

DCS

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: International Congress on Microbially Influenced Corrosion

DATE AND PLACE: October 7-12, 1990
Knoxville, Tennessee

AUTHOR: Gustavo A. Cragnolino

DISTRIBUTION:

CNWRA:

J. Latz
CNWRA Directors
CNWRA Element Managers
EBS Staff

NRC:

S. Mearse
J. Funches
S. Fortuna
B. Stiltenspole
M. Silberberg
W. Ott
P. Reed
J. Pearring
R. Weller
C. Interrante

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: International Congress on Microbially Influenced Corrosion

DATE AND PLACE: October 7-12, 1990
Knoxville, Tennessee

AUTHOR: Gustavo A. Cragolino

PERSON PRESENT: G. Cragolino, CNWRA

BACKGROUND AND PURPOSE OF TRIP:

The aim of the conference was to provide a forum for the discussion of mechanisms relevant to Microbially Influenced Corrosion (MIC), taking into consideration various environments, such as sea water, fresh water, deionized water, waste water, etc., and a variety of materials including metals and alloys. Experimental and monitoring techniques and control methods were addressed, as well as economic and regulatory considerations in the case of the nuclear industry. The purpose of the trip was to become acquainted with new developments in the study of MIC and to establish contacts with researchers active in this field.

SUMMARY:

The conference was attended by approximately 130 scientists and engineers from private and government organizations involved in many aspects of research, development, and industrial activities. It was characterized by a high level of technical discussion, presentation of new techniques for the study of MIC and, above all, a significant interaction between participants with many different backgrounds. A relatively large proportion of them were microbiologists who are contributing significantly to the understanding of MIC. Approximately 70 papers and more than 15 posters were presented by authors from different countries, including the U.S., U.K., France, Japan, Canada, etc. The program for the conference is provided as an attachment to this report. The Proceedings will be published in the first quarter of 1991.

The Section I on Theoretical Considerations was important in setting the tone of the Conference since the presentations brought to a common focus the important, recent developments in electrochemical corrosion science with those in the field of microbiology. In the latter case, the establishment and characteristics of biofilms attached to metal surfaces, and the emerging understanding of biochemical reactions with the consequent generation of corrosive metabolic products were emphasized in relation to MIC.

The application of techniques, such as Fourier Transforming Infrared Spectroscopy (FTIR) and Gas Chromatography/Mass Spectrometry (GC/MS), to the study of the chemical composition of biofilms was discussed and presented in several papers dealing with various metals and environments. The importance of biofilms in changing the local chemistry of the environment and in altering the diffusion of cathodic reactants to the metal surface was emphasized, as well as their eventual role in changing the speciation of cationic and anionic specie via chelating

properties. Some papers deal with the important effect of biofilms on the corrosion potentials of metals and alloys (e.g., stainless steels, copper).

There were several presentations on proposed mechanisms of MIC for stainless steels and nickel-based alloys in the presence of Sulfate Reducing Bacteria (SRB). In some of these presentations (Hamilton, Webster, Gendon), it was clearly pointed out that the reduction of oxygen or a comparable cathodic reactant is necessary to sustain the localized corrosion process that occurs in the anaerobic regions which are the sites of SRB activity.

A wide variety of materials are currently considered to be susceptible to MIC as reported in many presentations. Cases of pitting of copper pipes in hot water systems installed in buildings, corrosion under deposits in heat exchanger tubes made of Alloy 800 and other nickel-based alloys in nuclear power plants, corrosion of GaAs semiconductor devices employed in photodetectors and high speed electronic circuitry, deterioration of concrete exposed to waste water, etc. were presented by different researchers, indicating that a diversity of microorganisms and environmental conditions are involved in failure cases caused by MIC. It is interesting to remark, however, that no cases of MIC have been reported, to date, for titanium and titanium alloys, an observation that was confirmed in the conference.

The relatively high incidence of localized corrosion failures in stainless steel weldments, observed mainly in auxiliary and safety-related water systems of nuclear power plants and other industrial installations, was the subject of two papers (Borenstein and Danko). The attack has been observed in welds (mainly in the austenite phase) and in the heat affected zone, but in many cases the microorganisms involved have not been unambiguously identified. In other cases, although some of them (*Pseudomonas*, *Aerobacter*, etc.) have been identified as a part of a consortium of active organisms, no clear interpretation of their specific action exists.

In a paper presented by Wolfram, the isolation of several microbes from the primary water of the Three Mile Island reactor was discussed. It is obvious that the microorganisms survived the intense radiation field present in-core. Corrosion of welded 304L stainless steel was observed in laboratory tests in the presence of some pure cultures. The canister material used as a container of the damaged fuel (Boral, a composite of aluminum and boron carbide, clad with pure aluminum) was also severely attacked by the remanent contaminated water. Wolfram's presentation illustrates very clearly that certain microbes involved in MIC are able to grow under extreme environmental conditions.

Although the presentation mentioned above was unique in relation to the potential problem of MIC in high-level nuclear waste repositories, I had the opportunity to discuss the issue with many other researchers during the course of the conference. The role of microbes under extreme environmental conditions (e.g., temperature, very low water contents, lack of appropriate nutrients, etc.) and their impact on degradation processes for a variety of materials were addressed in informal talks. I had a useful exchange with J. Wolfram from Idaho National Engineering Laboratory. The possibility of consultations and future collaborative work was considered within the scope and development of our IWPE program.

I visited the Institute of Applied Microbiology, which hosts the Conference in conjunction with the Center for Materials Processing. I was highly impressed by the modern facilities, the quality of the experimental work and the enthusiasm of the scientific staff.

IMPRESSIONS/CONCLUSIONS:

The attendance to the conference was useful to become fully aware of the advances in the understanding and control of MIC. Attendance to similar conferences in the future is recommended.

PROBLEMS ENCOUNTERED:

None

PENDING ACTIONS:

None

SIGNATURE:

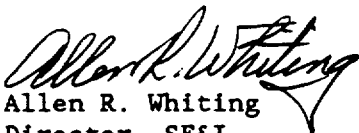

Gustavo A. Cragnolino

11/2/90
Date

CONCURRENCE:


Prasad Nair
Manager, EBS

11/2/90
Date


Allen R. Whiting
Director, SE&I

11/2/90
Date

SCHEDULE OF THE INTERNATIONAL CONGRESS FOR MICROBially INFLUENCED
CORROSION (MIC) AT THE KNOXVILLE HYATT HOTEL.

[Speaker total = 75]

SUNDAY OCTOBER 7, 1990.

5.00 PM. ON-SITE REGISTRATION AND ORIENTATION.

6.30 PM. COCKTAILS AND WELCOME ADDRESS.

MONDAY OCTOBER 8, 1990.

[Registration continues at 7.00 am]

8.05 - 8.20 INTRODUCTION AND NOTICES: N.Dowling IAM, USA.

8.20 - 9.05 OPENING ADDRESS: K. Tiller, National Physical
Laboratory, UK

9.05 SESSION I: THEORETICAL CONSIDERATIONS

9.05 - 9.10 Introduced by W. Costerton, University of Calgary,
Canada.

9.10 - 9.50 D.D. MacDonald, SRI International, USA.
Critical issues in the mechanisms of microbial
influenced corrosion.

9.50 - 10.10 BREAK

10.10 - 10.50 D. C. White, Institute for Applied Microbiology,
USA.
The effects of increased bacterial community
structure on the corrosion of carbon steel.

10.50 - 11.30 R.A. Buchanan, Center for Materials Processing,
USA.
Fundamentals of electrochemical corrosion as
related to MIC.

11.30 - 12.10 G.G Geesey, University of California, Long Beach,
USA.
Properties of microorganisms that facilitate
corrosion.

12.10 - 1.30 LUNCH

1.30 SESSION II: MECHANISMS

Convened by Alfonso Mollica and David Duquette.

1.30 - 2.00 M.B. Deshmukh*, I. Akhtar, R.B. Srivastava, A.
Karande. Naval Chemical & Metallurgical

Laboratory, Bombay, INDIA.

Role of marine aerobic and anaerobic bacteria in inducing corrosion of austenitic stainless steel.

- 2.00 - 2.30 T. Gendron* and R.L Tapping, Chalk River Nuclear Laboratories, CANADA.
The role of chloride and SRB in underdeposit corrosion of alloy 800 in freshwater.
- 2.30 - 3.00 B. Webster* and R.C. Newman, University of Manchester Institute of Science and Technology, Manchester, U.K.
The electrochemistry of SRB corrosion
- 3.00 - 3.20 BREAK
- 3.20 - 3.50 Z. Lewandowski* and W. Lee, National Science Foundation Engineering Research Center for Interfacial Microbial Process Engineering. MSU, Bozeman, MT. USA
pH at polarized metal surfaces: theory, measurement and implications for MIC.
- 3.50 - 4.20 A. Mollica*, G. Ventura and E. Traverso. C.N.R. - Istituto per la Corrosione Marina dei Metalli, Genova, ITALY.
On the mechanism of corrosion induced by biofilm growth on the active-passive alloys in seawater.
- 4.20 - 4.50 K. Kasahara*, and F. Kajiyama Tokyo Gas Co., R&D Institute, Tokyo, JAPAN
Electrochemical aspects of microbiologically influenced corrosion in buried pipes.

TUESDAY OCTOBER 9, 1990.

8.00 SESSION II: MECHANISMS continued: Convened by Alfonso Mollica and David Duquette.

- 8.00 - 8.30 R. Edyvean, The University of Leeds, Leeds, U.K.
The effects of microbially generated hydrogen-sulphide on the corrosion-fatigue of offshore structural steels.
- 8.30 - 9.00 G. Hernandez-Duque*, A. Pedersen and D. Thierry. Swedish Corrosion Institute, Stockholm, SWEDEN
Protective properties of exopolymers produced biologically on corrosion of steel in sea water.

- 9.00 - 9.30 I. Beech*, C.C. Gaylarde, J.Smith and G.Geesey.
Biological Sciences Dept., City of
London Polytechnic, London, ENGLAND.
Acidic polysaccharides in biofilms and in free EPS
of *D.desulfuricans* in the presence of mild
and stainless steel and their role in corrosion.
- 9.30 - 10.00 C.R. Das*, and Md. Hussain
Dept. of Chemistry, (Utkal University) ORISSA,
INDIA.
A study of kinetics and mechanisms of microbial
corrosion of welded steel specimens in presence of
marine bacteria such as Pseudomonas Aeruginosa.
- 10.00 - 10.15 BREAK
- 10.15 - 10.45 W. Characklis* and W. Lee. Center for Interfacial
Microbial Process Engineering Research, Montana
State University, USA
Interactions between process waters, microbial
biofilms, and metal substrata.
- 10.45 SESSION V: EVOLVING MONITORING TECHNOLOGIES
Convened by R. Tatnall and R. Buchanan.
- 10.45 - 11.15 G. Salvago, G. Taccani* and G. Fumagalli
CNR-ITM, Milano, ITALY.
Electrochemical methods for biofilms monitoring.
- 11.15 - 11.45 B. Little* and P. Wagner, Naval Oceanographic and
Atmospheric Research Laboratory, Stennis Space
Center, MS., USA
An electrochemical evaluation of biofilms
and calcareous deposits formed in natural seawater.

TUESDAY OCTOBER 9, 1990

- 8.00 SESSION III: MATERIALS CONSIDERATIONS: Convened
by J. Guezennec and A. Hamilton
- 8.00 - 8.30 N. Dowling*, S. Brooks, T. Phelps, and D. White
Institute for Applied Microbiology, USA.
Synergistic corrosion of pipe-line steels by
obligately anaerobic bacteria.
- 8.30 - 9.00 A. Moosavi*, R. Pirrie and W. A. Hamilton
Dept. of Genetics and Microbiology, University of

Aberdeen, SCOTLAND.

Effect of sulphate-reducing bacteria activity on performance of sacrificial anodes.

- 9.00 - 9.30 E. Bock
Dept. of Microbiology, University of
Hamburg, Hamburg, F.R.G.
Microbially influenced corrosion of concrete and
natural sandstone.
- 9.30 - 10.00 M. Franklin*, D. White and H. Isaacs
Institute for Applied Microbiology, USA.
Effect of bacteria on carbon steel corrosion
inhibition by phosphate.
- 10.00 - 10.15 BREAK
- 10.15 - 10.45 N. Benbouzid-Rollet*, J. Guezennec, M. Conte, and
D. Prieur, IFREMER/DERO, Plouzane, FRANCE
Corrosion of stainless steel as influenced by
experimental biofilms containing sulfate-reducing
and fermentative bacteria in a laboratory tubular
flow-system.
- 10.45 - 11.15 D. Duquette, Dept. of Materials Engineering,
Rensselaer Polytechnic Institute, NY., USA
Materials selection for resistance to biocorrosion.
- 11.15 - 11.45 S. Borenstein, Pacific Gas & Electric Co., San
Francisco, CA, USA
Microbiologically influenced corrosion of stainless
steel weldments.
- 11.45 - 1.15 LUNCH
- 1.15 - 1.45 J. Kearns, Allegheny Ludlum Corporation, Technical
Center, PA., USA.
Welding for MIC resistance
- 1.45 - 2.15 V. Ferrante* and D. Feron, CEA, Laboratoire
d'Essais Technologiques de Corrosion, Etablissement
de La Hague, Cherbourg, FRANCE.
Microbially influenced corrosion of ferritic steel
containing molybdenum and chromium: A biological
and electrochemical study.
- 2.15 - 2.45 A. Chamberlain*, P. Angell and H. Campbell
Dept. of Microbiology, University of
Surrey, Guildford, UK
Influence of microorganisms on pitting corrosion
of copper tubes.

- 2.45 - 3.00 BREAK
- 3.00 - 3.30 J. Jones and M. Walch*, Naval Surface Warfare Center, Silver Spring, MD, USA
Microbiologically influenced corrosion (MIC) of coated 4140 steel by mixed communities of anaerobic and facultatively anaerobic bacteria.
- 3.30 - 4.00 C. Kulpa* and C. Baker, Dept. of Biological Sciences, University of Notre Dame, IN., USA.
Involvement of sulfur-oxidizing bacteria in concrete corrosion.
- 4.00 - 4.30 R. Blake II* and G. Bowers-Irons Dept. of Biochemistry, Meharry Medical College, TN., USA
Microbially influenced corrosion of metal arsenides.

WEDNESDAY OCTOBER 10, 1990

- 8.00 SESSION IV: CASE STUDIES
Convened by G. Licina and D. Pope
- 8.00 - 8.30 B. Thurgood* and R. Hellner, GA Technologies, Public Service Co. of Colorado., USA
Microbially influenced corrosion of Fort St. Vrain tendon wires.
- 8.30 - 9.00 D. Hill and S. Bross*, ARCO Alaska, Inc., USA.
The impacts of microbial souring of a North Slope oil reservoir.
- 9.00 - 9.30 D. Pope, Bioindustrial Technologies, Inc., Grafton, New York, USA.
Case histories of microbiologically influenced corrosion on gas production, gathering and transmission facilities: monitoring, system analysis and targeted mitigation.
- 9.30 - 10.00 T. Jack*, Worthingham, and F. Ferris, Nova Husky Research Corporation
External corrosion of line pipe under disbonded coatings: field observations and mechanistic studies.
- 10.00 - 10.15 BREAK
- 10.15 - 10.45 A. Brennenstuhl*, P. Doherty, P. King and

T.Dunstall, Ontario Hydro, Toronto, Ontario,
CANADA.
The effects of biofouling on the corrosion of
nickel heat exchanger alloys at Ontario Hydro.

- 10.45 - 11.15 S. Marmo*, E.-L. Nurmiaho-Lassila, O. Varjonen and
M. Salkinoja-Salonen, Dept. of General
Microbiology, University of Helsinki, Helsinki,
FINLAND.
Biofouling and microbially induced corrosion
on paper machines.
- 11.15 - 11.45 I. Ignatiadis*, J. Guezennec, J. Honnegger, J.
Foucher and H. Traineau, BRGM, IMRC, FRANCE.
Electrochemical studies of some stainless steels
in low enthalpy geothermal wells. Influence
of sulphate-reducing bacteria.

WEDNESDAY OCTOBER 10. 1990

8.00 SESSION V: EVOLVING MONITORING TECHNOLOGIES
Continued. Convened by R. Tatnall and R. Buchanan

- 8.00 - 8.30 G. Suave, Betz Inc., Alberta, CANADA
Measurement of sessile organisms in industrial water
systems.
- 8.30 - 9.00 R. Tatnall* and G. Horacek, DuPont Co. Central
Research & Development Dept., Experimental Station.,
Wilmington, Delaware, USA
New perspectives on testing for sulfate
reducing bacteria.
- 9.00 - 9.30 F. Mansfeld* and B. Little, Department of Materials
Science, University of Southern California, CA.,
USA.
A critical review of the application
of electrochemical techniques to the study of MIC
- 9.30 - 10.00 G. Licina* and G. Nekoksa, Structural Integrity
Associates, San Jose, CA, USA.
An electrochemical method for monitoring
the development of biofilms in cooling water.
- 10.00 - 10.15 BREAK
- 10.15 - 10.45 D. Nivens*, J. Chambers and D. White.
Institute for Applied Microbiology, Knoxville, TN,
USA
Monitoring microorganisms at solid surfaces using

on-line devices.

10.45 - 11.15 H. Aldrich*, A. Chaote, L. McDowell, P. Bono, D. Chynoweth, D. Pope and J. Yang. Univ. Florida, Gainesville, Florida, USA.
Microscopy of microbial corrosion of pipeline steel in a model system.

11.15 - 11.45 G. Wolfaardt, WATERTEK, CSIR, Pretoria, South Africa.
Direct in situ quantification of MIC in industrial reticulation systems.

12.00 DEPART FOR SMOKEY MOUNTAINS TRIP OR TECHNOLOGY TOUR OF OAK RIDGE NATIONAL LABORATORY (ORNL) HIGH TEMPERATURE MATERIALS LABORATORY (HTML) AND NORRIS DAM. BOX LUNCH PROVIDED TO ALL ATTENDEES.

7.30 - 9.00 POSTERS & EXHIBITS:
Posters must be set up in the foyer of the ballroom by 12.00 and must be manned between 7.30-9.00 pm wednesday evening. Exhibits will be set up during the afternoon and will be manned untill 9.00 pm. Coffee and dessert will be provided at 7.30 - 9.00 pm for attendees to interact with both exhibitors and those presenting posters. Posters will be left up untill Thursday 5.00 pm.

- 1) S.C. Dexter and H.J. Zhang
Effect of Biofilms, Sunlight and Salinity on Corrosion Potential and Corrosion Initiation.
- 2) T. Ford and R. Mitchell
Acceleration of hydrogen damage to metals by anaerobic bacteria.
- 3) W. Lee and W. Characklis
Anaerobic corrosion processes of mild steel in the presence and absence of anaerobic biofilm
- 4) N. Dowling, S. Brooks and D. White
Considerations in using electrochemical techniques to assess microbially influenced corrosion.
- 5) G. Salvago, G. Taccani and G. Fumagalli
Acidification effect on the electrochemical behavior of stainless steel in artificial and natural seawater.
- 6) P. Wagner and B. Little

An electrochemical evaluation of copper alloys colonized by copper-tolerant marine.

- 7) M. McNeil
Acanthite and argentite production during microbially influenced corrosion of silver.
- 8) C.-G. Peng, J. Park and R. Patenaude
Prediction of metal culvert corrosion rate influenced by microorganisms.
- 9) J. Boivin
The Hydrogenase test - A rapid enzyme based test for corrosion causing bacteria.
- [10) J. Wolfram, R. Rogers and J. Burke-Holst
Microbial consortium from nuclear plants show tolerance to commercial biocides.
- 11) R. Cahoon, V. Agrawal, W. Characklis and C. Wagner
Microbially influenced corrosion (MIC) of stainless steel 304 in an open, recirculating, cooling tower system of a ethanol plant.
- 12) J. Gannon and J. Belcher
Biofilm removal efficiency of selected water treatment chemicals.
- 13) I. Ignatiadis, J. Cheradame, Brach, S. Castagne and J. Guezennec.
Reduction by biocide treatment of hydrogen sulfide concentration in a geothermal brine.
- 14) E. Van der Wende.
Biocide action on biofilms.
- 15) P. Bremer and G. Geesey.
Nondestructive, real-time studies on the interactions of bacterial biofilms on submerged copper surfaces.

THURSDAY OCTOBER 11, 1990

:-

8.00 SESSION IV: CASE STUDIES Continued: Convened by D. Pope and G. Licina.

8.00 - 8.30 G. Farquhar, Saudi Aramco. CSD/CCD. Dhahran, SAUDI ARABIA.

A review of current trends in microbiologically influenced corrosion (MIC) from the viewpoint of the practicing corrosion engineer.

- 8.30 - 9.00 R. Facey*, D. Smith and K. Emde,
University of Alberta, Canada.
Case Study: Water Distribution Corrosion, City of
Yellowknife N.W.T.
- 9.00 - 9.30 A. Sinha*, J. Wolfram and R. Rogers, Idaho National
Engineering Laboratory, USA.
Microbially influenced corrosion of stainless steels
in nuclear power plants.
- 9.30 - 10.00 [J. Wolfram*, R. Miller and R. Rogers, Idaho National
Engineering Laboratory, USA.
Evidence of microbially influenced corrosion of
Boral used in spent fuel canisters
- 10.00 - 10.15 BREAK
- 10.15 - 10.45 D. Hirsch. Carolina Power & Light Company, H.B.
Robinson Plant, USA.
Case History of Service Water System Rehabilitation
- 10.45 - 11.15 J. Walker*, A. Dowsett, P. Dennis and C. Keevil
Porton Down, Salisbury, Wilts. London, ENGLAND.
A laboratory model to evaluate control of
microbially associated corrosion of copper pipes.
- 11.15 - 11.45 A. Stein* and C. Merlino, Stone & Webster
Engineering Corp., Boston, MA., USA.
Susceptibility of a 6% Molybdenum Stainless Steel
to Microbiologically Influenced Corrosion.
- 11.45 - 1.15 LUNCH

THURSDAY OCTOBER 11, 1990

8.00 SESSION V: EVOLVING MONITORING TECHNOLOGIES
Convened by R. Tatnall and R. Buchanan

- 8.00 - 8.30 A. Olowe, J. Genin, J. Guezennec* and P. Refait
Laboratoire CNRS Maurice Letort et Dept. of Sciences
des Materiaux, ESSTIN, University of Nancy
Nancy, FRANCE.
Role of the Green Rust 2 compound in biocorrosion
induced by sulfate reducing bacteria.
- 8.30 - 9.00 D. Feron, laboratoire d'Essais Technologiques de

- Corrosion, Etablissement de La Hague, Cherbourg, FRANCE.
Chemical and electrochemical aspects of the corrosion of stainless steels in the presence of sulfate-reducing bacteria.
- 9.00 - 9.30 W. Costerton* and J. Boivin, Dept. of Biological Sciences, University of Calgary., Alberta, CANADA
The role of biofilms in microbial corrosion.
- 9.30 - 10.00 T. Phelps*, N. Dowling and D. White, Institute for Applied Microbiology, University of Tennessee/ORNL, Knoxville, TN., USA
Techniques for assessing microbial activities associated with MIC.
- 10.00 - 10.15 BREAK
- 10.15 - 10.45 H. Fleming* and G. Schaule University of Stuttgart, FRG.
Biofouling on membranes-influence of various factors on initial microbial adhesion.
- 10.45 SESSION VI: CONTROL METHODS Convened by W. Fellers and R. Lutey
- 10.45 - 11.15 G. Nekoksa, Corrosion Failure Analysis & Control, San Ramon, CA., USA
Determination of cathodic protection criteria to control microbially influenced corrosion in power plants.
- 11.15 - 11.45 F. Blackburn, Tennessee Valley Authority, Decatur, AL., USA.
Detection and control of bacterial corrosion using internal corrosion monitoring devices.
- 11.45 - 1.15 LUNCH
- 1.15 - 1.45 M. Reis*, J. Carvalho, I. Moura, J. Moura, A. Lino, B. Barata, J. LeGall and M. Carrondo.
Lab. de Eng. Bioquimica, Monte da Caparica, PORTUGAL.
Mechanisms and control of biocorrosion by sulfate reducing bacteria.
- 1.45 - 2.15 G. Severyn, Sauereisen Cements Co., Pittsburgh, PA. USA.
Control of microbiologically induced corrosion of concrete in wastewater collection and treatment systems.

- 2.15 - 2.45 W. Poulton, Engineering Investigations ESCOM,
Johannesburg, SOUTH AFRICA.
Mitigation of microbiologically influenced corrosion
and biofouling in open recirculating cooling water
systems.
- 2.45 - 3.00 BREAK
- 3.00 - 3.30 W. Fellers, Electric Power Research Institute, Glen
Rose, TX., USA.
Strategies for control of fouling and MIC.
- 3.30 - 4.00 J. Guezennec*, N. Dowling, L. Fiksdal and E. Antoine
IFREMER/DERO, Plouzane, FRANCE.
Cathodic protection in marine sediments and
the aerated water volume.
- 4.00 - 4.30 G. Boulon*, G. Mandrillon and G. Villa
ITECH-Lyon & Universite' Lyon I, FRANCE.
Biodeterioration of coatings; new formulations.
- 7.00 BANQUET PROGRAM

FRIDAY OCTOBER 12, 1990

- 8.30 SESSION VI: CONTROL METHODS Convened by W. Fellers
and R. Lutey.
- 8.30 - 9.00 R. Hart, Conoco Inc., Ponca City, OK., USA.
The effect of iron deposition and water treatment
in controlling a cooling water system
that experienced a prior MIC failure of 304 SS.
- 9.00 - 9.30 P. Sanders*, D. Robinson and B. Struszcak
Oil Plus Ltd., Newbury, Berks., U.K.
Implications of residual chlorine in
seawater injection systems.
- 9.30 - 10.00 G. Spires* and E. Conley, Heat Exchanger Systems,
Inc., Boston, MA., USA
The role of protective coatings in
controlling microbiologically influenced corrosion.
- 10.00 - 10.15 BREAK
- 10.15 - 10.45 D. Holt* and M. Mosley Micran Ltd., Unit 1A,
Wellheads Crescent, Dyce, Aberdeen, SCOTLAND.
The effects of biocides on thermophilic sulphate-
reducing bacteria from north sea oil production

facilities and their role in preventing reservoir souring and corrosion.

- 10.45 - 11.15 B. Quioc* and A. Gounot
University Lyon 1, Villeurbanne Cedex, FRANCE.
Efficiency of biocides and inhibitors on biofouling
in a cooling water mode.

8.00 SESSION VII: REGULATION AND MANAGEMENT: Convened by
M. Russell

- 8.00 - 8.30 F. Witt
Materials & Chemical Engineering Branch, Office of
Nuclear Reactor Regulation, US. Nuclear Regulatory
Commission
A regulatory perspective on microbiologically
influenced corrosion.

- 8.30 - 9.00 J. Frank. Gas Research Institute, Chicago, USA.
Aspects of MIC in the natural gas industry.

- 9.00 - 9.30 M. Russell Energy, Environment & Resources Center
& Department of Economics, University of Tennessee,
Knoxville, TN.
Strategies for environmentally benign use
of biocides.

9.30 SESSION VIII: ECONOMICS: Convened by J. Danko

- 9.30 - 10.00 D. Dziwulski, Biondustrial Technologies,
Inc., Grafton, NY., USA
Economic consequences of MIC in the utility
industry.

10.00 - 10.15 BREAK

- 10.15 - 10.45 A. Brennenstuhl* and P. Doherty, Ontario Hydro
Research Division, Toronto, Ontario, CANADA.
The economic impact of microbiological influenced
corrosion at Ontario Hydro's nuclear power plants

- 10.45 - 11.15 Lynda Kiefer
Westvaco Inc., USA.

11.15 - 11.45 CLOSING ADDRESS by J. Danko.