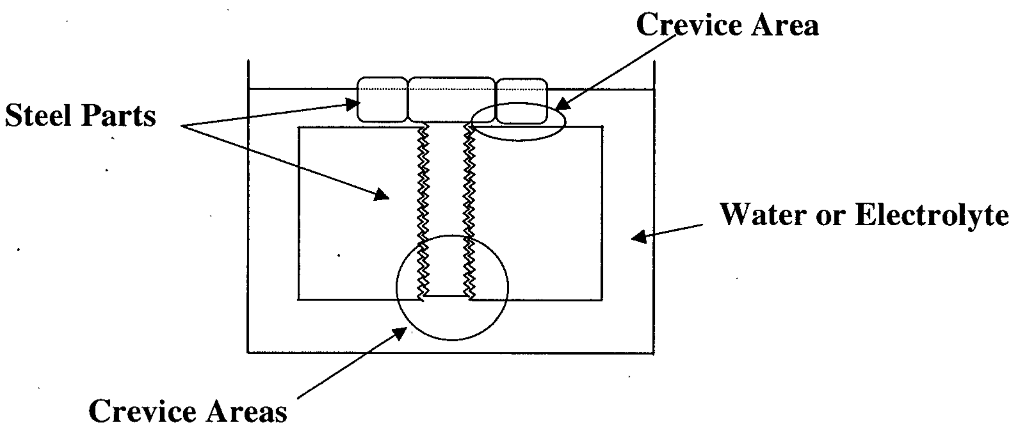


Figure AI-2

Evans Diagram for Coupling of Iron in Aerated Solution With Iron in Deaerated Solution