

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Docket No. CP15-554 Atlantic Coast Pipeline

September 16, 2019

Secretary Bose:

I have reviewed Dominion's July 22, 2019, and August 23, 2019 reports to the Federal Energy Regulatory Commission (FERC). The reports were in response to FERC's July 3, 2019 request for data regarding possible environmental and health impacts from the 3M Scotchkote Fusion Bonded Epoxy 6233 external pipe coating, and other pipe coating products used for the Atlantic Coast Pipeline (ACP).

I believe that Dominion's reports significantly understate the risk to public health and the environment from this coating, and other products used on the exterior of the pipe. I believe the reports use questionable data, and questionable methodologies to arrive at unreliable conclusions, and therefore, do not adequately answer the FERC's request for information, or the concerns raised by the Virginia Department of Health.

The following comments critique the July 22, 2019 report.

RESPONSE TO QUESTION 1

Dominion states that manufacturer 3M has stated that hazardous substances shown on the safety data sheet for Scotchkote Fusion Bonded Epoxy coating 6233 are expected to be encapsulated in the coating and not migrate onto the surface or leach out of the coating.

Coating manufacturer 3M states in its September 19, 2018 Material Declaration on 3M EMD Products sold in the USA "As leaching studies

have not been performed on these products, soil leachability from these products is unknown. This definitive declaration from 3M contradicts the 3M statement in the preceding paragraph.

The Virginia Department of Health has determined that epoxy resins similar to this coating can leach out substances that negatively impact human health, including carcinogens benzene and styrene.

Dominion further states in the first sentence in paragraph 2 of their July 22, 2019 report...“potential environmental pathways include (1) possible leaching by contact with water into soil and groundwater...”

These facts are contrary to 3M’s above stated expectations.

Dominion states that 3M’s FBE coating has obtained NSF 61 certification.

3M Scotchkote Fusion Bonded Epoxy 6233W (6233W) has received that certification. 3M Scotchkote Fusion Bonded Epoxy 6233 (6233), which is used to coat the exterior of the pipes for the ACP, has not received that certification. Although these materials are similar or identical, they are used differently, and subject to vastly different environmental stressors which impact them in different ways. NSF certification for 6233W which is used on the interior of drinking water pipes, does not indicate that 6233, used on the exterior of the pipes, will not release substances that are detrimental to human health or the environment.

Perhaps the most outstanding difference is 6233W is not subject to UV degradation when applied to the interior of potable water pipes, while 6233 is subject to UV degradation when stored in sunlight. In fact, many of the pipes for the ACP have been exposed to UV degradation during storage for over 3 years, and may be exposed to further UV degradation for an undetermined period into the future, since the project is currently inactive due to multiple permit revocations by the courts. The same September 19, 2018 3M Materials Declaration document cited above indicates that “some photo degradation products will be toxic to aquatic life”.

6233 is also subject to mechanical impacts from construction handling,

and abrasive materials in the backfill that will cause particulate matter to dislodge from the main body of the coating. This does not occur with 6233W.

6233 is subject to contact with groundwater with widely variable chemical properties, including pH, salinity, and a variety of minerals, microbes, and other organisms, including burrowing animals. 6233W is exposed to regulated static water contact.

Application techniques and procedures for 6233W and 6233 may be different as well, and this could create a difference in how this product leaches, extracts, or discharges particulate matter and pollutants.

Stating that 6233W has received NSF 61 does not indicate that 6233 is free from negative health or environmental impacts when applied to the exterior of gas pipelines.

Dominion states "According to 3M, chalking is a phenomenon that occurs when epoxy-based coatings are exposed to UV for an extended period of time. The chalk is a thin layer (microns thick) that adheres to the surface of the pipe that is composed of polymer degradation products (not typically known with specificity) that are created by exposure of the surface of the pipe to UV light from the sun. Although 3M has no conclusive evidence at this time to confirm their exact identity, the degradation products are generated in low quantities, have low water solubility, and are therefore not expected to enter the environment in amounts capable of producing an adverse human health effect."

The pipes have been exposed to UV for an extended period of time, exceeding 3 years at this time, and they could be exposed to UV for an indefinite period of time into the future due to the project shut down. The Pipeline and Hazardous Materials Safety Administration (PHMSA) confirms that these pipes are chalking. PHMSA has also recently stated that Dominion has advised that they have not taken any of the actions recommended by 3M to reduce, or stop UV degradation of the coating.

3M states that it cannot specifically identify the degradation products in its

Material Declaration cited above.

The degradation products are not generated in low quantities. A 3M Technical Brief entitled UV Protection of Coated Pipe states that UV exposure can cause degradation (chalking) of the coating up to 1.5 mils per year, and that degradation is increased by heat and humidity. A number of industry experts have advised that up to 2 mils of degradation can occur per year.

Please note that 3M advises against removing chalking material from the pipes as this will increase UV degradation of the underlying intact coating.

At over 600 miles in length the ACP has about 80,000 pipes in total. As they are generally stacked 4 high in storage, the top 25% of the pipes will receive most of the UV degradation. Therefore, approximately 20,000 pipes are producing large volumes of degradation product.

The ACP would include 333 miles of pipe 40 feet long and 42 inches in diameter are included. If a 40 foot long by 42 inch diameter pipe at the top of the stack in a pipe storage yard has 3 mils of chalking on the top half (the portion most exposed to UV) that volume of chalked material is approximately 95 cubic inches, or a little more than the volume of 7 baseballs (at 13 cubic inches each). That's one baseball volume of chalking for every 6 feet of UV exposed pipe, and that unidentified product, which is toxic to aquatic life, according to 3M, is escaping into our environment.

One hundred and eighty six miles of pipe 40 feet long and 36 inches in diameter are also proposed for the ACP. With 3 mil of chalking, each of these pipes could produce about 82 cubic inches of chalking, about the volume of 6 baseballs, or one baseball sized volume for every 7 feet of pipe. Eighty three miles of 20 inch diameter pipe would produce 45 cubic inches of chalked material for each 40 foot length of pipe, and another mile of 16 inch pipe would produce 36 cubic inches of chalked material for each 40 foot section of pipe.

Pipes not at the top of the storage stack will suffer UV degradation as well, although probably to a lesser degree. These will include pipes stored at

the outer edges of the stack, pipes that are temporarily stored at contractor yards, and pipes that are resting on the ground prior to placement in the trench.

This is a very large amount of UV degraded coating material, all of which could be detrimental to human health, and according to 3M, some of which is toxic to aquatic life. This material is escaping into our environment, and it is likely that it is being inhaled and ingested by citizens and wildlife. Persons at particular risk are those living near the proposed pipeline, especially those using private wells and springs for their drinking water, even more so for those using private wells and springs in karst areas, and those living near pipe storage locations.

See statement from Paul Davies of Cambridge University below regarding health concerns from airborne UV damaged coating in response to Dominion's report of August 23, 2019.

Human health impacts are cumulative. We are subjected to many negative health impacts from a large number of chemicals and products in today's world. Numerous chemicals and products have not even been assessed for their impacts to human health or the environment. We all carry these substances in our bodies, and will be for the rest of our lives.

Human health impacts cannot be accurately determined in isolation. Varying pollutants may interact with each other within our bodies to create impacts that are more negative than the separate impacts from each pollutant.

The assumptions stated by Dominion in response to question 1 are not based on valid scientific evidence, and do not prove that this coating is safe for human health, or our environment.

In fact, the evidence indicates that 3M Scotchkote Fusion Bonded Epoxy coating 6233 used for the pipes on the ACP:

- Contains known carcinogens, mutagens, toxins, and irritants.
- Has not been tested for leachates by manufacturer 3M

- May leach benzene and styrene like similar epoxy resins
- Has been exposed to UV degradation from sunlight for over 3 years, and will be exposed for an additional undetermined amount of time
- Has not been protected from UV degradation since Dominion has not taken measures recommended by manufacturer 3M to reduce, or stop that degradation
- May be losing 1.5 mi to 2 mil of coating per year to UV degradation
- Will produce 95 cubic inches of UV degradation byproduct, or chalking residue, from a 40 foot long 42 inch diameter pipe at the top of the storage stack that contains 3 mil of chalking on the upper, sun exposed, half of the pipe
- Produces UV degradation products that are toxic to aquatic life, and whose specificity is unknown to 3M, according to the 3M Material Declaration cited above, and may be harmful to human health.

These facts indicate a substantial threat to human health and the environment from this coating.

Attachment 1

This includes a number of Safety Data Sheets prepared by 3M and other manufacturers of products used in coating the pipes for the ACP.

These sheets list a large number of chemicals that are carcinogenic, mutagenic, and toxic to human health, and the environment. Some of these are toxic in relatively low concentrations.

The sheets list numerous negative health symptoms expected from contact with the chemicals, and specific warnings regarding exposure.

Attachment 2

This is a statement of general testing procedures used by NSF International (NSF). NSF is a private company that receives compensation for testing the products for use in drinking water transport. NSF is not a government regulatory agency, nor a non profit company.

Qualification Testing

NSF states that the product is flushed according manufacturer's instructions. I question why the product is not flushed per NSF specifications. The manufacturer's specifications may not provide proper flushing.

NSF states that the product is exposed to formulated water for a number of days specified by the standard. They state that most municipal water contact products are conditioned with water for 17 days.

Monitor Testing

NSF states that certified products are retested and audited on an annual basis.

Attachment 3

This is the results of lab tests performed by NSF on December 21, 2018 for Scotchkote Fusion Bonded Epoxy Coating 6233W 4G Powder in the chemistry lab. The sample was tested for metals, VOC's, semi-volatile compounds, and volatile organic compounds

I question the short duration of lab exposure. These tests show a maximum lab exposure time of 16.5 hours. This is much less than NSF qualification testing procedures above which state that most products are exposed for 17 days. ACP pipe coatings will be exposed to groundwater and other stressors for decades. An Alben, et al 1989 leachate study cited below found that only 77% of leaching was complete after 30 days of exposure. The short exposure time in the NSF test draws into question the validity of

their findings.

Barium, copper, aluminum, tin, and chloroform were found. Chloroform, even in small quantities can daze a person, or result in unconsciousness.

These tests are not appropriate for 3M Scotchkote Fusion Bonded Epoxy Coating 6233, as stated above, since the coating is applied to the exterior of pipes, most of which have been subject to UV degradation for over three years, and then are placed underground under much different environmental stressors than coating applied to the interior of potable water pipes.

Attachment 4

This is the result of lab tests performed by NSF for the same product on November 3, 2017. This testing date does not comply with NSF stated testing procedures that call for annual testing (and therefore a test in 2018) of NSF approved products.

I again question the short lab exposure time. The test shows a maximum exposure time of 24 hours. This is much less than NSF qualification testing procedures above which state that most products are exposed for 17 days, and the 30 day exposure for the 1989 leachate test..

Barium, aluminum, tin, chloroform were found.

Attachment 5

This is a 4/1/19 letter from 3M Electrical Markets Regulatory Affairs. This letter understates the threat to public health and the environment from the coating.

The letter states that the coating is expected to resist degradation, but in the next paragraph states that the coating degrades in exposure to sunlight. The previously cited 3M technical brief states that up to 1.5 mil of

chalking can occur per year, and simple calculations show that a significant volume of chalking can escape into our environment from a single pipe. This contradicts the statement in the letter that these substances are generated in low quantities.

The letter also restates that 3M does not know the identity of the photo degradation products.

Please note that I did not receive this letter from 3M by e-mail, regular mail, or in any other manner. The first time I saw this letter was in the July 22, 2019 Dominion response to FERC. I had been trying to obtain information from 3M regarding this coating starting in August, 2018, until December 2018 with no information ever provided by 3M. This letter may be in response to my earlier inquiries, but it was apparently handed over to Dominion, rather than being delivered to me.

The above information indicates that Dominion's July 22, 2019 response to FERC greatly understates the risk to public health and the environment from 3M Scotchkote Fusion Bonded Epoxy Coating 6233, as well as numerous other products used on the pipes for the ACP.

Comments below critique the August 23, 2019 report, and most specifically the Tox Strategies report.

2.1 Silica is not included as a Chemical of Potential Concern (COPC). Silica is toxic by inhalation, but chalky residue is well adhered to pipe, and does not become airborne in the wind

No tests were conducted to confirm that the chalky residue is well adhered. Three years of storage in an open field would likely cause chalky residue to disadhere from the pipes due to wind erosion, and become airborne.

Expert Paul Davies has advised me that it is his view that chalking epoxy material from pipes stored in the open and left out in the sun is likely to be carried downwind from pipe storage locations. He also advised that he

personally would be concerned about breathing UV damaged epoxy dust on a near continuous basis, even if the concentration in the air is extremely small, and that he would choose to avoid living in a home downwind from a stack of unprotected, weathering FBE coated pipe.

Paul Davies has a Masters degree in Engineering from Cambridge University.

Paul Davies is a consultant engineer who has been working independently, specializing in corrosion control, since 1988. His knowledge of industrial protective coatings is respected. He has been engaged as an expert witness by the UK Government and by commercial enterprises seeking to resolve disputes concerning coatings. He has worked in the corrosion control field since 1969 and has been responsible for coatings selection, specification, application, and resolution of issues, on major projects since 1978.

Mr. Davies' career resume is attached.

The FBE coating will experience only 1-2 mils loss to UV, and total quantity of dust to be released to the air is extremely limited

3M advises up to 1.5 mil loss to chalking per year due to UV, heat, and humidity. The pipes have been stored for over 3 years, and due to project shut down, the pipes will be stored for a further indefinite period of time. Only 3 mil of chalky residue from the top half of a 42 inch diameter 40 foot long pipe equates to 95 cubic inches of residue that could become airborne.

Silica not included as COPC

The Material Safety Data Sheet for 6233 lists silica and quartz silica as known human carcinogens through inhalation. Silica should be included as a COPC

2.2 Selectively quotes the Material Declaration on 3M EMD Products Sold in the USA

The report excludes the following sentence from the Declaration...“None

of the photo-degradation products are expected to bio concentrate, although a few will be toxic to aquatic species.”

2.3 Sulfur and Phosphorous not included as COPCs

Both of these chemicals are generally considered to be of low toxicity. But Sulfur ingestion has been found to result in ruminant (cattle) death, and Phosphorous can be toxic for those with impaired renal function.

2.4 A 1989 leaching test for FBE found 77% of leaching complete in 30 days in water

I question why NSF only tested the FBE for 16-24 hours. This refers to the NSF tests which were included in the July 22, 2019 report.

3 Ten sampling locations were chosen, and shown in a diagram

Sampling should have been done on the top half of pipes at the top of the stack where 3M advises UV degradation is at its most intense. I question if the pipe owner was advised what pipes would be sampled, if someone handled the pipes or wiped off the chalky residue prior to the sampling, and why the pipe in the provided image is not in a stack.

Sampling locations were chosen to avoid highly saturated soils from recent rain events

I question why saturated soils were not sampled, and why receiving waters or standing water on the site were not sampled.

During the August sampling event a wipe sample and soil sample were taken from the same locations as the June sampling event

If the wipe sample and soil were taken in the very same location, the earlier wipe sample would have already removed the chalky residue, and the soil sample would have already removed some chalky residue from the soil.

Samples were transported to Utah for analysis

The chain of custody documents and sample sheets are missing, which

are needed to show that maximum holding times and temperature requirements for the various tests were met, correct preservatives used, and the samples were not tampered with, or mishandled by an unqualified person.

4 The wipes themselves contain some inorganics, and are not sterile

This could invalidate test results due to contamination from the inorganics. In fact, an asterisk at the bottom of Table 4 indicates that wipe sample results are adjusted for content of clean wipe. I question how these results were adjusted to make up for the contaminated wipes.

5 The World Trade Center settled dust screening levels are referenced (Reference 7)

A search of this document finds indoor air and settled dust levels for only Lead and Silica, and not the chemicals shown in Table 4. In fact, Silica is not shown in Table 4. The World Trade Center indoor environment assessment was strongly criticized by peer groups and the U.S. Government Accountability Office (GAO). This is an indoor environment assessment, and I believe that it is not valid for the assessment of outdoor air quality, especially for areas downwind of the pipes.

High concentrations of Silica are not expected to result from the dispersion of pipe chalky residue into the environment

See earlier responses to Section 2 in the critique of the July 22, 2019 submittal which demonstrate a large volume of chalky material that is likely being dispersed into the environment, and becoming airborne. The Tox Strategies report also indicates that Silica may be a significant component of the chalky material.

Table 1 Reporting units are in micrograms per sample

This does not indicate the concentration of the chemical in the chalky residue, nor the maximum safe exposure limits.

Tables 1, 2, 3, and 4 Arsenic is detected in tables 1, 2, and 4, but the Arsenic weight percent is not shown in table 3, and it is listed as non

detectable in table 3

This discrepancy needs to be corrected for this extremely toxic chemical

Tables 2, 3, and 4 Mercury is detected in Tables 2 and 4, but the Mercury weight percent is not shown in table 3, and it is listed as non detectable in table 3

This discrepancy needs to be corrected for this extremely toxic chemical.

Table 4 shows WV natural background levels in soil

This is a general average, and is not based on the soils in the immediate area outside the storage yard. Soil samples should be taken in the immediate area outside of the storage yard, and especially up wind and upgrade of the storage yard to avoid contamination from windblown and waterborne chalky residue.

6 Findings

1) No impact to health or the environment

The data presented does support this conclusion

3) Silica was not included as a COPC. The chalky residue is well adhered to the pipe, does not become airborne in the wind, and is present in very limited quantities that are available to be released into the air

The data presented does not support this conclusion. No testing was done to determine if the chalky residue is well adhered to the pipe. Silica is a carcinogen through inhalation. Airborne silica is a significant threat to human health, and large amounts of chalky residue that may contain silica could become airborne.

4) SVOC's not detected

It is possible that the admitted contamination of the wipes themselves may invalidate the wipe samples.

5) Concentrations of chemicals detected in the wipe samples are lower

than available WTC settled-dust screening levels

I believe that this is an invalid comparison of settled dust standards to airborne pollutants.

7) Because chemicals (except calcium) were found below natural background levels in soils located below the pipe, no impacts to groundwater, surface water, or ecological receptors are expected from the chalky residue

The natural background levels of chemicals in the area of the pipe storage yard and along the proposed route were not tested. References 14 (Virginia soils), and 15 (North Carolina soils) should be checked for valid applicability to soils in the respective locations of the proposed pipeline route in those states.

Summary:

- The 6233 coating and other pipe coating materials contain many chemicals that are carcinogenic, mutagenic, and toxic to humans, animals, and aquatic species. 3M advises that some UV degradation products will be toxic to aquatic life. The Virginia Department of Health advises that similar epoxy resins leach out carcinogens benzene and styrene.
- There is a lack of research on the health and environmental impacts of 6233, including the absence of 3M leaching studies. 3M has also stated that they do not know what specific products will result from UV degradation.
- The chemicals in 6233 are not completely encapsulated. A large amount of material could be chalking off the outside of many pipes, and escaping into our environment due to UV degradation. Particulate matter is likely also disadhering from the pipes due to contact during transportation and placement in the trench, and due to contact with soil and rocks while in the ground. Leaching of these chemicals has also been demonstrated.
- 3M advises that 1.5 mil of coating per year may be degrading on UV

exposed pipes. The pipes have been exposed to UV for over 3 years, and may be exposed for an undetermined amount of time into the future. Dominion has recently advised PHMSA that they have not followed 3M's recommendations for reducing, or stopping the UV degradation.

- NSF's tests and certification for 6233W do not apply to 6233.
- NSF's tests for 6233W used questionable procedures.
- Tox Strategies' failure to include Silica as a COPC is based on an untested assumption that UV damaged chalking coating will not become airborne, and is unacceptable.
- Paul Davies of Cambridge University advises that UV damaged coating is likely becoming airborne and poses a health threat.
- A 3M Material Declaration Sheet states that some photo-degradation products will be toxic to aquatic species
- Tox Strategies sampling locations excluded the top of the pipes at the top of the stacks, where 3M advises UV degradation will be most intense.
- There is no supporting documentation for chain of custody, and correct handling, preservation, and lab procedures for the Tox Strategies report.
- The Tox Strategies wipes were contaminated.
- Tox Strategies comparison of the risk from wind borne UV degraded coating to World Trade Center settled dust screening levels is not valid.
- There are numerous inconsistencies in the Tox Strategies tables.
- Background soil samples in adjacent areas upwind and updrift of the storage area were not taken by Tox Strategies.
- The data does not show that there will be no impact to human health, groundwater, surface water, air, or wildlife, including endangered species.
- Since there is currently no close out plan for the ACP, all of the coating will be left in the ground with the pipe. Given an average coating thickness

of 15 mils, that amounts to about 950 cubic inches of coating for every 40 foot section of 42 inch diameter pipe, or about 10 baseball sized volumes of coating for every 6 feet of pipe. That amount would total 820 cubic inches for every 36 inch diameter pipe 40 feet in length, 450 cubic inches for every 20 inch pipe 40 feet in length, and 360 inches for every 16 inch diameter pipe. 40 feet in length. This is a large amount of material with unknown impacts to human health and the environment that would be left in ground.

Conclusion

The Dominion reports use questionable data and questionable methodologies to arrive at unreliable conclusions. They do not prove that the pipeline coating is safe, or that there will be no negative health or environmental impacts from the coating and associated products used on the exterior of the pipes for the ACP. They do not reliably answer the questions presented in FERC's request, nor the concerns of the Virginia Department of Health.

Recommendations

Additional study using valid data and methodology needs to be completed to reliably assess the health and environmental impacts from these products.

FERC should consult with federal agencies with expertise in these matters. The Environmental Protection Agency and the Department of Health and Human Services should be consulted, and these agencies should conduct needed studies.

FERC should advise the United States Fish and Wildlife Service (USFWS) that a 3M Material Declaration states that UV degradation byproducts will be toxic to aquatic life, and request that USFWS include this information in any future biological opinion and incidental take statement for endangered

species for the ACP.

FERC should require the ACP to conduct pre and post construction sampling for chemicals associated with this coating and other products used on the exterior of the pipes in drinking water wells and springs in the vicinity of the proposed pipeline, and provide a potable water source and fair compensation for drinking water sources that are contaminated by these products.

FERC should require that all pipes be immediately covered to prevent UV degradation material from becoming airborne.

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DAVIES, Paul, T

Mechanical/Electrical Engineer, Corrosion/Materials Specialist

Personal

Date of Birth:- 15th November 1945
Marital Status:- Married, two children.
Nationality:- British

Academic and Professional Attainment

Cambridge University, Corpus Christi College, (1963-1966)
Mechanical Sciences Tripos (1965)
Electrical Sciences Tripos, BA (Honours) Engineering, (1966).
M.A. Degree, Engineering, Cambridge University, (1970).

Professional Experience Resume

More than forty years specialist experience in corrosion control, electrical, mechanical and materials engineering in the petroleum, construction, and marine engineering industries. Specialisation on work in the corrosion control field has been developed based on electrical and electronic background starting in 1969 with John Morgan at Morgan Berkeley. John Morgan was a Cambridge scientist and the leading UK pioneer in impressed current cathodic protection (CP) systems. This continued with field work in the middle east (Caproco, Aramco, KOC etc.) and then with North Sea jacket and pipeline corrosion control design work with Brown and Root, the industry leader at the time. This included lead design responsibility and supervision of supply, installation/construction, and commissioning, for all types of corrosion control systems for many major oil companies, whilst working as a staff specialist and consultant for Brown and Root UK Ltd.

As Staff Engineer (Head of Field Corrosion Section) for Occidental of Libya (later Zueitina Oil) for over three years, "hands on" oilfield experience was gained managing all the inspection, condition evaluation, repairs and certification of all the facilities of a major operating oil company, as well as managing and supervising all the activities of the Company internal corrosion control, cathodic protection and inspection departments.

For the last 28 years as an independent consultant engineer, Davies has worked with and for oil and gas majors and numerous prestigious design houses in the oil, gas and construction industries. He has maintained a long relationship with Saipem and the ENI group as well as with Brown and Root (KBR) and more recently Atkins.

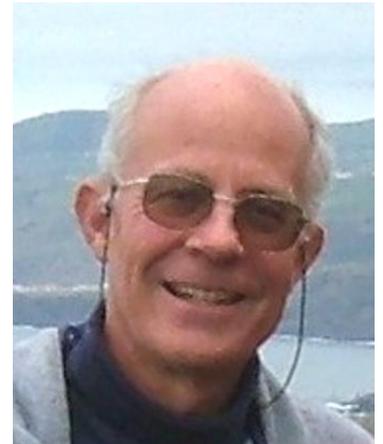
Specific Expertise

Materials engineering design, installation and operation support; cathodic protection system design, protective coatings systems design; corrosion inhibitors; corrosion monitoring; offshore platforms and floating vessels; marine terminals; land and sub-sea pipelines; oil and gas process corrosion prediction and control; oilfield water system corrosion and scale control (including produced water scales); corrosion resistant materials (metallic and non-metallic); microbiological corrosion. Materials specification for oil and gas production, processing and shipping; welding, non-destructive testing and ultrasonic testing; pressure vessel/piping inspection; sour gas corrosion; hydrogen induced cracking; carbon dioxide gas corrosion; failure investigations; submarine pipeline ROV inspection; internal corrosion monitoring; tank and vessel linings; coating inspections, troubleshooting and quality control; procurement and contract specifications; and vendor inspections. Work as expert witness.

Software Development

DES has developed innovative software including:

- Pipeline and structure cathodic protection to most industry codes and oil company design practices
- Pipeline and process system internal corrosion prediction and material selection
- Water (injection) pipeline internal corrosion prediction.
- Thermal insulation design calculation software for subsea pipelines



DAVIES, Paul, T

Mechanical/Electrical Engineer, Corrosion/Materials Specialist

DETAILED PROFESSIONAL EXPERIENCE

DAVIES ENGINEERING SERVICES LTD

May 1988 to date, (see attached tables for details, 1998 to present date.)

Consultant Engineer

Paul Davies is the principal consultant and managing director of Davies Engineering Services Ltd. which carries out Materials Engineering and Corrosion Engineering work as an independent consultant. Client list includes the following engineering and oil companies; ENI Group Companies, Saipem UK Ltd, Saibos, Sonsub; Kvaerner Brown and Root (KBR), Genesis, Petrofac Uk Ltd, Petrofac International, Intec Engineering, European Marine Contractors Ltd. (EMC), Boreas Consultants Ltd.(now Atkins), Penspen Andrew Palmer Associates (APA), Brown and Root Ltd., (now KBR) Marathon Oil UK Ltd, Marathon Oil Houston, BHP Petroleum, AMEC, Shell UK Exploration, LASMO, John Brown Engineers and Constructors, Genesis, Heerema, Energy and Power Consultants Ltd., Global Engineering Ltd. (GEL), Coflexip Stena Offshore Ltd., Granherne Ltd., Mott MacDonald, Dunlop Coflexip Umbilicals Ltd., Woodhill Group, Mustang Engineering, Atkins Global and Allseas Engineering. Work is done in Davies Engineering's premises and clients and their facilities are visited when required.

Work has also been carried out on painting and corrosion protection as an expert witness for the Treasury Solicitor and The Ministry of Defence as well as for commercial organisations.

Consultancy Work Carried Out

The most recent large design project is the corrosion engineering work being done for Atkins on the Premier Oil Solan tank. This comprised both the internal and external cathodic protection designs plus the specification of all coatings. The tank was recently installed on the seabed west of Shetland..

Work continuing with Atkins includes corrosion protection design work for offshore wind power projects and ongoing support for assisting Atkins clients with solving corrosion problems on large onshore pipelines, terminals and loading jetty.

Major past projects have included Yoho Development jackets and pipelines, Dolphin project pipelines, Blue Stream, the Black Sea gas pipeline from Russia to Turkey (Saipem/Intec/Petergaz), the In-Salah Gas project (BP/Granherne) and the Mossgas EM subsea pipelines. Work for EMC includes the design and specification of CP systems for the Shell Galleon Phase 2 pipelines and consultancy concerning the BHP Lennox gas injection pipeline and the Clyde Petroleum 10" pipelines.

Consultancy has been provided to Marathon Oil on materials selection for the Central Brae field, the Ballycotton pipeline, and for cathodic protection studies on the Brae jackets. (Davies Engineering developed the theory of application and first specified (1988) the use of Schottky Barrier diodes with aluminium sacrificial anodes to control potential to avoid hydrogen embrittlement due to cathodic overprotection, for Marathon Oil's Central Brae duplex pipeline as contractor to Global Engineering/Santa Fe as expert nominated by Marathon Oil.) We have since designed a similar system for Marathon Oil, Houston for the super martensitic Alba subsea pipelines, now installed and successfully commissioned.

Other work through GEL included the Halul water disposal scheme for QGPC, and Amerada Hess Scott Development pipelines for GEL.

Consultancy was provided for Stena Offshore for the Dagmar Pipeline after installation for Maersk Olie og Gas AS. Detail design of CP for the Shell Nelson pipeline and subsea structure CP systems were completed for APA. As nominated consultant by Agip, the CP designs for the Tiffany pipelines were validated for Allseas Engineering.

Cathodic protection and corrosion control design work was also carried out for JBEC's oil and gas customers which have included BP, (Miller pipeline onshore CP design), Mobil (new Beryl risers) and Total (also new

risers on existing platforms). Materials performance project management work has been carried out for the MOD(PE) on JBEC's SIP contract concerned with improvement of secondary systems on nuclear submarines.

Assistance was provided to Shell and AMEC on the Brent Redevelopment Project for the quality control of all coatings for new facilities including new glass flake lined pressure vessels. Corrosion consultancy on subsea pipeline corrosion prevention (CP/coatings) is provided direct to Shell UK Exploration and reports were prepared on operational changes on the North Cormorant and Kittiwake pipelines. The CP study for the piggyback pipeline spoiler system was carried out for Shell.

Work for APA included the Amerada Hess Guillemot and Bittern developments (CP & coatings), the new Valhall/Ekofisk gas pipeline and structures and the Moss gas F-A Satellite development, the Amoco Arkwright project, (materials selection, cathodic protection of pipelines and structures), Shell Schooner pipelines cathodic protection assistance, consultancy on the NAM L13 development, the Repsol Poseidon pipeline, the Amoco Davy Bessemer project and the corrosion control engineering for the North Morecambe 36" pipeline including determination of internal corrosion allowance and land and marine cathodic protection and coating specification.

Work for Granherne included the Saga Kristin/Lavrans and Snorre 2 developments topsides materials selection and materials selection for the Amerada Hess Abbot field FPSO. Also materials selection for the Arco Tyne/Trent project, materials selection advice (pipeline and downhole materials) for the Amoco Telford Project, topsides process materials selection for the Conoco MacCulloch, the Statoil Asgard, the Texaco Galley and the Rasmussen FPSOs.

Assistance has been provided to the Ministry of Defence in connection with special coating specifications used at the Atomic Weapons Establishment, Aldermaston.

Consultancy has been provided to Coflexip Stena Offshore Ltd. on a regular basis since assistance was provided with the Dagmar pipeline CP. The detailed design of the corrosion protection systems for the Valdemar and Regnar pipelines and the Shell Barque and Phillips Dawn Projects has been completed for Stena. A study was also carried out on direct electrical heating for subsea pipelines.

Work for Snamprogetti and later SASP UK Ltd. and Saipem UK Ltd. included the materials selection, cathodic protection and corrosion control engineering for the CATS extension pipeline, Bonaccia/Barbara pipelines, the Europipe Nybro Tee Pinghu to Shanghai pipelines, the Norsk Hydro Visund development, Agip Kitina pipeline (offshore Africa), the Scotland to Northern Ireland pipeline, the Agip Thelma subsea development, the ETAP Project and CP work on Conoco Jupiter, Loggs 48/49, Texaco 48/49, Agip Luna developments (Ionian Sea).

The special CP system for the Douglas Development Accommodation Jack-up using aluminium anodes with Schottky barrier diodes to provide protection of high strength steel without hydrogen embrittlement risks has been designed and engineered for BHP Petroleum (Concept pioneered by DES on the Marathon Central Brae Pipeline).

Davies Engineering was called in to give immediate advice to BHP on the failure of the Douglas to Lennox 12" sour gas injection pipeline, and to set out the plan which BHP followed for investigation and reconstruction.

DES also advised BHP on various other corrosion problems and on protection methods for offshore topsides bolting corrosion.

The following work has been done through client Brown & Root.

Rankin 2 Jacket corrosion protection detail design. Pemex Cantarell field CP bid engineering, Esso Balder project materials specifications and cathodic protection designs and general sour gas pipeline philosophies. Earlier work has included the following. Lead corrosion engineer for the Elf Froy jacket EPC contract, the Kerr McGee Gryphon A project, British Gas Interconnector Project (coating specification and cathodic protection systems design). Materials and insulation systems review for EMC Texaco Erskine bid. Amoco

Central Graben (CATS) Development; (lead corrosion engineer, consultant to Amoco), detailed design and assistance with construction of all land and marine pipeline corrosion control systems, all jacket, and subsea structure corrosion control, topside facilities materials selection and coating. Marathon East Brae Jacket - Design of cathodic protection and all corrosion control systems and specification of overall jacket thermal sprayed aluminium coating. BP Schiehallion FPSO, protective coatings systems design, cathodic protection design.

Subsea pipeline and facilities cathodic protection and coatings design, and design studies including Haltenpipe, Shell Galleon pipelines, Statoil Europipe, Statoil/Shell Troll pipelines, Saga Petroleum Tordis field pipelines, BP Miller subsea Tee, Piper Bravo Development, Norske Hydro Brage Development, all Amoco CATS pipelines.

Materials selection for the Texaco Strathspey high CO₂ subsea development. Cathodic protection and coatings consultancy for the Wintershall As Sarah project, (land based storage tanks and pipelines).

ZUEITINA OIL COMPANY (Formerly Occidental, Libya) February 1985 to June 1988

Staff Engineer, Field Based

Management of field corrosion engineering and inspection groups comprising ten British specialists and seven Libyan technicians and trainee engineers and up to twenty contractor technicians, handling all corrosion control, failure prevention and inspection functions for all the Company operations in Libya.

These operations included about twelve oilfields in six major complexes, three of which had large gas processing and condensate recovery plants. The major installations were connected with each other and with the marine terminal by a network of buried pipelines which transported batched crude, condensates, gasses, and various waters.

Operations varied from the management of very large and declining fields with wet production and with sour gas problems, to the discovery and development of new fields. Secondary recovery techniques in use included very large gas injection schemes and various different water floods. Much of the equipment had exceeded its design life and consequently major inspection works were in progress which I directed, with replacements being installed where required, including major items such as pressure vessels, crude storage tanks, pipelines, coolers and exchangers.

Major cathodic protection projects included the implementation of cathodic protection to the company well casings country-wide, and the refurbishment and upgrading of the CP for the Zuetina Terminal foreshore pipelines and tank farm. Cathodic protection was successfully installed on long desert pipelines using combined solar/wind-powered d.c. power systems.

BROWN & ROOT UK LTD. Jan 1981 to Feb 1985 and Mar 1978 to July 1979

Consultant and Staff Specialist

Detail design of corrosion control systems of all kinds for Brown and Root clients for whom Brown and Root acted as Consultant or Detail Design Contractor. Appointment and supervision of consultants working for Brown and Root when representing clients as Management Services Contractor.

Projects for which detail design work was carried out as follows; Heimdal, Morecambe Bay, Esmond/Forbes/Gordon, Valhall/Ekofisk, Beatrice.

Evaluation of Vendors on behalf of Clients, preparation of tender document technical specifications, evaluation of bids, inspection of specialist supplies or services on behalf of clients.

Technical assistance to clients to clarify client requirements and if necessary to resolve disputes with vendors or contractors.

Field and or offshore assignments to commission monitoring systems, train client staff and carry out surveys of cathodic protection systems.

Field or offshore assignments at clients request to study and report on specific corrosion problems.

Carry out acceptance testing on behalf of clients.

ALLDAY ALUMINIUM LTD July 1979 to Jan 1981

General Manager/Production Manager

Management of production unit employing about 100 people engaged in high quality welded aluminium fabrications. Products included Combat Support Boats for M.o.D. and U.S. government, also a wide range of industrial products. Experience gained in M.I.G., T.I.G., and pulsed M.I.G. welding and plasma arc cutting, also in M.o.D. quality control requirements and procedures.

Responsible for production planning and forecasting, capital expenditure, manning levels, productivity, training, safety, and achievement of production targets. Reporting to the Managing Director.

CAPROCO (Edmonton, Alberta, Canada) 1977 to 1978

Senior Engineer

Kuwait Oil Company; Supervision of installation of impressed current cathodic protection systems on the Gas Gathering Pipeline Complex.

Aramco; Audit survey of all corrosion prevention systems on buried pipelines throughout the Eastern Province of Saudi Arabia, following two major fire incidents caused by pipeline failures.

A. E. FREEZER & CO LTD 1974 to 1977

Director

Design and manufacture of workboats and engineering structures in aluminium alloys and stainless steels for clients in the oil exploration and general marine business and for the Ministry of Defence.

MORGAN BERKELEY & CO LTD 1969 to 1974

Technical Director

Research and development of new impressed current equipment for the cathodic protection of ships, jetties, pipelines, steam turbine cooling water systems, chemical process plant, and the installation and commissioning of such equipment. Detail design of electronic controlled thyristor and triac power controllers for impressed current systems and electrochemical applications and detail design of inverters. Mechanical and electrical design of air cooled and oil cooled transformer rectifier units. Design of sacrificial anode systems for oil and gas platforms, underwater pipelines, floating docks and marine tankage. Design of monitoring and alarm facilities for corrosion potentials on offshore structures. Design of electronic equipment for automatic controlled rectifier power impressed systems. Mechanical and electrical design of flameproof rectifier equipment and cable systems for oil jetty protection. Design of anodes, reference electrodes and half cells.

Supervision and management of field engineering service and commissioning department.

STORNO LTD. 1968 to 1969

Systems Engineer

Design and installation of VHF and UHF radio communication systems.

ELLIOTT AUTOMATION (SPACE AND WEAPONS RESEARCH LABORATORY) 1967 to 1968

Project Engineer

Electronic circuit design for various space and defence research projects.

ALLEN WEST & CO LTD 1962 to 1967

Student Apprentice

Five (5) year course including pre and post university years spent working in all departments of Allen West's switchgear manufacturing factory, including training in sheet-metalwork, welding, machining, electrical assembly and laboratory development work.

Details of work since 1998.

Date of Kick-Off/ continuing	Client	Ultimate Client, facility	Brief Description of Work
Jan-98	SASP UK Ltd. (ENI Group)	Amoco	Preliminary engineering for CATS 2 expansion project. Materials selection, corrosion protection, coatings.
Jan-98	SASP UK Ltd. (ENI Group)	Agip	Bonaccia development. Pipeline corrosion protection design.
Jan-98	Granherne Ltd	Mossgas	E-M Field Development, materials selection and corrosion protection design. Topsides and pipeline materials, pipeline internal corrosion control and monitoring.
Jan-98	Granherne Ltd	BP/Sonarco	In-Salah gas development. Flowline and pipeline materials selection, high CO2 wet gas field, 13 chrome vs carbon steel decision studies.
Jan-98	European Marine Contractors Ltd.	Shell	Shell Galleon II Pipeline cathodic protection design, coatings consultancy
Jan-98	Mott MacDonald	QGPC	Cathodic protection design for subsea pipelines.
Jan-98	Intec	Gazprom	Basic Engineering, Blue Stream (Black Sea crossing deepwater 2150m) pipeline materials and corrosion protection systems design. Specify, supervise and evaluate offshore corrosion test program.
Feb-98	Andrew Palmer & Associates	Shell	Ketch & Corvette, pipeline attenuation study.
Feb-98	Andrew Palmer & Associates	Ammerada Hess	West Guillimott, formulate the CP design basis
Feb-98	Granherne	Brass Petroleum	Brass (Nigeria) offshore pipelines, all materials selection, internal and external corrosion protection systems design.
Feb-98	Brown & Root UK Ltd	Norsk Hydro	Troll Gas Pipeline, cathodic protection and coatings design. Support through procurement and installation.
Feb-98	SASP	Statoil	Europipe Nybro Tee subsea structure CP and coatings detail design.
Feb-98	SASP		Marmara Sea crossing pipeline preliminary design, materials selection, cp systems design
Feb-98	Borealis Consultants	Talisman	Grant Development, internal corrosion/inhibition assessment. Corrosion resistant alloy materials selection for valves.
Feb-98	CSOL Norge	Saga Petroleum	Study on interaction between direct electric heating of subsea pipelines and cathodic protection.
Feb-98	European Marine Contractors	Shell	Detail design of CP system for pipeline initiation sheave.
Mar-98	Andrew Palmer & Associates	Shell	Bittern development internal corrosion analysis.
Mar-98	Andrew Palmer & Associates	Shell	Guillemot development cathodic protection of pipelines
Apr-98	SASP	CNOOCH	Pinghu (China offshore) oil and gas pipelines, operations manual, corrosion control section.
Apr-98	SASP	Mobil	Zafiro development, materials selection, internal and external corrosion analysis and design.
Apr-98	Intec	Gazprom	2 week offshore survey in Black Sea. Deep sour water CP testing.
May-98	Borealis	Amerada Hess	Hudson pipeline attenuation study, water injection pipeline internal corrosion calculations.
May-98	Granherne		Rosetta topsides internal corrosion analysis.

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Jun-98	Andrew Palmer Associates	Amerada Hess	Scott subsea oil pipeline failure. Provide assessment of failure analysis reports commissioned by Amerada Hess from corrosion laboratories.
Jun-98	SASP/Saipem	Texaco	Captain development, outline CP designs for jacket bids.
Jun-98	DUCO	Kerr McGee	Gryphon FPSO umbilical terminations materials selection and cathodic protection analysis.
Jun-98	DUCO	DUCO	Review The Welding Institute failure analysis report on split subsea hose fitting.
Jun-98	Borealis	Talisman	Grant/Ellon Development, assess dead-leg corrosion hazard.
Jun-98	Granherne		Oil cuttings pipeline internal abrasion and corrosion studies.
Jul-98	Intec	Gazprom	2 week offshore survey in Black sea (senior company rep. In charge).
Aug-98	DUCO	DUCO	Assess corrosion protection requirements for hot super duplex umbilical.
Aug-98	Borealis	Talisman	Buchan redevelopment materials assessment
Sep-98	Granherne	Anadarco	Process corrosion calculations and materials selection
Sep-98	SASP	Saga Petroleum	Snorre II Pipeline. All materials selection and corrosion coatings and cathodic protection for detail design and construction.
Sep-98	Amerada Hess	Amerada Hess	Flora development materials selection. Mediate in disagreements between AHL and Bluewater Developments on corrosion allowance decisions.
Oct-98	Granherne	Kerr McGee	Pilgrim, technical note on internal corrosion and sour gas problems.
Oct-98	Granherne	Total/Sonatrach	Quobba field development, process materials selection report, inhibitor availability and track record study (high salt high CO2 very low pH oilfield). Also complete flowline and export pipelines materials selection and corrosion control systems design.
Oct-98	SASP	Saibos/Mossgas	Detailed design engineering support to Saibos, (installation contractor for E-M development project).
Nov-98	DUCO	DUCO	Carry out one day training/seminar for DUCO engineers on materials selection and cathodic protection as applied to subsea umbilicals.
Dec-98	Granherne	Elf	Amenam Kpono, materials selection and all corrosion protection engineering for offshore development including process platform topsides and subsea pipelines.
Jan-99	Granherne	Monument oil	Land pipelines materials engineering, Burun (former USSR.)
Jan-99	Andrew Palmer Associates	Shell	Rosetta riser cathodic protection
Jan-99	SASP	Soekor	Insulated subsea pipeline and offshore structure
Jan-99	Granherne	British Gas Isle of Grain	Advise on materials selection, re-vamp of process, knock out pot in high CO2 service.
Jan-99	Granherne	Exxon	Hibernia job, materials for heat exchangers
Jan-99	CREA Consultants	UK Government agency	Prepare technical note on pressure vessel and piping materials.
Feb-99	DUCO	Brazil subsidiary	Advise on materials for flexible pipe construction.
Feb-99	SASP	Sumed	Cathodic protection system proposal for internal protection of de-ballasting pipelines.
Feb-99	Andrew Palmer Associates	Elf	Claymore water injection pipelines report
Mar-99	SASP	Sonsub/EMC/Saga	Subsea tie-in skid corrosion protection design.

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Mar-99	SASP	Elf Petroland	GRP riser coating details
Mar-99	Borealis Consultants		CP design for Buchan template pipe spools.
Mar-99	Granherne	Mossgas	Visit Confab pipe fabrication plant in Brazil to negotiate acceptable coating procedures.
Apr-99	Granherne	Phillips	Jade high temp pipeline materials, bid support.
Apr-99	Coflexip Stena Australia	Esso	Review Blackback cathodic protection problems, (arbitration)
Apr-99	Stolt Comex Seaway	Talisman	Review third party's pipeline CP report, provide technical justification of design parameters.
May-99	DUCO	DUCO	Advise on materials for gas lift jumper termination. Kuito Project
May-99	Borealis Consultants	Amerada Hess	Triton Project, response to A. Hess queries.
May-99	DUCO	Terranova Alliance	Materials selection and cathodic protection design report for umbilical systems for FPSO
May-99	Sage / SeaSteel	Sage / SeaSteel	Corrosion protection design for offshore wind turbine foundation pile.
Jun-99	Saipem	Snam/Gazprom	Review corrosion control design data in Milan offices and provide ongoing support
Jun-99	SASP	Wintershall	Produce write-up on coatings and external corrosion protection. Review Field Joint Coating Spec. Advise on use of 13 Cr materials.
Jul-99	Borealis Consultants	BP/Amoco	Review BP Miller pipeline system integrity reports
Aug-99	Granherne	Phillips	Jade bid support. Cathodic protection designs for jacket bids.
Aug-99	Mott MacDonald (Manchester)	Elf	Advise on land cathodic protection interference, Silk Pipeline.
Sep-99	Borealis Consultants	CACT Operators Group	Materials selection and internal corrosion control design, offshore operations, China.
Sep-99	SASP	Saga/Sonsub	SBV skid CP design and materials selection.
Oct-99	Sonsub (SASP)	Statoil	Norne Heidrun subsea pipeline tie-in structures and tees, cathodic protection and coatings design, materials selection, internal corrosion control.
Nov-99	Saibos (Paris) (SASP)	Shell	Bonga subsea oilfield development off Nigeria, bid support. Materials selection, cathodic protection, subsea oilfield, pipelines, FPSO, mooring systems.
Nov-99	Stolt Comex Seaway	Maersk	Halfdan development pipelines cathodic protection detail design.
Dec-99	NKT Flexibles (Dk)	NKT Flexibles (Dk)	Provide report and corrosion control design for flexible pipelines for offshore applications and FPSO connections. (Girassol Project)
Jan-00	Andrew Palmer Associates	BP/Amococ	South Everest, J-tube and pipeline corrosion protection concepts and detailed design.
Jan-00	SASP	Petrobras	Roncador bid engineering. Materials selection for high CO2 (8%) production pipelines and water injection pipelines. Anti-corrosion coating and insulation coating selection and bid evaluations, CP philosophy and design for super 13 chrome pipelines.
Jan-00	SASP	Elf Libya	Material selection for 3 km pipeline - produced oil from the 137 B field to the FPSO. Some H2S, very high CO2 (37% in associated gas), other factors allowed carbon steel to be selected.
Jan-00	SASP	Rasgas Expansion	Feed engineering - materials selection for wet and dry gas options, (previous almost identical project used internal alloy 825 clad pipe for the wet sour high CO2 gas. Carbon steel plus internal corrosion control measures to be used for wet gas in Expansion project.

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Jan-00	Wood Group	Statoil	Materials engineering and CP design for Snorre 2 barrier valve.
Feb-00	Sasp/Saipem		Bid support, CP design for insulated 6" pipeline, Spain.
Feb-00	Sasp	Exxon, Angola	Block A-15 bid support. Internal corrosion rate calculations for production, gas and liquids, and water injection flowlines and pipelines for deep water development off Angola. Also external coatings and CP design.
Mar-00	Boreas Consultants	BP/Amoco, Gael	Internal corrosion review, Liquids Export Pipeline System to Forties Unity
Mar-00	Intec	NIOC (Shell)	Soroosh and Nowrooz development. Subsea pipelines internal corrosion calculations (wall thickness allowance) and materials selection for production, gas and water injection pipelines. Also external coatings and CP.
Mar-00	Boreas Consultants	Buchan	CP review.
Mar-00	Sasp/Saipem	Jamnagar (India)	Evaluate cathodic protection problems on jetty to plant facility pipelines.
May-00	Granherne	In-Amenas	Land pipeline gathering system. Cathodic protection design.
May-00	Sasp	Elf Canyon Express	Bid support. Materials selection and CP design for deepwater mexican Gulf project.
Jun-00	SASP	Espoir pipeline	CP and coatings detailed design.
Jun-00	Granherne	Britannia (Conoco)	Advise on coatings problems and cathodic protection anomalies encountered during construction of new phase.
Jul-00	Boreas Consultants	BP Hoton	Internal corrosion/ materials selection study.
Jul-00	SASP	Rasgas, WH4 elimination	Coatings evaluation.
Jul-00	Boreas Consultants	Rhum/Harding	High level internal corrosion/ materials selection study. Cost estimates for CRA options.
Aug-00	SASP	Hannay (Talsiman)	Internal corrosion report
Aug-00	Granherne	South Pars	Review corrosion control aspects of Master Development Plan document.
Aug-00	Boreas Consultants	Forties Pipeline System	Internal corrosion study related to maximum allowed contaminants (water, H2S, CO2 etc.) specification.
Sep-00	Granherne	In Salah Gas	Review CP philosophy (including for super 13 chrome buried land pipelines).
Oct-00	SASP	Elf Canyon Exp SMDL	Detail design of SMDL pipeline. Corrosion allowance determination for X-80 material, coatings specification, CP design, procurement and installation support.
Nov-00	Boreas Consultants	Glenelg	Materials assessment
Dec-00	Sasp	Kizomba	Design competition support. CP design.
Jan-01	Sasp (Sonsub Clough)	Elf Canyon Exp Production	Detail design of CP and coatings systems for flowline sleds and foundations.
Jan-01	European Marine Contractors	Talisman	Beatrice replacement 16" pipeline bid support, evaluation of client CP requirements.
Jan-01	SASP	Foukanda	CP Design for new riser support structures on Kitina platform.
Jan-01	Sasp (Sonsub Clough)	Elf Canyon Exp Production	CP and coatings design plus internal corrosion assessment for Single Methanol Distribution pipeline
Feb-01	Saipem UK (Sasp)	NC41 Jacket (Libya)	CP design concept and detail design for lightweight jacket concept.
Feb-01	Kerr McGee	Leadon FPSO	Firewater ring main corrosion investigation. Design of cathodic protection system.

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Mar-01	Boreas Consultants	BP Fibre Optic Cable	Corrosion control advise for installation aid conduit.
Mar-01	Sonsub	Beluga trenching vehicle	Cathodic protection design for trenching machine/vehicle for Blue Stream Black Sea Crossing project.
Apr-01	Sasp	Sanha condensate field	Internal corrosion/materials selection report.
Apr-01	Saipem Energy	Maersk Halfdan bid	Jacket Cathodic Protection and Coatings designs.
Apr-01	Sasp	Ormen Lange	Cathodic protection design for J-Lay pipeline (S-7000 barge)
May-01	European Marine Contractors	Vesteled Tee	Catthodic protection design.
May-01	Boreas Consultants	Talisman	Internal corrosion assessment for 3" gas lift pipeline
May-01	Sasp	NC41 pipelines	Review FEED designs. Carry out CP design work for 4" pipeline.
May-01	Sasp Carina	Carina	Pipeline materials selection, coatings and CP designs.
May-01	Boreas Consultants	Chevron Alba Extreme South	Sour service limits advice and materials selection.
May-01	Boreas Consultants	Amerada Hess	Proposals for developing a Company (Hess) corrosion control general philosophy.
May-01	Granherne	Hibernia A Block	Pipeline internal corrosion report, cathodic protection design, materials and insulation coatings selection
Jun-01	Sasp	Erha	Internal corrosion assessment, coating selections cathodic protection designs.
Jun-01	Petrofac		Materials selection advice for Khuff gas land processing facility extensions.
Jul-01	Boreas Consultants	West Brae, Marathon	Advise on excessive anode consumption, CP data search. Check on gas line CP design and anode resistance.
Jul-01	Energy and Power Consultants	Kerr McGee, Leadon	Expert witness for claim considered by KMG against Mitsuit relating to fitness for purpose of fire system materials
Aug-01	Sasp	Deep Panuke FEED	Pipelines and jackets. Pipeline materials selection report, CP and coatings specifications and reports
Aug-01	Sasp	Burling ton	Review corrosion control documentation
Aug-01	Boreas Consultants	Kildrummy	Review pipeline designer's materials selection report and calculations.
Sep-01	Saipem Energy	Neptunus K2 Jacket (NAM)	Jacket CP design to Shell/NAM DEP.
Sep-01	Sasp	Kizomba	Review cathodic protection spec.
Sep-01	Boreas Consultants	BP/Amoco Rhum	Materials selection re-evaluation considering revised field/production data.
Sep-01	European Marine Contractors	Shell Penguin Pipelines	Review design contractor's cathodic protection designs and calculations. Provide revised optimised designs conforming to Shell DEP.
Oct-01	Petrofac UK	Lundin	Internal corrosion and produced water scaling calculations.
Oct-01	Saipem UK/Buoygues Offshore	Kizomba, Exxon Mobil	Detail design. Development of cathodic protection philosophy
Oct-01	Petrofac UK	Shapkino	Materials selection for pipelines and process facilities. Assessment of suitability of non-metallics for flowlines.
Nov-01	Boreas Consultants	Scoter Field	Advise on suitability of 13 Cr materials for pipeline.

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Dec-01	Saipem UK	NC-41 Development	Pipeline thermal insulation studies.
Jan-02	Saipem UK	Conoco Viscount	Bid support engineering for EMC, CP design, coatings proposals.
Jan-02	Petrofac UK	Anaran	Process materials selection
Jan-02	Petrofac International	Dorood, Total/Fina/Elf	Materials selection for process facilities. EPC contract.
Feb-02	Saipem UK	Kizomba, Exxon/Mobil	Lump sum flowline CP detail design
Feb-02	Petrofac UK	Palmyra	Gas process plant materials selection report
Mar-02	European Marine Contractors	Clyde	CP design for inline tee and valve on pipeline. Review existing designs and anode performance.
Mar-02	European Marine Contractors	Grane, Norsk Hydro	Pipeline CP design review.
Mar-02	Petrofac UK	Saih Nihayda gas plant	Materials selection report
Apr-02	Petrofac UK	Shell Bonny Oil	Materials selection report for oil separation and gas compression.
Apr-02	Petrofac UK	Atlantis	Umm Al Quwain Gas Plant - review materials selections.
May-02	Saipem UK	SKIRME BYGGVE BID -	Protection Structure Cathodic Protection job 2458829 WBS code 1B06B10045.
May-02	Saipem UK	Mobil East Areas bid	Review specifications, CP designs for structures and pipelines.
May-02	Boreas Consultants	JIP	Plastic line pipe anti-corrosion concepts development
Jun-02	Saipem UK	Deep Panuke Feed	Sasp Deep Panuke Feed - Pipelines , spec.s, CP design.
Jul-02	Saipem UK	Shell	Shell Goldeneye, review conceptual design, CP & Coatings design
Jul-02	Saipem UK	BP	BP Clair Template CP and Coatings
Jul-02	Petrofac		Alagoas Gas Plant Materials Review
Jul-02	Boreas Consultants	Venture Production Co.	Boreas Consultants Sycamore Materials Review
Aug-02	Saipem UK	Conoco	Viscount subsea structures and pipelines detailed design, cathodic protection and coatings for EMC.
Aug-02	Saipem UK	NOC	NC 41 (offshore Libya) pipelines cathodic protection and coatings, detailed design.
Sep-02	OPE	Marathon Oil (Houston)	Alba Project, Super 12 chrome pipelines cathodic protection detailed design of controlled potential CP system. CP consultancy.
Sep-02	CSOL Duco		Sable umbilical pull head CP and materials consultancy.
Oct-02	Saipem UK	Exxon Mobil	Yoho project, jacket CP and coatings detail design. (5 jackets)
Oct-02	Saipem UK	Exxon Mobil	Yoho project, subsea pipelines CP and coatings detail design. (Insulated and conventional pipelines)
Nov-02	Boreas Consultants		Beaulieu Uprating Study
Dec-02	Saipem UK	Encana	Deep Panuke Wellhead Jacket CP design.
Jan-03	Boreas Consultants	TFE	Alwyn to Flags, internal corrosion study
Jan-03	EMC		Dong Nini/Cecilie
Jan-03	Intec BV	BP	Mardi Gas consultancy on pipeline anode detail design
Feb-03	Saipem UK	Encana	Sable Compression Jacket Job 245847, CTR SACP 201 (Bid engineering CP design checks.)
Feb-03	Boreas Consultants	MOUK	Marathon Braemar, review internal corrosion and materials selection for sour high pressure

Date of Kick-Off/ continuing	Client	Ultimate Client, facility	Brief Description of Work
			pipelines.
Feb-03	Petrofac		Materials selection, Darquain Oilfield Dev. Manifold.
Mar-03	Boreas Consultants	MOUK	Review materials report on Brae B to Miller link.
Mar-03	Boreas Consultants		Sleipner to CATS pipeline, advise on materials issues.
Mar-03	Energy and Power Consultants	Encana	Support Company in discussions with detailed designers, process materials selection issues.
Mar-03	Petrofac		Ras Lanuf tank farm proposal
Apr-03	Heerema	BP	Study on CP issues concerned with anode tapers installed to facilitate pipelay.
Jun-03	Saipem UK	Exxon/Mobil	East Area Project, detail design, pipeline CP, Coatings.
Jun-03	Boreas Consultants	Shell	Review specifications, advise on corrosion/coating issues re. duplex subsea pipeline cooling spool.
Jul-03	Saipem UK	TFE	Dolphin project bid support, subsea pipeline materials selection, CP and coatings
Aug-03	Energy and Power Consultants	Tullow Oil	Interpret corrosion rate measurements for existing pipeline, advise on risks of changes in operation parameters.
Aug-03	Boreas Consultants	TFE	Review insulation spec. for Akpo.
Sep-03	Saipem UK	NOC	NC 41 pipeline decommissioning study
Oct-03	Saipem UK		Buzzard pipeline bid support.
Oct-03	Petrofac		In Amenas bid support.
Nov-03	Petrofac	Crescent Petroleum	Materials selection for amine and sulphur plant.
Nov-03	Duco		Husky White Rose, umbilical corrosion design report
Jan-04	Saipem UK		South Pars, CP designs for Phase 15/16 32" and 4"
Jan-04	Petrofac	Barca Gas Tunisia	Materials selection technical note, kick off meeting, Working. Preliminary corrosion calculations.
Jan-04	Petrofac		Flow Assurance project JU 03/396, advise on corrosion aspects of nitrogen injection.
Jan-04	Saipem UK	Exxon/Mobil	Yoho project Note on internal corrosion of flooded pipelines. PM/GL request
Feb-04	Boreas Consultants	Shell	Howe thermally insulated pipeline, review documents,
Feb-04	Petrofac	Total, Libya	Technical note on corrosion resistance of CRA materials at high temperature
Mar-04	Boreas Consultants	Boreas Consultants	Support on in-house studies and tests on plastic line pipeline technology
Mar-04	Saipem UK	TFE	Sasp Dolpin Feed Endorsement, detailed design start, review and check CP designs and materials selections.
Apr-04	Saipem UK	Saipem UK	Saipem Kvitbjorn Tie-ins, CP design for Wye structure, spreadsheet calculations
Apr-04	Saipem UK	Exxon/Mobil	Damage to Cable, review inspection reports, Assessment of corrosion consequences, design check for CP requirements.
Apr-04	Saipem UK		Akpo, internal protection study, Catenary pipelines
May-04	Saipem UK	Exxon/Mobil	East Area Design - Review of Vendor Doc.s
May-04	Petrofac		Rospan gas treatment facility Materials Selection spreadsheet

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Jun-04	Marathon Oil UK	Marathon Oil UK	Advice on internal protection for duplex heat exchangers
Jul-04	Saipem UK	Exxon/Mobil	Rosa service line CP.
Jul-04	Petrofac		Cavendish, review of ubstream metallurgy, resistance of 22Cr duplex to brine.
Jul-04	Petrofac	KOC	Review MR0175 2003 proposed materials changes
Aug-04	Saipem UK	Encana	Saipem Sable Compression Jacket , CP detailed design follow up (in Nova Scotia)
Sep-04	Petrofac		Anadarko EL Merk, gas process plant detail design, materials selection.
Oct-04	Saipem UK	TFE	Dolphin pipelines land cathodic protection detailed design.
Nov-04	Saipem UK	Encana	Buzzard detail design follow up, procurement support, coatings procedures reviews.
Dec-04	Saipem UK	Exon/Mobil	Sasp East Area projects, - Second Campaign Crossings. Verify CP designs.
Jan-05	Saipem UK	TFE	Support on Espoir project provide 5-layer pp coating tech details
Jan-05	Petrofac		In Amenan (write text for Ops/Maint man)
Mar-05	Saipem UK	Exon/Mobil	Sasp East area - Crossing 3.1 and 3.2 - Deign of CP and coatings for steel arches, study of alternative options.
May-05	Saipem UK		Rasgas 2 pipelines, CP an coatings design
May-05	Energy and Power Consultants		Write up and spreadsheet calculation on Berkhine corrosion issues
June/Oct	Saipem UK	TFE	Dolphin project. Continuing support on design and construction.
Nov-05	Saipem UK		Saipem Balgzand Bacton Pipeline (BBL) Project, review materials issues.
Dec-05	Saipem UK	Shell	Starling bid support, thermal insulation coatings calculations
Dec-05	Saipem UK		Olowi project. Direct heating technology review.
Jan-06	Duco	BP	S.E.C.U. - Corrosion Protection of Subsea Umbilicals and Interfaces, support through project, final report issued April
Jan-06	Saipem UK	TFE	Dunbar project. Advise on coatings and pipeline thermal insulation.
Jan-06	Saipem UK		Turkmenistan Block 1 Project, Coatings selection, thermal insulation design, cathodic protection design
Feb-06	Genesis	BG	Review corrosion engineering documents, Maria project. Carry out CP detail design for subsea structure and high temperature 25 Cr cooling spool.
Mar-06	Boreas Consultants		Kessog. Review design basis and corrosion calculations.
Apr-06	Boreas Consultants	Shell	Mergansa. Review of materials selection work and corrosion rate prediction calculations for high CO2 and organic acid production.
May-06	Boreas Consultants	BP	Block 18 Angola. Review CP design report.
Jun-06	Energy and Power,	Hess (Rhourde el Rouni)	Materials selection and corrosion control recommendations for the BIR EL MSANA (BMS) Surface Production Facilities
Jun-06	Genesis	Nexen	Ettrick project. CP and coatings design for subsea structures and pipeline facilities.
Jul-06	Boreas Consultants	Shell	Tweedsmuir. Review design report for CP for cooling spool, pipe in pipe type.

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Jul-06	Boreas Consultants	Shell	Starling. Review design report for CP for carrier pipe.
Jun-06	Genesis	BG	Miskar project. Coatings specification, TSA for high temperature super duplex pipe spools. CP consultancy on avoidance of HISC. CP detail design.
Aug-06	Boreas Consultants		Laggan. Internal corrosion rate calculations.
Sep-06	Boreas Consultants	Total Kazakhstan	Advise on CP options for 42 inch pipeline.
Nov-06	Genesis	BP Egypt	Tuart Project. Advise on 3-layer polypropylene coating, review supplier procedures. Carry out technical audit at coating plant in Port Said
Dec-06	KBR	Shell Australia	Cathodic protection design. North Rankin Jacket.
Jan-07	Genesis GATT Feed		Prepare coatings specifications
Jan-07	Mustang Eng	ATP Oil and Gas	Process materials selection
Mar-07	Saipem, Mafumeira	Cabinda Gulf Oil	Pipeline and riser coatings design and coatings materials selection. Includes vortex shedding strakes materials and design.
Mar-07	Boreas Consultants		Advise on corrosion rates for HTHP pipeline.
Apr-07	Genesis Wissey Development	Tullow Oil UK Ltd.	Pipeline cathodic protection and coatings design
Jun-07	Genesis Menzel Ledjmet East	Sonatrach/First Calgary Petroleums	Cathodic protection and coatings design for desert pipeline gathering system and export lines
Jul-07	Saipem Malongo, design	Chevron	Pipeline cathodic protection and coatings design
Jul-07	Saipem Mongstad		Review of CP requirements for pipeline routed through tunnel at landfall
Sep-07	Genesis Okwok	Oriental Energy/ADDAX	Review of design basis, design of pipeline CP and coatings systems
Oct-07	Boreas Consultants, Auk	Shell	Review of Auk pipeline corrosion protection requirements due to upward revision of temperature.
Nov-07	Saipem Akpo	Total	Advise on clamp lining materials and application issues.
Dec-07	Boreas Consultants CATS	BP Amoco	Review safe operating limits for CATS pipeline system.
Dec-07	Mustang Cheviot	ATP/Bluewater	New scope. Process materials selection for revised process system with new H and M B.
Jan-08	Saipem	Saipem Corporate	Develop formalised procedures for pipeline cathodic protection design.
Jan-08	Mustang Castor	Casgas offshore UTE	Review of paint specification.
Feb-08	Saipem Malongo, procurement	Chevron	Bid evaluations for field joint coatings contract, vendor meetings, attend works qualification trials etc.
Mar-08	Saipem	Statoil	Advise on strake materials and design, advise on super duplex bolting
Mar-08	Woodhill Okworri Gas Injection		Materials study for wellhead and tubing
April through June 08			Ongoing work on Rankin Jacket for KBR, Malongo pipeline for Saipem, Cheviot materials selection and protective coatings for Mustang, MLE project for Genesis.
July-08	Energy and Power	Encana	Buzzard PS, and P jackets. Review jacket CP designs.

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Sept-08	Boreas		West Breagh pipeline, internal corrosion predictions. Materials selection.
Sept/Oct-08	Saipem	Conoco	VTS project, review CP designs and anode designs.
Nov-08	Genesis		Antrim, causeway pipeline, thermal insulation coating system design.
Nov-08	Saipem	TFE	K5CU, check CP design and thermal insulation design calculations.
Dec-08	Genesis		Cygnus pipeline. Anode specification, coatings and CP design specifications.
Jan-09	Mustang Cheviot	ATP/Bluewater	Advise on caisson coating requirements
Jan-09	Saipem Malongo	Chevron	Technical support for jetty riser coating repair.
Jan-09	Boreas	Breagh pipeline	Internal corrosion, materials selection
Jan-09	Woodhill		Vacuum discharge column corrosion failure investigation, evaluation, recommendations.
Jan-09	Boreas		Advice on CP issues associated with 13 Cr pipelines
Feb-09 ongoing	KBR	Rankin 2 Jacket	CP design for box girders, support for biocide procurement and system installation, support for coatings issues
Feb-09	Woodhill	KOC	Tank 84 failure. Advice on effect on tank bottom CP system
Mar-09	Mustang	PDO	Advise on environmental limits for Super Duplex
Mar-09	Saipem	Urugua	Review comments on paint spec. Review supplier coatings proposals. Check Fab spec. requirements.
Apr-09	Saipem	Saipem	Work Instruction for CP design
Sep-09	Boreas	Deep Panuke	Caisson corrosion protection
Oct-09	Woodhill	West Delta	Corrosion management philosophy
Nov-09	Genesis		Long lead procurement support
Dec-09	Saipem	Laggan Togmore	Bid support, piggyback pipeline attachment design
Dec-09	Atkins Global	Falkirk Council, Helix Project	Cathodic Protection design for "Kelpie" (Pontoon supported sculpture)
Jan-10	Saipem	Total	Franklin West Jacket, cathodic protection design for various coating system options
Feb-10 ongoing	Genesis		Baird pipelines corrosion protection designs, coatings, CP.
Feb-10	Genesis		Oselvar pipeline, CP design to ISO 15589-2
Feb-10 ongoing	Genesis	BP	Clair pipelines, coatings specifications.
Feb-10	Atkins Boreas	Chevron	Support for direct electric heating for pipelines
Mar-10	Saipem	AOC	Review corrosion protection related specifications
Mar-10	Genesis		Breagh pipeline, cathodic protection design
Apr-10	Atkins Boreas	BP	Review Xodus pipeline coatings spec.s
May-10	Genesis	Hannibal 24" Pipeline	Insulation Joint bid reviews, followed through Nov with procurement support

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Jun-10	Saipem	Jasmine pipeline	Review documents and advise re. thermal insulation coatings.
Jul-10	Saipem	Nordstream	Advise re valve and pipeline materials, valve painting, CP for subsea equipt.
Aug-10	Saipem	Shtokman	Thermal insulation requirement calculations.
Aug-10	Boreas	Auk-Fulmar	CP and coatings design work.
Sept-10	Genesis	Oselvar	Review client input re design temperature
Nov-10	Genesis	BG	Review of standards on risers
Nov-10	Genesis	Clipper South	Review of coatings spec. and supplier clarifications. Detailed design of CP.
Dec-10	Genesis	Breagh	Review 3 rd part CP design (by JPK)
Jan -11	Saipem	Nordstream	Ongoing support with materials. CP and coatings issues.
Jan-11	Genesis	Islay	CP concept change advice
Feb-11	Genesis	Clipper South	Completed detailed design of CP.
Mar-11	Genesis	CNOOC PY34/35	5 pipelines plus associated subsea structures, CP design and anode MTO
Mar-11	Saipem	Nordstream	Review of paint procedure for aluminium actuators
May-11	Lankhorst	Lankhorst	Report on CP shielding and pipeline coatings
May -11	Genesis	Valiant Causeway	Review 5 layer coating spec.
Jun-11	Saipem	York	CP and coatings support, pipeline and shore tunnel.
Jul-11	Saipem	Katy	CP and coatings design and support
Jul-11	Saipem	K4Z	Pipelines and spools, CP and coatings report
Jul-11	Atkins	Shell Brent	Pipeline abandonment, corrosion support
Sept-11	Saipem	K4Z, Total	Structure CP design
Nov-11	Atkins	Wind turbine	Support re internal corrosion issues
Jan-12	Saipem	Katy and Kelvin, Conoco Phillips	Procurement support, anodes for pipelines and structures. Coatings and subsea pipeline mechanical accessories design.
Mar-12	Saipem	Iona Kells	CP design and cost estimates for pipeline and 2 subsea structures
Apr-12	Atkins	Premier Oil Solan Tank	External CP design
May-12	Atkins	Premier Oil pipeline CP queries	Reviews of subsea CP survey reports
Jun-12	Energy and Power	Bangora Compression Package	Materials selection report
Jul-12	Energy and Power	Bangora Compression Package	Carry out CO2 corrosion rate calculations for specific items.
Jul-12	Atkins	Premier Oil Solan Tank	Internal CP design
Aug-12	Atkins	Premier Oil, Solan Tank	Coatings Specification, CP Monitoring System TN.
Sep-12	Atkins	Galley pipeline	Review subsea survey data and associated CP design data
Oct-12	Energy and Power	Bangora Compression Package	Support to E&P to answer Client queries re scrubber drain materials
Nov-12	Atkins	Dong Siri, Acergy	Support on materials, coatings and CP issues

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Jan-13	Atkins	Premier Oil, Solan Tank	Project support through fabrication, continued all year. Procurement assistance, site queries, etc.
May-13	Atkins	Gabbard wind turbine	Advice re. corrosion protection measures.
Jun-13	Atkins	Laggan pipeline	CPDesign, advice re HISC issues.
July-12	Saipem	Edradour	Thermal insulation u-value calculations advice
Aug-13	Atkins	Premier Oil, Solan Tank	Chemical Treatment (Biocide) Specification
Oct-13	Atkins	Galloper	Foundation Design, review CP design for monopole wind generator
Jan-14	Atkins	Premier Oil, Solan Tank	Continuing engineering support through fabrication and installation
Apr-14	Atkins	Dudgeon wind farm	Internal and External CP and coatings designs, FEED progressing through 2015 (to date) with detailed design and engineering support.
Jun-14	Atkins	Dong Siri repair	Materials selection, CP and coatings consultancy.
Aug-14	Atkins	ADMA-OPCO barges	Advise on corrosion problems inside legs.
Nov-14	Atkins	Premier Oil	Analysis on cause and consequences of premature wastage of pipeline anodes.
Jan-15	Atkins	Beatrice Wind Farm	CP design and coatings specification work for numerous jacket support structures
Mar-15	Atkins	BP	Turkey Wax Handling Unit (WHU) - Heating Exchanger Investigation
Jun-15	Atkins	BP Baku pipelines	Advise on inspection activities for buried sections.
Jun-15	Atkins	GDF Suez Wind Energy	Corrosion protection options for alternative support structure types.
Jul-15	Atkins	BP AGT Jetty and pipelines	Advise on assorted corrosion issues and improvement projects.
Nov-15	Atkins	New Alba Pipeline	Preliminary materials selection study.
Jan -16	Glencore (Petrochad)	Mangara facilities	Shutdown/mothballing study.
Feb-16	Atkins	Kuwait Oil Co	Schlumberger, sour process facility materials selection.
April-16	Atkins	Kuwait Oil Co	Al-Khafji corrosion risk study
April -16	Glencore (Petrochad)	Mangara -Badila pipelines	CO2 corrosion study.
June - 16	Atkins	Beatrice wind farm	Corrosion protection design for substructures
Aug - 16	Atkins	Lexen (Canada)	Advice re pipeline failures.
Oct - 16	Atkins	BP AGT	Corrosion management of pigging sump tank
Nov -16	Glencore (Petrochad)	Mangara facilities	Review coating specification.
Dec -16	Glencore (Petrochad)	Mangara - Badila pipelines	Water injection pipeline coating procedures
Feb - 17	Atkins	BP AGT project	Wax Handling Unit (heat exchanger corrosion)
Mar - 17	Glencore (Petrochad)	Mangara facilities	Review new specifications.
Mar - 17	Atkins	BP AGT	Hot Oil Surge Drum Corrosion. Options for materials/operational changes.
Apr - 17	Atkins	KOWL	Kincardine Offshore Wind Farm, Corrosion protection design advice re. protection of concrete substructure.
May - 17	Atkins	Sonagol	Sonagol Tank Farm, Angola. Advice on preservation of new unused facilities.

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Jul - 17	Glencore	Mangara - Badila pipelines	Review pipeline CP procurement documents
Sep/Nov - 17	Glencore	New Badila gas inj. pipeline	CO2 corrosion rate prediction. Materials selection review for process facilities and pipeline.
Dec 17/April 18	Atkins	Beatrice offshore wind	Advise on investigation into premature protective coating wear at boat landings.
Dec 17	Atkins	BP AGT	Closed drains corrosion investigation.
Jan 18	Atkins	Premier Oil Solan Tank	Advise re CP monitoring measurements and anode consumption rate.
Jan-June 18	Glencore (Petrochad)	Mangara - Badila pipelines, new process facilities.	Cathodic protection systems design and design reviews. Coating specification work. Materials selection support.
Aug 18	Glencore (Petrochad)	Mangara - Badila pipelines, new process facilities.	Review materials conformity for WI pipeline CP system
Oct-Dec18	Glencore (Petrochad)	Mangara - Badila pipelines	Assist with design/construction for Gas Injection pipeline CP system
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