Appendix 7.2

Final Report of Networks – Corrosion

HEFCE UK-BRAZIL NETWORK

CORROSION PROTECTION

Third Year and Final Report

EXECUTIVE SUMMARY

Several new Thematic Research Networks have been established between Brazil and the UK as a result of a UK Government initiative. The original objectives were healthy development of higher education in the UK and Brazil through knowledge partnership, sharing best practices and strategic and influential research collaborations leading to tangible outcomes. Start-up funding for the Pilot Scheme for the establishment of the Network, spread over three years, was provided by HEFCE.

One of the Network's key focus areas was corrosion control, a topic of great importance to both countries with significant scientific, engineering, industrial and commercial implications. Therefore, a major initiative in asset integrity management (AIM) for corrosion damage was mounted covering several key projects reflecting the important strategic nature of the Network, assisting take-up by industry as appropriate to the tactical issues of corrosion in its many forms. The initiative was integrated into a cohesive programme of research with input and involvements from both Brazilian and UK representatives culminated into several innovative projects and three projects were submitted to EPSRC for funding. While the initial referees' comments on the proposals were very encouraging, none of the projects attracted funding; this has clearly frustrated the continued progress of the Network.

Without doubt, a major success of the Network to date has been the bringing together of distinctly separate groups from both the UK and Brazil in order to promote AIM with precise corrosion data, detailed mechanistic information and their verification. This theme enjoys full support of industrial partners and is a key to establishing progressive dialogue between the two countries, individual institutions and industrial associates.

A pivotal point in the third year was the November 2002 Corrosion Control and Integrity Management Workshop which was held in Rio. Through active representations from both Countries, the Workshop brought a large number of organisations together sharing progress and enrolling further industrial and academic collaborators.

On the Brazil side, some operationally related proposals have been successful in attracting funds. However, the available funding is not sufficient to cater for the enormity of the subject and continuation of the relationship. On the positive side, Brazilian representatives are committed to the Network and are active.

A web-site has been created (http://www.uk-brazil-corrosion.net/) with active participation from industry, commerce and academia. This acts as a focal point for information exchange.

On the negative side, despite very favourable referees' comments from EPSRC, the three initial proposals did not receive funding. However, the

intention is to discuss further the overall strategy for resubmission with EPSRC representatives.

The HEFCE funding will terminate in January 2003. Continuation of the Network, to facilitate the interactions within the UK, has been agreed in two complementary and parallel levers of “integrity management” and “corrosion control”. Funding is being sought to finance the initiative in the future.

In summary, encouraging progress has been made within the UK in line with the original objectives with key tangible achievements including (i) creation of innovative means of international collaborations with a strong applied focus, (ii) development of export potential for associated industrial partners and (iii) improvement in research and higher education links between Brazil and the UK.

It is also pleasing to conclude that UMIST’s Corrosion and Protection Centre was awarded the Queen’s Anniversary Prize for its pioneering work in education, training, research and technology transfer. The interactions with Brazil through the Network made a contribution to the overall submission.

The UK-Brazil Integrity and Corrosion Control Network has made encouraging progress towards establishing progressive research avenues with active collaborations between respective UK and Brazil organisations. This report captures the progress made throughout, focusing largely on the third year and provides an overview of the background, and key achievements. A forward plan for continued network activity is also given.

1. UK Membership

The Membership has expanded over the period of the Network and currently encompasses five key UK universities with active participations from:

Professor George Thompson, UMIST
Professor Bill Dover, UCL
Dr Bijan Kermani, UCL
Professor Mike Cowling, University of Glasgow
Professor David Williams, UCL
Dr Trevor Hodgkeiss, University of Glasgow
Dr Steve Turgoose, CAPCIS/UMIST
Dr Neil McMurray, University of Swansea
Dr Dave Worsley, University of Swansea
Professor David Edmonds, University of Leeds
Professor Bob Cochrane, University of Leeds

In addition to the previous, the membership also includes the following departmental colleagues:

Dr Stuart Lyon, UMIST
Dr Alistair Greig, UCL
Dr Daren Caruana, UCL

Such widening has been necessary to cover the areas of interest, and to accommodate retirements of individual academic staff.

2. Brazil Membership

As a result of extensive discussions and meetings between respective members, a focused Brazil Network has now been formed and meets regularly – the key members include:

Dr Eduardo Cavalcanti, INT
Professor Carlos Nelson Elias, UFF
Professor Jose Ponciano, COPPE-UFRJ
Prof. Ricardo Coutinho, IEAPM
Prof. Dalva Lago, UERJ
Dr Denise S de Freitas, INT
Dr Marcia Tresa Lutterbach, INT
Prof Ivani de S Bott, PUC-Rio
Ricardo Carneval, PETROBRAS/CENPES
Cezar Medaber Jambo, PETROBRAS

3. The Background and Original Objectives

Several new thematic research networks were established between Brazil and the UK as a result of a UK Government initiative. The original objectives were healthy development of higher education in the UK and Brazil through knowledge partnership, sharing best practices and strategic and influential research collaborations leading to tangible outcomes.

Deliverables from the collaboration included the following:

- Innovative means of international collaboration with a strong applied focus
- Creation of export potential for associated industrial partners
- Improvement of research and higher education links between Brazil and the UK.

Start-up funding for the Networks, spread over three years, was provided by HEFCE. One of the network's key focus areas was corrosion control, a topic of great importance to both countries with significant scientific, engineering, industrial and commercial implications. In particular, initial discussions confirmed that both countries have substantial oil and gas reserves, located on- and offshore, and that the successful and continued exploitation of these reserves requires further research on corrosion-related activities. For this reason it was agreed that a major initiative in asset integrity management (AIM) for corrosion damage should be mounted. This reflected the important strategic nature of the Network, assisting take-up by industry, as appropriate to the tactical issues of corrosion in its many forms. The initiative was integrated into a cohesive programme of research with input and involvements from both Brazilian and UK members of the network.

The Corrosion Control Network developed a framework for an exciting, new collaboration focusing on "Multi-Phase Hydrocarbon Transmission, MHT". This has significant theoretical and industrial implications and involves the three key elements of (i) Integrity Management (defect assessment, life prediction and inspection scheduling), (ii) Control Measures and Monitoring (innovative monitoring, inhibition, safe limit of cathodic protection, high temperature coatings), and (iii) Mechanisms and Modelling (CO_2 corrosion, H_2S Corrosion and weld corrosion). These elements are interrelated through a common objective of developing effective measures to ensure asset integrity management.

Through extensive bilateral discussions, the base for a broader dimension of operational integrity was accepted as in building a highly influential network and attracting an increased number of industrial, commercial and academic collaborators. The title of "Integrity & Corrosion Control Network" was therefore adapted.

4. Collaboration with the Brazilian Network

A pivotal point in the third year was the November 2002 Corrosion Control and Integrity Management Workshop which was held in Rio. Through active representations from both Countries, the Workshop brought some 26 organisations together, sharing progress and enrolling further industrial and academic collaborators. The Workshop was partly sponsored by DTi (UK Trade Partners) and involved 15 presentations with attendees from industry, commerce and research institutions. The UK was represented by four of its Network Members (Dr Kermani, Professor Edmonds, Dr Turgoose and Dr Worsley). The outcome of this Workshop is appended in Annex 1.

During the visit to Rio, the four UK committee members met with Dr Cavalcanti and several members of the proposed Brazilian Network. This proved instrumental in bringing together an increased network of Brazilian members including COPPE/USP and PUC/RJ and facilitating the formation of a coherent Brazil Network. In addition, avenues of funding in Brazil were identified and discussions were held with Petrobras, the British Consulate and the UK Trade Partners.

In addition, the interaction in the third year has proceeded electronically, assisted by visits to the UK by Dr Eduardo Cavalcanti (Brazilian Co-ordinator). Dr Cavalcanti, whilst based in Manchester, visited UCL to discuss and review the activities.

Further, in January 2003, Professor George Thompson visited Brazil, meeting with Dr Cavalcanti and several members of the Brazilian Network; discussion included means for continuation of the Network, consolidation of the Brazilian activities, international collaboration and funding, and widening of the Network, if appropriate. The Minutes of the Meeting are given in Annex 2.

5. Progress of the Network

The development of the Network has been further progressed through two formal meetings at UCL (March 2002) and (November 2002), with additional meetings between Professor Thompson and Dr Kermani on issues such as workshops, web-site etc. At the March meeting, elements of the framework on MHT were developed with individual contributors from each UK universities. This theme was selected after extensive discussions with UK and Brazil industries, academe and research representatives. This was considered a key challenge, requiring concerted long-term research activities. An approach to EPSRC for funding was felt best suited to this theme and to kick-start the necessary innovative technologies allowing a platform to attract tangible industry funding within 1-2 years. Regardless, industrial support has been and will be sought to steer the theme from the start. A complete list of projects is included in Annex 3 which includes complementary projects compiled following the Rio Workshop and associated meetings.

Three separate proposals (Annex 3, Proposals a, c and d) were submitted to EPSRC in May 2002 as follows:

(a) “Probabilistic Based Inspection Scheduling for Corrosion”, led by UCL.

(b) “Preferential Weld Corrosion; Prediction, Monitoring and Inspection”, led by Swansea.

(d) “The Role of Microstructure and Steel Composition on Corrosion in Carbonic Acid Environments”, led by Leeds.

While the initial referees’ comments to the proposal were very encouraging, none of the projects attracted funding; this has clearly frustrated the continued progress of the Network. Such frustration is compounded by the low responsive mode success rate nationally, the long elapsed time to learn of the fate of the proposals (up 8 months) and the need to wait for a further six months to submit a related proposal. It is intended to revise and to strengthen the proposals, and to discuss the strategy for re-submission in 2003, with phased submission of the remaining high priority projects.

In addition to the previous, a proposal submitted to EPSRC, entitled “Plasma Electrolytic Oxidation” was funded (£420K); this proposal supports a project student who is examining coatings on titanium oral implants. The subject is a key parallel area to MHT, and involves collaboration between the UK, Brazil and Sweden.

While the HEFCE funding terminates in January 2003, continuation of the Network, to facilitate the interactions within the UK, through a focal point has been agreed. Funding is being sought to finance this initiative in the future. It should be noted that the theme of the UK network had been selected to facilitate strategic and complementary partnerships and this is now achieved by the formation of a strong and coherent UK Network.

Without doubt, a success of the Network to date has been the bringing together of distinctly separate groups from both the UK and Brazil in order to promote asset integrity management with precise corrosion data, detailed mechanistic information and their verification. This theme enjoys full support of industrial partners and is a key to establishing progressive dialogue between the two countries, individual institutions and industrial associates.

The establishment of a mirror Network in Brazil is further major development with Dr Cavalcanti together with Dr Denise Souza de Freitas of Instituto Nacional de Tecnologia (INT) acting as Conveners.

The creation of a dedicated, lively web page (http://www.uk-brazil-corrosion.net/) is a further success in displaying to a wide audience the UK strength in the area and the overall intent and key contacts.

On the negative side, despite very favourable referees' comments from EPSRC, the three initial proposals (Annex 3 Proposals a, b and d), did not receive funding. However, to progress further, the intention is to discuss further the overall strategy for submission with EPSRC representatives. This may involve the development of a seamless syndicate proposal, incorporating elements from the 5 current UK universities with submission to EPSRC over an agreed timetable. The additional proposals, covering inhibitor persistency, erosion corrosion, condition monitoring and fatigue aspects which have to yet be submitted, will be drawn into this strategy.

6. Key Achievements

Encouraging progress has been made within the UK in line with the original objectives, with key achievements including:

- The formation of multi-disciplinary UK and Brazil networks (compromising of distinctly different groups of materials scientists, metallurgists, corrosion scientists, mechanical engineers, chemists, NDE experts, chemical engineers) with strong industry support. This is a highly innovative means of international collaboration focused on applied science - the network has been influential in :
    - *Identifying a theme of common interest for progressive and integrated research collaboration between UK and Brazil with significant short, medium and long term scientific and industrial impacts.*
    - *Focusing on Multiphase Hydrocarbon Transmission and Integrity Assurance - this theme enjoys full support of Oil & Gas sector, has the highest CAPEX and OPEX impact while meeting the environmental challenges. This has paved the way export potential for associated industrial partners.*
- The creation of a dedicated web page (http://www.uk-brazil-corrosion.net/) to incorporate all the elements and act as a lively interface for the individuals, both Countries and industry partners. This web page has some 80 members.

- The UK-Brazil Corrosion Control and Integrity Management Network Workshop held in Rio which acted as a turning point in actively pursuing UK-Brazil interface and collaborations.

On the Brazil side, the Network has placed a major focus on incremental technologies. The Network provides a forum for individuals/ groups to collaborate, and to share expertise and a limited financial resource has been made available. Notable achievements include:

- The formation of a Network Committee culminated in bringing together a diverse range of discipline areas with parallel themes to those of the UK. This Network is represented by key researchers and academia with steer and input from industry partners.

- Eight operationally related projects have started and will continue to end March 2003. These involve active collaborations between nine universities, three research institutes and consultants. Two grants have been received from FINEP/FAPERJ which has provided support for postgraduate students and project development. Brazilin Activities and Projects developed under these grants are shown in Annex 4.

In summary, key achievements and steps put in place for closer interactions between the two countries, with associated partners bringing together respective industries, researchers, academia, will continue to lead to improvement of research and higher education links between Brazil and the UK.

7. Obstacles

From the UK side, lack of progress on securing funds from EPSRC has rendered limited research progress. In addition, HEFCE funding for the initial three years has come to an end, and further Network progress requires further continued pump priming funding to continue the dialogue required to bring to fruition the Network and its associated activities.

The obstacle in the slow response from the Brazilian Network is now overcome; however, the modest level of funding in limited areas available to the Brazilian Network does not allow wide international interactions. In order to overcome this, a UK-Brazil joint source of funding would be advantageous, allowing increased level of interactions and joint activities. This has been discussed; however, whilst national activities have been identified, an appropriate joint source of funding is available.

It is apparent that the initial funding by HEFCE for the Pilot Programme has been instrumental in bringing together and setting up the UK Network and providing the necessary means for active interfaces with Brazilian partners. In the absence of this funding and to avoid stalling of the Network progress, significant use of the website is envisaged. The limited funds to maintain this should not be an obstacle, given the main aim of significant research proposals and wide collaboration.

Generally, the success of the Network and progress in the UK-Brazil collaboration are highly dependent on (i) funding of individual projects, (ii) provision of funds to maintain and manage the Network and the interface and (iii) means of technology dissemination. The previous clearly require manpower and associated costs; many sources have already been examined. Such quests for funding will continue, with the following representing key areas:

- EPSRC Networks

- EU Frame Work 6 – Network of Excellence
- Building requests for partial funding of the Network within individual grant applications
- Possibility of an initiative along the line of the Faraday Partnership (sponsored by DTi/EPSRC)
- Royal Academy of Engineering.
- HEFCE

On the Brazil side, notable obstacles arise including:

(i) Several of the Brazilian contacts have changed positions, ie new secretaries have been appointed to International Relations and Technological Affairs.

(ii) Possible change in the interests of funding bodies.

(iii) Concerning the Brazilian Groups, some have been successful in attracting modest funds, which are primarily operationally related; however, such funds are not sufficient to cater for the enormity of the subject and continuation of the relationship. On the positive side, Dr Cavalcanti and Dr Freitas are committed to the Network and are active, and the Brazilian Network has been confirmed. Together, these facilitate a move towards the formation of larger projects and more tangible progress, allowing regular meetings and improved interactions.

8. Future Actions

The major activity of the coming year is to agree the schedule for submission of the UK research proposals and to achieve success. This mainly requires staged submission of the proposals over the year, because of the limited funds available to Research Councils. However, subject to discussion with EPSRC, the possibility of a change in the strategy, with incorporation of high priority projects into a large syndicate proposal may become a favoured route. Future activities in Brazil are outlined in Annexes 2 and 4.

Additional activities in the UK include:

- Arrangement of a Workshop in the UK, bringing together representatives from both countries, and to engage additional industry and commercial participants.
- The response to the dedicated web site from both Countries', industry, researchers and academia has been overwhelming. A common request is to establish an "e-technical discussion cluster", allowing wider interactions. The intention is to set up this web-based cluster in 2003, although its funding and maintenance is subject to discussion.
- Continuation of the Network, to facilitate the interactions within the UK, will continue in two complementary and parallel levers of "integrity management", led by Professor Dover, and "corrosion control", led by Professor Thompson and Dr Kermani. Funding is being sought to finance the initiative in the future.
- Further meetings between respective groups with intermediate activities involving discussions with Dr Cavalcanti concerning the support of his activities.

- In 2002, two additional themes of common interests between the two Countries have been identified which are key industrial activities and require substantial efforts in corrosion, materials and operational integrity. These involve (i) the nuclear power industry and (ii) marine technology. Dialogues embracing these two themes have commenced in order to bring together participants from both countries; such discussions will also consider the merit of developing complementary Networks or integrating those activities within the current Network.

Necessary steps towards obtaining support for the continuation of the Network have been put in place with a letter from Professor George Thompson (UK Coordinator) and Ms Jannette Cheong (Head of HEFCE International Collaboration and Development) to Professor de Wanderley de Souza (Executive Secretary of Brazil Ministry of Science and Technology). These are presented in Annex 5.

9. IPR

IPR issues are as stated previously and, to date, have not generated any challenges.

10. Industrial & Commercial Partnerships

As part of the development of the proposals, Dr Kermani and others have discussed the contents with several UK industries (eg BP, BG, Clariant, TotalFinaElf, Tenaris Group, Corus etc) who wish to maintain their involvements.

The response to the dedicated web page has been strong and this will be used as the vehicle to enrol future industry partners.

11. Purpose of Funds for the Past Year

UK Meetings, Meetings/Workshop in Brazil, Visits of Brazilian Co-ordinator to the UK; UK Co-ordinator visit to Brazil; network management and operational costs; further development of the website.

The major spend for the coming year is a final (HEFCE supported) Network Meeting, the proposed March Workshop (provisional) and Dr Cavalcanti's visit to the UK (provisional). The limited, residual funds, which are carried over from the end of January, will be used, the final meeting with HEFCE and assistance for the March Workshop in the UK.

12. Other Incomes to the Network

Limited support from DTi for the Rio Workshop was obtained. One EPSRC proposal has been successful, with a project student in position. The Brazilian Network has received limited funds, with one PhD and seven MPhil students receiving support.

13. Other information

A web-site has been created (http://www.uk-brazil-corrosion.net/) with active participation from industry, commerce and academia. This acts as a focal point for information exchange.

From recent discussions, Professor Dover has agreed to take joint overall future Network Coordination with Professor Thompson. Professor Dover will cover the structural integrity aspects; Dr Kermani and Professor Thompson will have responsibility for corrosion-related activities and inputs.

It is pleasing to conclude that UMIST's Corrosion and Protection Centre has received the Queen's Anniversary Prize for 2002. This is for the pioneering education, training, research and technology transfer by the Centre. The interactions with Brazil through the Network made a contribution to the overall submission. The Prizes for Higher and Further Education are awarded every two years for outstanding achievements in areas of work which have benefited the Nation.

Annex 1

UK-Brazil Corrosion Control and Integrity Management Network

Workshop # 1

21 November 2002

The Outcome

UK-Brazil Corrosion Control and Integrity Management Network
Workshop # 1
The Outcome

The first Workshop of the UK-Brazil Integrity Management and Corrosion Control Network was successfully held on 21 November at COPPE/UFRJ in Rio de Janeiro. This brief document captures key elements of the outcome.

The Workshop was planned to engage further industry-university-commerce interactions, provide key innovative technologies, facilitate knowledge partnership and plan for future course of action. It was built on the progressive interactions between Brazilian and UK professionals since the launch of the Network in May 2000 by HEFCE (UK) and FAPERJ (Brazil). The Workshop aimed to cover:

- *the potential impact of corrosion on oil and gas production*
- *hear a selection of novel avenues*
- *networking and strengthening the relationship between industry, commerce and technology providers*
- *seek support and set the scene for potential avenues of further joint activity*

The Workshop was kindly supported by the UK Department of Trade & Industry (DTi), Higher Education Funding for England (HEFCE) and Brazil COPPE/UFRJ.

A Brief Overview

The Workshop was opened by the British Consul General highlighting the importance of bilateral relationships between Brazil and UK in this key area of science, technology and engineering.

This was followed by four complementary sessions; (i) sharing information on the intent and the current status of the Network, (ii) hearing industry perspectives and challenges, (iii) summarising key projects aligned to Multiphase Hydrocarbon Transmission (MHT) a theme of common interest between the two Countries and (iii) planning the next course of action.

These were covered by some 12 presentations from both Countries. The Workshop was attended by some 40 participants from some 26 organisations.

The Workshop proved a success and very valuable in bringing together representatives from a wide range of discipline areas, endorsing the focus and intent of the Network and supporting key avenues of activity. Overwhelming response was received from the attendees in support of the initiative, the theme, the Network and its continuation.

Key Action Plans

The delegates shared and endorsed a number of key actions placed on the Network Steering Committee – these are as follows:

1	Hold a reciprocal Workshop in the UK to review progress and engage further UK industry involvements	by March 2003
2	Include an additional key area within MHT to cover coating (internal/external)	Ongoing
3	Ongoing dialogue has to be sustained with more emphasis on personal and organisational interactions and increased frequency of reciprocal visits/review meetings	Ongoing
4	Make available status and progress of each projects on the dedicated web-site when sought feasible	Ongoing
5	Building on the successes of the MHT theme, other areas of corrosion control need to be considered such as nuclear industry, marine industry,	Ongoing

	subsea components etc	
6	Make available the outcome of the Workshop and summary of individual projects to attendees	ASAP

The Workshop

Following the opening remarks by the British Consul General, the background to the Network and an update on its current progress was given. The Theme of Multiphase Hydrocarbon Transmission (MHT) was then introduced as a key integrated technology challenge facing oil & gas industry sector and a theme of common interest to both Countries with significant technological and commercial impacts. This integrated approach to addressing MHT is sub divided into key focus areas addressing (i) mechanism & modelling, (ii) control measures and monitoring and (iii) asset integrity management details of which are provided in a dedicated web-site (www.uk-brazil-corrosion.net).

Two key presentations were given by industrial representatives (Tenaris Group and Clariant) sharing their technical achievements and challenges sharing their vision of future technology drivers. The Workshop was then followed by four complementary sessions aligned to the theme of MHT with contributions from both UK and Brazil representatives.

Session 1: Mechanism & Modelling

This focus area studies of the mechanism of corrosion in production conditions leading to the development of realistic models to foresee its occurrence and engineered metallurgies to substantially improve the performance of production facilities. A number of contributions from both Countries were shared followed by discussions on each presentations relating to inhibitor persistency and development of high built inhibitors, development of superior resistant carbon steels and comparative performance of new generation of linepipe steels.

Session 2: Control Measures and Monitoring

This focus area targets the study and development of radical means of erosion/corrosion monitoring and development of qualitative approach to preferential weld corrosion. Three presentations were given including innovative approach to the recognition of preferential weld corrosion, corrosion monitoring in refineries and an outline of a radical approach to online realtime condition monitoring of pipelines and flowlines.

Session 3: Asset Integrity Management (AIM)

This area aims to deliver innovative means of integrity assurance through life prediction and implementation of probabilistic inspection scheduling. The intent is to capture and encapsulate all information emerging from the current and past projects into an integrated package for industrial implementations. Two presentations were given highlighting the necessary requirements and approach to this important end user requirement.

Session 4: Summary & Round Table Discussion; the Way Ahead and Action Plan

It was concluded that integrity management of production facilities remains a major challenge in the oil and gas industry. With its impact in terms of capital and operational expenditures (CAPEX and OPEX) and its consequence on the health, safety and the environment (HSE), the efforts of the Network to bring together an integrated approach to addressing the topic was considered highly influential. The Workshop endorsed the initiative as an effective means of technology development and networking.

Summary

The Workshop proved highly beneficial in bringing together experts from both Countries. It was considered that pleasing progress has been made in line with the overall intent of the Network delivering technologies with significant industrial and commercial impacts.

The key driver of the Network remains the use of carbon and low alloys steels and the need to develop superior means of integrity management, corrosion prediction and control and development of carbon steels with inherent resistance to corrosion. It has provided a proactive stance for looking to future fundamental and applied technology needs. The outcome will lead to the development and implementation of breakthrough technologies in corrosion prevention methods and integrity assurance with potential to substantially reduce the impact of corrosion and inspection on oil & gas industry. The Network has paved the way for:

- The development of innovative means of international collaboration between the two Countries with a strong applied focus
- Creation of export potential and trade avenues for associated industrial partners
- Improvement of research and higher education links between Brazil and the UK

Organisational Representation

The workshop was attended by some 40 attendees representing 26 organisations including:

Brazilian Centre for Physics Research (CBPF) Brazil	Organisation of National Petroleum Industries (ONIP) Brazil
British Consulate General Brazil	Pan-American Chemical Industries Brazil
Bureau Veritas Brazil	Petrobras Research Centre – TMEC Brazil;
CAPCIS UK	Petrobras Transpetro Marine Division Brazil
Chemical Institute-UFRJ Brazil	PUC-Rio Brazil
Clariant (TR Oil Services) UK/Brazil	Tenaris Group Brazil, Argentina, Italy, Mexico
ComCorr Consultancy Brazil	UK Trade Partners Brazil
COPPE/UFRJ Brazil	Unicamp, DEMA, Brazil
CorroCoat UK/Brazil	University College London (UCL) UK
Eletronuclear Brazil	University of Leeds UK
FMC Energy Systems Brazil	University of Manchester (UMIST) UK
Instituto Nacional de Tecnologica (INT) Brazil	University of Swansea UK
KeyTech UK	Vallourec & Mannesmann Brazil

Annex 2

Rio de Janeiro, Brazil;

Visit and Discussions by Professor George Thompson

15-17 January, 2003

- Met initially with Professor Carlos Elias concerning titanium implants. Information forwarded on successful EPSRC proposal and work of project student in UMIST. UMIST Group also trying to build relationship with TiUnite, Swedish manufacturer of oral implants. Professor Elias has good contacts with Conexao implants in Sao Paulo. Possibly meet again in October at time of Latincorr, 2003; in the interim, routes to be determined for disseminating information and including Gothenberg University, Sweden into the collaboration.

- Second meeting with Eduardo Cavalcanti and Denise Freitas of INT, Rio de Janeiro. Denise has been appointed recently to a permanent position in the Corrosion Division at INT. She is available to assist Eduardo in the Network activities. Denise's specific interests are in the field of inhibitors, which fit well with the UMIST, Glasgow and Swansea interests. Denise received her PhD from UMIST after completing her research studies in the Corrosion and Protection Centre. Concerning other members of the Brazilian Network, none has expressed interest in taking on the role of Coordinator, with being too busy cited as the major reason.

- The recent elections in Brazil had created a vacuum, but this has now been filled with the various Ministers/ Officers currently settling into their new positions. Thus, Eduardo can now make or renew contacts. International collaboration appears to be an area of priority.

- Within Brazil, the Corrosion Network has a major focus on incremental technologies not step change. The Network provides a focus for individuals/ groups to collaborate, and to share expertise and the limited financial resources available.

- Eight projects are continuing until the end of March, involving nine universities, three research institutes and consultants. Two grants have been received from FINEP/FAPERJ; the amount awarded equates to about 65k pounds. This has provided support for one PhD student and seven MPhil students.

- Beyond March 2003, taking into account the likely priorities in Brazil and the personal interests of individuals in the funding ministries/agencies the following activities head the priority list:

    1. Structural integrity, with a major push from Petrobras/CENPES

    2. Corrosion resistance and qualification of API 5L X-70 and X-80 steels, with inputs from Petrobras/CENPES, and CONFAB pipeline manufacturers.

    3. Biofouling and corrosion field studies of carbon steel, with major interest and input from the Brazilian Navy.

    4. Surface studies of dental implant materials and performance, with inputs from the Brazilian Institute of Implantology and Conexao implants.

    5. Other high interest activities include sharing expertise and approaches for examination of the "Black Powder Problem", analysis of retrieved

orthopedic implants, corrosion information dissemination and distance learning. Finally protection of cultural heritage, including cast iron artifacts, remains relevant.

- Whilst there are many other areas of interest, the previous list gives the priorities. Further, with the relatively modest funds available in Brazil, there is a need for cost and effort sharing and cost minimisation.

- Concerning further funding of the Brazilian side of the Network, with individuals in place in the ministries/agencies, contact will be revisited. The typical funding routes are indicated below:

1. Federal Agencies

Individual may apply to CNPQ (somewhat similar to HEFCE) for research projects (limit of 20k Reais) and student scholarships. Institutions may apply to FINEP, which has various divisions, with funds of up to 200k Reais available to develop projects. Increased value applications for grants can be made to the fourteen Sartorial Funds, for example including petroleum, energy, transport, bio, aerospace and health. Academic staff of the universities may also apply for scholarships to study abroad.

INT, being a government unit, can apply for the above funds.

2. Regional Funding

Support may be gained regionally from applications to FAPERJ, Rio de Janeiro State.

- Concerning the Ministry of Science and Technology (MCT), which also funds the seventeen national institutions, including INT, some important, relevant changes have occurred. A new Executive Secretary, Professor Wanderley de Souza, has been appointed. He is a biophysics with interests in befouling and biocorrosion. His interests relate closely to those of the Brazilian Navy and, hence, Eduardo's further push of the marine activity. Professor de Souza is aware of the Network. Nuclear materials may also be relevant, but we have not yet identified the individuals who are championing this area.

- With regard to regional agency (FAPERJ) a new executive director has been appointed, Professor Brunet. Eduardo is Coordinator of the materials activities of FAPERJ. Very limited, or no, funding is expected from FAPERJ during the transition period of about 6 months. Consequently no funds are available in the short term to support visits to the UK .

- It appears that international collaborations have greater importance to MCT and FAPERJ than previously. Now that individuals are in position, further interaction with the British Consulate and the British Council may be beneficial in promoting short, 3-month exchange visits for individuals from Brazil to work in the appropriate UK group(s).

- From discussion with Caetano Moraes, Coordinator at INT, with responsibility for Technological Developments, the great interest in international collaboration was repeated. With the Director of INT, he will meet with Professor Wanderley de Souza, the new Executive Secretary of MCT, to discuss strategic areas. Eduardo has now been invited to the meeting to talk about the Network and related collaborations. In the meantime, a letter from the UK to Professor

Wanderley de Souza, introducing the Br-UK Corrosion Network project, may be beneficial. (The letter, with attachments has been sent; see later).

- Of general interest, I noticed in the Financial Times (15 January) That Brazilian Companies are beginning to return to international capital markets. Thus, CVRD, the world's largest iron ore producer, has received a $ 300m cash injection. This may increase the enthusiasm of Corus to participate in the activities of the Network.

- Summarising the previous, there is a major requirement to continue the Brazilian Network to bring together groups in different locations to maximise use of resources. Several priorities areas have been identified. Eduardo as Materials Coordinator for FAPERJ can assist in requests for regional funds. Individuals are in position to whom approaches can be made for overall federal support, including exchange schemes.

- Areas of direct relevance to the UK side of the Network are not really altered, as indicated below:

    1. Structural integrity with Carneval from CENPES and UCL.

    2. Steel microstructure, joining, corrosion/inhibition of relevance to sweet and sour environments involving all the UK groups together with Bott, Ponciano, Cavalcanti and Freitas. This activity is supported in Brazil by Petrobras/Cenpes, and Confab.

    3. Biofouling and Corrosion field studies of carbon steels. Coutinho and Cavalcanti are leading this with Navy support. Eduardo has suggested that Ann Neville could join the UK activity.

    4. Surface studies of dental implant materials with Elias and Freitas, and the Brazilian Institute of Implantology and Conexao, UMIST has interest here, with a project student in position in Manchester.

    5. For those interested in the black powder and retrieved orthopedic implants, there is a need for access to specialised facilities to improve the detective work.

    6. Information dissemination, discussion lists, development of case studies re of interest to several Brazilian Groups including Eduardo; this interest matches that of Bob Cottis at UMIST and, possibly others. Bob has been successful in attracting European funding, which may be relevant here.

Annex 3

Multi-phase Hydrocarbon Transmission (MHT)

Multi-phase Hydrocarbon Transmission (MHT) as a key industry challenge and a theme of common interest between the two Countries, board but focused, applicable to both existing facilities and new developments and in great need of innovative solutions. The current projects in the UK are summarised in this Annex.

Project a: **Probabilistic based inspection scheduling for corrosion damage (PISC)** aims to develop quantitative procedures to assure integrity of facilities by fracture mechanics and defect assessment procedures utilising highly innovative corrosion modelling techniques to explore critical conditions for development of corrosion instabilities. EPSRC funding is being sought.

Project b: "**Corrosion inhibitor film formation, persistency, breakdown and repair in oilfield applications"** aims to develop innovative high-build inhibitor chemicals capable of providing sustained protection at low dosage rates under a diverse range of production conditions bearing in mind complex combination of toxicity, biodegradability, bio-accumulation properties and hydrodynamics together with remedial measures to minimise the impact on the environment.

Project c: "**Preferential weld corrosion, prediction, monitoring and inspection"** aims to develop innovative quantitative and qualitative means of assessment, monitoring and inspection of weldments to minimise and predict the occurrence of preferential weld corrosion.

Project d: "**The role of microstructure and steel composition on corrosion in carbonic acid environments"** aims to develop carbon and low alloy steels with superior corrosion performance. It will focus on structure/property relationship of new generation of corrosion resistant carbon and low alloy steels utilizing microalloying elements and heat treatment by emphasising on the microstructure and surface engineering aspects.

Project e: "**Use of potential fluctuations caused by local turbulent flow as a means of monitoring corrosion rate of steel"** aims to develop innovative means of in-situ corrosion and erosion monitoring through the use of ultrasonic tomography for fluid dynamic prediction and monitoring and flow perturbation/ fluctuation enabling in-situ corrosion monitoring.

Project f: "**Erosion modelling and detection in solid containing fluids"** aims to characterize 3-phase (fluid, gas and solid) flow dynamics and develop erosion modelling and innovative monitoring tools to address multi-phase hydrocarbon transmission and related properties.

Project g: "**Online realtime monitoring of pipelines and flowlines (Piglet)"** aims to develop and produce a prototype self contained "Inspection/Monitoring Tool" capable of continuously monitoring internal status of trunk lines, pipelines and flow lines without disruption to the normal operations.

Project h: "**Stress Monitoring of pipelines/flowlines to detect degradation due to corrosion"** aims to implement current penitential stress measurement (ACSM) technique to quantify, non-destructively and remotely, corrosion damage through translation of degradation morphology.

Annex 4

Brazilian Activities and Projects

No	Activities / Projects	Leading Institution	Coordination	Beneficiaries
1	Coordination, Management, Marketing & Web Home Page	INT/DCOR (UERJ/HUPE)	Dr Eduardo Cavalcanti	All
2	Retrieved Orthopedic Implants Analysis	INT/DCOR	Dr Eduardo Cavalcanti Eng Sonia Coelho Dr Liszt Palmeira	Rio Public Health Department
3	Wet Blasting Alternatives Assessment of New Processes and Abrasives	INT/DCOR (CEPEL)	Dra Olga Ferraz Eng F Fragata	FURNAS ELECT Co PETROBRAS/ REDUC Paint Companies & Surface Treatment Contractors
4	Discussion List Corrosão-L (expected end: 31/12/2002) & Distance Learning Sessions (project to be submitted)	INT/DCOR	Dr Eduardo Cavalcanti	All
5	Corrosion Information Dissemination (ended 31/08/00)	INT/DINT	Gilda Coelho Massari	All
6	Coated Steels for Automobile Applications (ended 31/08/00)	UFF/EEIMVR	Prof Paulo Ribas	CSN
7	Surface and Corrosion Studies on Dental Implant Materials	UFF/EEIMVR	Prof Carlos N Elias	Brazilian Institute Implantology & Conexao Implants
8	Heat Exchangers Corrosion Control of Angra I Nuclear Power Plant (ended 31/08/00)	COPPE/UFRJ	Prof Jose Ponciano Gomes	Electronuclear
9	Bronze Statuary Corrosion Control (ended 31/12/01)	COPPE/UFRJ (UERJ/HUPE)	Prof Luiz de Miranda Prof Dalva Lago	Rio Public Monuments Department
10	Corrosion Assessment of Motorways Infrastructure Viaducts Rebar Corrosion (ended 31/08/00)	COPPE/UFRJ (INT/DCOR)	Prof Luiz de Miranda Dra Telma Villela	Rio Monuments Department Rio Gardens Foundation

No	Activities / Projects	Leading Institution	Coordination	Beneficiaries
11	Standardisation & Setting up of Brazilian Corrosion Standards Committee (CB-43); Inter-laboratorial ISO TC 156 in Salt Spray Testing	ABRACO (INT/DCOR)	Eng Laerce P Nunnes Eng Gutemberg Pimenta Dr Eduardo Cavalcanti	All Members
12	Thermal Spray Coating Assessment for Use on Campos Basin Oil & Gas Platforms (ended 31/08/01)	PETROBRAS/ CENPES	Eng Marcelo Torres Piza Paes	PETROBRAS/E P-CB UNIT
13	Specialised Technological Services in Partnership The Black-Powder Problem	INT/DCOR PUC-RIO	Dr Eduardo Cavalcanti Prof R Avillez	TGB GASBOL PIPELINE
14	Comparative Corrosion Resistance and Qualification API 5L X-70 and X-80 Steels for Use in H_2S+CO_2 Rich Fields	PUC-RIO (COPPE/UFRJ) (INT/DCOR)	Prof Ivani Bott Prof Jose Ponciano Gomes Dr Eduardo Cavalcanti	CO PETROBRAS/C ENPES CONFAB PIPELINES
15	Bio-fouling and Marine Corrosion Field Studies of Carbon Steels	IEAPM (INT/DCOR)	Prof Ricardo Coutinho Dr Eduardo Cavalcanti	Brazilian Navy

Annex 5

Recent Correspondence on the Network and its Continuation

Professor de Wanderley de Souza
Executive Secretary
Ministry of Science and Technology
Esplanada dos Ministérios - Bloco E
70067 –700
Brasilia – DF
BRAZIL

6th February 2003

Dear Professor de Souza,

Brazil-UK Networks

I am writing to inform you of the above activity, which has been underway for the past three years under the auspices of the Higher Education Funding Council for England. Additionally, I am seeking your advice and guidance in promoting mechanisms for the continued development of the Networks.

As background, following a visit to Brazil by Baroness Blackstone and Professor Brian Fender (HEFCE) in 1999, it was decided to promote Brazil-UK Networks in the fields of catalysis, corrosion and phytopharmaceuticals. At that time, in Brazil, several local networks had been established by MCT to promote university-institute-industry-government partnerships.

Following the signing of a Memorandum of Understanding (copy enclosed), a pilot scheme to develop the Brazil-UK Networks was initiated, with Professor Brian Clarkson providing the overall leadership role. Within Brazil, the Catalysis Network was co-ordinated by COPPE/UFRJ, Corrosion by INT and phytopharmaceuticals by UFRTl; within Brazil, funding was gained through the so-called state-wide (regional) coalition programme (RECOPE-RJ) with the Federal Government and the Rio de Janeiro State Government as signatories and involving FINEP and FAPERJ.

Concerning the Corrosion Network, which I co-ordinate for the UK side, with Dr Eduardo Cavalcanti being responsible for the Brazilian side, interaction has proceeded with universities, research institutions, government agencies and industry. This has led to the development of key joint projects, of direct relevance to the UK and Brazil and beyond. Meetings in Brazil and the UK, together with a Workshop in Rio in late 2002, have confirmed the previous. Further, stemming from the workshop, which had a largely oil and gas focus, additional areas have been taken on board for further development of the Network. Thus, in addition to the collaboration focused on

Multiphase Hydrocarbon Transmission, involving integrity management, control measures and monitoring and mechanisms and modelling, the Network has broadened to include biofouling, non-destructive techniques, biomaterials (particularly oral implant) and distance learning.
In the light of the findings of the Pilot Scheme and the desire to promote further the activity, your advice and assistance would be very much welcomed in the following areas:

1. The need for a new Memorandum of Understanding, or otherwise.

2. Mechanisms for support for international collaboration, embracing visiting fellowships to enable researchers to visit the UK or Brazilian Laboratories for periods up to 12 months, and overseas travel grants to allow UK or Brazilian researchers to have short stays (1 month) to promote the collaboration and for increased periods to learn new approaches.

As indicated previously, the Pilot Schemes is coming to a close, with the findings being considered at a HEFCE organised meeting in London in March. I understand that the Brazilian Co-ordinators will also be involved at the meeting. Paulo Wroble, of the Brazilian Embassy in London, will contact the appropriate personnel. I realise that you will be too busy to attend the meeting, but there will be new information available from your Brazilian colleagues. Further, I also understand that you will be discussing related areas with the Director of INT, and international collaboration may have a prominent role.

I look forward to receiving your comments in due course.

Yours sincerely,

Professor George Thompson

PS I have enclosed relevant slides from the Rio workshop.

5 February 2003

Wanderley de Souza
Secretário Executivo
Ministerio da Ciéncia e Tecnologia
Esplanada dos Ministérios, Bloco E
CEP 70067-900 Brasilia-DF
Brazil

Dear S. da Souza

Brazil/UK Research Networks: Evaluation and final workshop

It has been suggested by Prof Eduardo Cavalcanti, that I write to update you on the above. As you are no doubt aware, the HEFCE has sponsored a pilot project over the last three years which has provided infrastructure support for three UK networks to develop links with corresponding networks sponsored through the State of Rio de Janeiro. The networks are in the areas of Corrosion, Catalysis and Phytopharmaceuticals, and I believe that in Brazil, these link into the national PRODENGE programme.

We are currently evaluating the project and will produce a report summarising the findings; this will form the focus of a workshop to be held in London on 19 March, to which Prof Cavalcanti has been invited. I understand that he is required to seek formal permission to attend this, and I am therefore writing to inform you of the event. Of course, if you, or any of your colleagues would be interested in attending this event, I would be happy to include you in the arrangements.

Yours sincerely

Jannette Cheong
Head of International Collaboration and Development

Copy: Dr P Wrobel, Brazilian Embassy