RCEA
(SUSSEX)

An Association for Retired Professional Engineers

NEWSLETTER August 2017

President's Message

Welcome to the August Newsletter. It is a 'bumper edition' as we have a more reports than usual. We have a comprehensive report on the Thameslink project from the talk last December and a report on the Buccaneer talk at our extra meeting held in April. Please consider receiving your newsletter by email rather than hard copy not only will it reduce our costs (printing and postage) but you will be able to view many of the photos and drawings in full colour.

We are approaching another year for the RCEA with our AGM and Talk on 19th September. I hope to see as many of you as possible there and at the talks during the autumn and spring.

Following a discussion at an earlier committee meeting when we talked about our Christmas lunch, we decided to go to the Windsor Hotel again but would opt for an earlier date in December (6th) before things get hectic nearer to Christmas.

We had some disappointments with our summer outings and visits. The visit to the Ford Technical Centre had to be postponed at the request of Ford. It has been rearranged for Wednesday 27th September. The visit to the Brighton Football Stadium had to be postponed because of building work following the Albion's promotion to the Premier Division.

Derek Webb

PROGRAMME OF EVENTS 2017 - 18

Thursday	**31st August**	**Coffee – with Partners at Swallow's Return**
Tuesday	**19th September**	**AGM and Talk – 'Working on the Construction of Britain's Motorways 1960-1990'**
Thursday	**21st September**	**Coffee – at Spotted Cow, Angmering**
Wednesday	**27th September**	**Visit – Ford Technical Centre, Dunton, Essex (postponed from 8th June) Fully Booked.**
Thursday	**28th September**	**Coffee – with Partners at Swallow's Return**
Tuesday	**10th October**	**Talk – The coast of West Sussex – Past, Present and Future**
Thursday	**19thOctober**	**Coffee – at Spotted Cow, Angmering**
Thursday	**26th October**	**Coffee – with Partners at Swallow's Return**
Tuesday	**14th November**	**Cooch Memorial Lecture – Don't buy an electric car!'**

Thursday	**16th November**	**Coffee – at Spotted Cow, Angmering**
Thursday	**30th November**	**Coffee – with Partners at Swallow's Return**
Wednesday	**6th December**	**Christmas lunch at Windsor Hotel, Worthing**
Tuesday	**12th December**	**Talk – Operation Chastise. No 617 Squadron, The Dambusters**
Thursday	**21st December**	**Coffee – at Spotted Cow, Angmering**
Thursday	**28th December**	**Coffee – with Partners at Swallow's Return**

2018

Tuesday	**9th January**	**Talk - Steel – from Bessemer to today**
Thursday	**18th January**	**Coffee – at Spotted Cow, Angmering**
Thursday	**25th January**	**Coffee – with Partners at Swallow's Return**
Thursday	**15th February**	**Coffee – at Spotted Cow, Angmering**
Thursday	**22nd February**	**Coffee – with Partners at Swallow's Return**
Thursday	**15th March**	**Coffee – at Spotted Cow, Angmering**
Thursday	**29th March**	**Coffee – with Partners at Swallow's Return**

All Talks and Meetings will commence at 2.30 pm and be held in the Chichester Room, Field Place, Worthing unless another venue or time is indicated.
Timings for visits and outings will be as printed in the detailed description of the activity.
Coffee mornings commence at 10.30 am.

Membership Subscriptions 2017/2018

These are due on 1st October 2017. Please send your cheque for £15 to the Hon. Treasurer,
Tony Tomkins, 2 Badger Drive, Haywards Heath, RH16 1EP
(Reply slip at end of newsletter.)

Website of the RCEA

Our website, **www.rceasussex.org.uk** carries the very latest information on all our events. As we occasionally have to make last minute changes to our programme due to matters beyond our control, we recommend that you always consult our website.

New Members and Speakers for Talks

The RCEA needs new members to ensure that we can continue as a thriving organisation. Please think of appropriate people you know and encourage them to come along to our talks and hopefully join the RCEA.
We also need more members to give talks to us on Tuesday afternoons from September to March. We are aware that many members have the knowledge from their working careers to provide interesting talks. If you are willing to give a talk please let us know. Speakers from outside organisations are increasingly harder to find and often seek payment for their services.

New Handbook

A new handbook is being prepared and it would be helpful if you let Malcolm Hind malcolmhind@msn.com know if you have any changes to your address, telephone number, etc. In particular if you have a new email address, as we now send out news updates and reminders of all our forthcoming meetings via e mail.

New Members

W.E Gallagher, BSc, C.Eng, MICE, FCIHT

R.G.Thomas, Mech.Eng. Technicians – Part 1and II

G.D.Virrels, C.Eng, MICE, MAPM

RCEA Insurance

Members need to be aware that the insurance policy that the Association holds is solely for the protection for the assets and liabilities for the Association as an entity. The policy does not provide cover for personal injury or loss to individual members. Members attend the Association's events at their own risk; although under some circumstances there may be some cover from the insurance arrangements of the venue owner.

Southern Retired Chartered Engineers (SRCE)

We have received the following programme information from the SRCE. Members wishing to attend any of these events should contact the SRCE secretary Jeff Williams on 02380 897078 or e-mail jagwilliams@waitrose.com.

24th August – visit to Bovington tank museum.
14th Sept – visit to Weald and Downland open air museum.
4th October – AGM to be held at Emsworth. Details are awaited.
10th October - last chance to visit Farnborough airport to see how the other half live! Details are awaited.

Brief Detail – Talks, Outings and other activities September 2017 – January 2018

AGM and Talk
Tuesday 19th September – "Working on the Construction of Britain's Motorways 1960- 1990"
Frank Duggan RCEA

The talk will describe Frank's experience of design and construction of motorways from 1963 to 1990. It will cover interesting aspects of his time as a Site Engineer, from the construction of Brent Cross Flyover in North London; design engineer on the M4 in South Wales; Contractor's Agent on the construction of London Bridge, sections of the M1 and M11 motorways; the A30, A470, and A6; to Project Manager on the construction of the M25/M40 Interchange. In addition to the technical aspects of the work, reference will be made to construction failures, the delays caused by environmental lobbyists, the oil crisis, 3 day week, and union unrest; and how the industry is now moving away from heavy construction to computer controlled 'smart motorways'.

Talk
Tuesday 10th October – The Coast of West Sussex – Past, Present and Future
Dr Uwe Dornbusch – Senior Specialist for the Coast at the Environment Agency

The talk will give an introduction into past, present and future issues faced by the coast, illustrated with examples from West Sussex. The later part will provide a critical perspective on what sea level rise will mean for the future of shingle beaches that provide the primary coastal defence along most of Southeast England. Is there a future for shingle beaches and what will they have to look like, or is the future one *"with only the sea breeze to enjoy from the concrete promenade"?* The speaker has published over 30 papers on the subject.

Talk
Tuesday 14th November – Cooch Memorial lecture: Don't buy an electric car!
Profs Averil MacDonald and Alun Vaughan, Southampton University

Everyone seems to think that electric cars are an excellent way to reduce pollution and our reliance on fossil fuels. But it's not that simple. Averil will explain the serious difficulties and threats that electric cars could bring, and consider the choices and life style changes that we will all have to adopt to move to a totally green electric world while Alun will describe the huge technological challenges in generating and transmitting the electricity we will demand and the current research being undertaken to achieve this.
Please note that this meeting will be held in **the Barn** as we expect a good attendance.

Christmas Lunch
Wednesday 6th December 2017

RCEA Christmas Lunch, Windsor Hotel, Windsor Road, Worthing BN11 2LX.

The menu is as below and early booking is advised due to the limit on numbers catered for.
Applications should be received by **Friday 1st December 2017** to ensure places. The cost this year is **£29 per person.**
Reply Slip is at the end of Newsletter.

'Resident' parking tickets can be obtained from reception if hotel car park is full.
Handicap parking can be arranged by including car registration number with booking application.

MENU

Carrot, Coriander and Ginger Soup with croutons
Ham Hock Terrine with a Piccalilli and Watercress salad
Prawn, Chilli and Tomato Bruschetta with a herb leaf salad
Brie, Caramelised Onion and Rosemary Tart with a warm Cranberry dressing

Breast of Turkey, lemon and sage stuffing (bacon wrapped) and Cumberland Sausage
Slow braised Lamb Steak set on Red Cabbage with Redcurrant and Port Jelly
Mushroom and Butternut Squash Wellington served with roasted vegetable gravy
Baked Salmon Fillet with a Pesto crust and Basil cream sauce

Christmas pudding served with brandy sauce
Tiramisu
Chocolate and Salted Caramel Torte
Trio of British Cheese with celery, grapes, chutney and a selection of biscuits.

Coffee and Mints

Talk
Tuesday 12th December – 'Operation Chastise', No 617 Squadron, The Dambusters
Dudley Hooley, Director, Tangmere Military Aviation Museum.

The story of the genius of Barnes Wallis and the skill and heroism of Wing Commander Guy Gibson VC and the men of No 617 Squadron given the task of attacking three major dams that contributed water and power to the Ruhr industrial region in Germany; the Mohne, Eder and Sorpe, in an operation code named 'Operation Chastise'.

Talk:
Tuesday 9th January - Steel – from Bessemer to today
Dr Tim Smith, Consulting Editor, Steel and Aluminium

In 2016, 1.62 billion tonnes of steel were made worldwide of which half was made in China.
Quality of product and efficiency in production has rapidly improved there largely thanks to the adoption of western supplied technologies.
Nearly three-quarters (74.2%) of steel today is made in the basic oxygen converter (BOC), the remainder mainly in electric arc furnaces. The BOC is an evolution of the Bessemer process introduced in 1856. In the BOC, pure oxygen is blown into molten blast furnace iron at supersonic speed to reduce the carbon content from 4.3% to near zero. The same principle was applied by Bessemer but he did not have tonnage oxygen or supersonic lances so blew air through the base of the vessel which caused porosity in the steel because of its high nitrogen content. With help and perseverance, this, and other problems, were overcome.
The talk will follow the development of steelmaking into the 21st century.

Talk
Tuesday 13 February

To be advised

Talk
Tuesday 13 March)

To be advised

Reports

Talk
Tuesday 13th December 2016 – The Thameslink Project – Electrical Challenges

M Sigrist MSc, BSc(Hons), CEng, MIET
Principal Design Engineer, Thameslink Programme, Network Rail,

The Thameslink Programme (TLP) has been an active project for the past twenty years or so, and went through a number of development phases before full design and construction, started in 2007.

The main objectives of the programme were to:

- Reduce overcrowding on the Thameslink and other commuter services, including London Underground;
- Reduce the need for interchanging between main-line and LUL train services;
- Provision of new cross-London services, so improving public transport accessibility in South East England;
- Facilitate the flow of passengers to and from St Pancras International station;
- Support the introduction of the new Class 700 Rolling Stock.

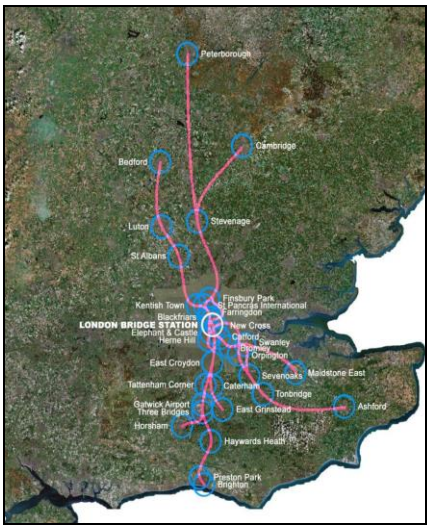


Figure 1 – Extent of the Thameslink Routes

The facilitate the construction works to enable these objectives, the programme was split into a number of Key Output stages to spread the costs associated with the works, but also allow more time to develop a complete construction strategy for the re-development of London Bridge station. The original proposal had been to complete all works, in all areas, at the same time over a four year period, which was thought to be too disruptive.

The programme was therefore split into the following Key Output (KO) stages:

- KO0 – enabling works for KO1;
- KO1 – Introduction of 12 Car Trains and service level increase to 16 trains per hour in the Core Area;
- KO2 – Introduction of New Rolling Stock and service level increase to 24 trains per hour in the Core Area;

1.1 KO1 Main Objectives

Following a short phase of enabling works, KO1 was the first main milestone required to allow longer 12 car train operations between Bedford and Brighton by December 2011. The phase of works also required an improvement in the service capacity up to 16 peak train paths per hour in the Core Area between Blackfriars and St Pancras stations.

To enable the increase in train length and service frequency there were a number of works identified that need to be completed, these were:

- Station rebuilds to allow longer Trains (Farringdon, Blackfriars);
- Platform Extensions (Numerous!) on the Midland Main Line;
- Resignalling the Core Area (Kentish Town to Loughborough Junction) to allow a higher service level;
- Revised Track Layout at Blackfriars station, to streamline services from London Bridge;
- 25kV OLE Extension and move AC/DC interface from Farringdon to Blackfriars, to allow for operational recovery of trains that fail to changeover between traction systems;
- Traction Power Reinforcement for 25kV & 750V DC to allow for the longer 12 Car trains that were to operation on the MML (AT system) and Brighton Main Line

All the works required to enable the change of longer trains and services for KO1 were completed on time during 2011.

1.2 KO2 Main Objectives

To provide the final Thameslink service the main objective of this stage is to give further improvement to the train service capacity in the Core area of up to 24 peak train paths per hour. In addition the connection through to the East Coast Main Line (ECML) from the Midland Main Line (MML) was required to be completed.

To enable the further increase in service frequency there were a number of works identified, these were:

- Station rebuild (London Bridge) to allow better access to the services and connections to London Underground, this also supported the plans to redevelop the London Bridge Area;
- Revised Track Layout for the London Bridge Area to streamline the Thameslink services through the London Bridge area to the Core Area tunnels;
- Implementation of ATO in the Core Area, to provide an enhanced train control to reinforce the ability to deliver a 24 train paths per hour service level;
- Power Reinforcement for 25kV to allow 12 Car operation on the ECML to support the new longer trains on the Route (this work was coordinated with and delivered by the East Coast Power Supply upgrade programme)
- Power Reinforcement for the 750V DC Thameslink Routes, mainly further works on the Brighton Main line to support the new longer trains on the Route;
- Main Depot Facilities at Three Bridges and Hornsey to allow for maintenance of the new Rolling Stock;
- Stabling Facilities at various sites including Brighton, Horsham, Cricklewood, Peterborough, Cambridge.

Currently the majority of the implementation works above have been completed, and of those still outstanding, all of the remaining works are programmed to be completed on time for the main KO2 milestone of December 2018.

2. Development of the Electrification Scope

The original electrification scope was based on studies and traction system design modelling that was undertaken by the original Thameslink 2000 project team during the 1990's. However the programme was then delayed for a number of years when the Transports and Works Act (TWA) was not initially accepted.

During the earlier 2000's, the Thameslink Programme was restarted and a number of key factors had to be re-considered from an electrification prospective, these were:

- Finding a suitable location of a 25kV Grid Intake point in the St Pancras / Kings Cross Area (originally referred to as Regents Canal), as no powers given in the TWA;
- Changes / amendments to the assumptions used for timetabling and rolling stock characteristics (i.e. for DC was high current operation required?), these affected the original Thameslink 2000 traction system design;

- Delivery Programme was amended from a flat delivery (all TLP with TWA permitted timescales of approximately 3 years) to Service level outputs (KO1 & 2) which then staged the power demands into two instead of just one.

These factors meant that all the previous traction system design had to be reassessed as many of the original assumptions had changed.

The largest area of change from the original electrification scope was the introduction of the 25kV Autotransformer proposal for a section of the Midland Main Line (MML) between Borehamwood and Kentish Town.

This solution was selected as there were a number of factors driving the decision, these were:

- No Location for the 25kV Grid Intake point in the St Pancras / Kings Cross Area could be found and agreed with National Grid. This would have also needed a public enquiry to gain local council acceptance as the proposed options were outside the Thameslink TWA powers
- The Programme given at the time for the new Intake Point was approximately 2015 (date given in 2007) and would miss the KO1 delivery date and delay KO2, which was then a 2015 milestone;
- In addition the estimated cost at the time exceeded the budget by approximately 300%, with all additional risk of land procurement and any public enquiry being the responsibility of the Thameslink Programme.

As the main driver for the programme, in terms of having a suitable solution was the timescale, due to the introduction of longer trains were required at KO1, therefore the Autotransformer (AT) system was selected and developed to reinforce the MML. Like the proposal of new intake point at Kings Cross, this was mainly due to making sure that the 25kV system voltage at City Thameslink, the most southerly part of the 25kV system on the Thameslink route, remained constant when loaded, for both the KO1 and 2 timetable changes. However with the AT system, the main intake could now be located further away from London.

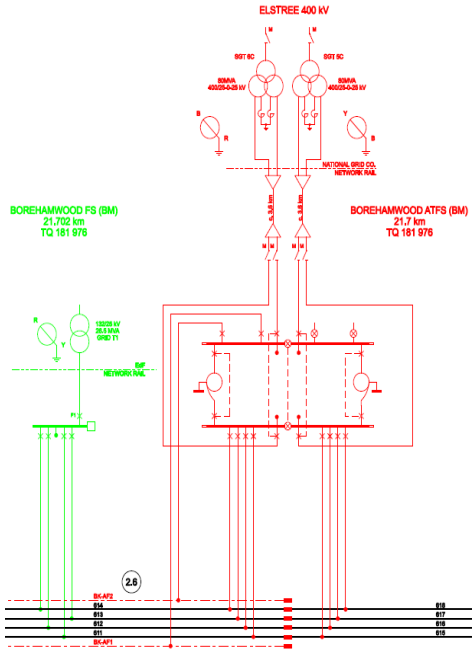


Figure 2 – Diagram showing the 25kV feeding changes at Borehamwood due to the AT system

3. Electrification Works

3.1 Midland Main Line Upgrade

The traction reinforcement scope defined for the Midland Main Line was to install a 25-0-25kV Autotransformer system between Borehamwood to Kentish Town which is approximately 20km of the route, this included:

- Provision of a new Grid Connection at Elstree, this is the nearest National Grid substation to Borehamwood (see figure 3);

- Replacement of three traction Feeder & Sectioning locations on the existing railway at Borehamwood (see figure 2), Grahame Park and Kentish Town (see figure 4);
- Installation of two new Autotransformer feeders, which run on each side of the railway that are located on the Overhead Structures;
- Installation of a return screen conductor, to provide an enhanced level of protection against lineside electro-magnetic induction (EMI) from the enhanced 25kV system;
- Removal of the booster transformers and the return current conductor as this function is replaced by the AT system and the return screening conductor.

Construction works for the AT system started in 2009 and initial commissioning started in May / June 2011 and was available for the train service change with longer trains and KO1 deadline in December 2011.

Figure 3 – One of the National Grid transformers at Elstree required to support the AT system

Figure 4 – Kentish Town lineside section locations

3.2 DC Routes Upgrade

As well as the upgrades to the north of London on the 25kV system, the routes south of London to destinations such as Brighton, also had to be upgraded due to the new and longer trains. So various traction reinforcement works were undertaken, basically to either install or replace various part of the DC traction System that the traction system design indicated would become overload under the worst case feeding, these works included:

- Upgrade of ten substations (Farringdon, Southwark, Cannon Street, Brockley, Coulsdon North, Great Lake Farm, Gatwick, Three Bridges, Ifield, Pangdean), where works in either the transformers / rectifiers or DC circuit breakers were required, due to higher loads, see figure 6;
- Conversion of one Track Paralleling (TP) Hut to a Substation (London Bridge), which involved cutting into an adjacent HV feeder cable and providing new HV switchgear, transformer / rectifiers and DC circuit breakers;

- Installation of one new Substation (Patcham), this was to reduce the loading at an adjacent substation and to improve the electrical protection on the DC electrical sections in the area;
- Installation of four new Track Paralleling Huts (Gipsy Hill, Clayton Tunnel North and South, Tinsley Green), where basically the DC electrical sections are paralleled via DC circuit breakers to improve the electrical section voltage and assist with load sharing;
- Completion of outstanding Power Supply Upgrade works associated with HV Feeder cable (F3061) – Three Bridges to Keymer. Completing this work gave an increase in availability of the HV distribution system as this is an alternative feed to maintain HV supplies to the railway if there are HV outages due to faults or maintenance;
- Upgrade of the Electric Track Equipment (ETE) positive and negative cabling from Brighton to Farringdon along the main and diversionary routes through Tulse Hill, which consisted on doubling all DC cables on all tracks, to improve the load capability of the cabling, see figure 7

Figure 5 – Substation Upgrade works at Gatwick

Figure 7 – Typical ETE works showing upgraded hookswitch

3.3 Dual Electrified Area works

While the upgrade works on the 25kV AC and 750V DC systems were challenging and complex, probably the most technically challenging was the changes brought about by extending the Dual Electrified Area (DEA) at Farringdon station in the Core area of the Route.

While there had been an AC / DC interface in this area since the late 1980's when the route was originally reopened, the Dual Electrification Area (DEA) was only in the Farringdon station area. The associated contactor equipment, used to prevent stray DC currents going into the earthed 25kV AC system, was located just south of Farringdon station within Snowhill tunnel although this was only configured for trains with a maximum of eight carriages, see figure 8. With the increase to twelve carriage trains the AC / DC interface contactors were not suitable for the longer and high frequent services.

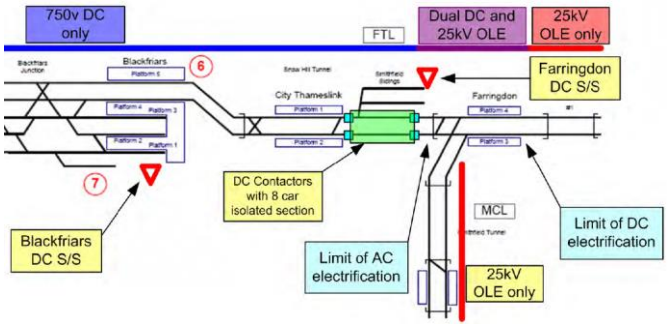


Figure 8 – Layout of the original AC / DC interface and DEA in the Farringdon Station Area

In addition to the AC / DC interface only being able to operate with eight car trains, Farringdon station itself could only accept eight car trains. To overcome this restriction, the platforms were lengthened which meant removing the railway lines to Moorgate. Although by removing these lines it also removed the means of recovering trains that failed to changeover from AC to DC, as the Moorgate line were used to recover these trains.

To overcome this operational restriction the 25kV overhead was extended to City Thameslink Station to the south of Farringdon. This meant that extending the DEA and relocating the AC / DC interface south of the City Thameslink station and clear of the limit of 25kV overhead line, see figure 9.

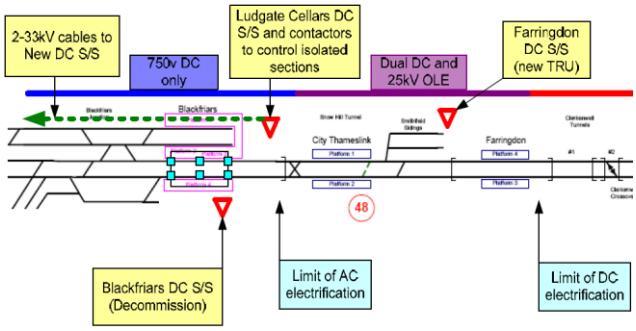


Figure 9 – Layout of the extended DEA and AC / DC interface in the Blackfriars Station Area

In addition to the 25kV Overhead Line and relocation of the AC / DC interface, it was also necessary to decommission at existing DC traction substation that was located under Blackfriars station. This was due to the re-construction of the station above and the refurbishment of Blackfriars bridge a new DC traction substation was developed that integrated the DC contactors required for the AC / DC interface into the substation design and building. The new combined AC / DC interface and DC traction substation called Ludgate Cellars, was built and installed between City Thameslink and Blackfriars stations.

Figure 10 – Ludgate Cellars combined AC / DC interface and DC traction substation

3.3.1 AC / DC Contactors

In terms of the AC / DC interface this consists on a series of contactors that are located within Ludgate Cellars, with a number of Insulated Rail Joints (IRJs) in the return rail which are aligned to gaps in the conductor rails. The basic premise is for contactors, with the IRJs and conductor rail gaps, is to always maintain separation between the AC traction (earthed) and the DC traction (floating) return systems. If this is not achieved that DC stray currents could flow towards the earthed 25kV system and anything else that system is connected too, such as stations etc. To make sure that the contactors open and closed at the correct times to guarantee system separation, it is essential to know precisely where the train is as it passes through the AC / DC interface. The separation is achieved by using the signalling track circuits to control the operation of the contactors, so that contactors can keep the required open point on the positive and negative return systems and also maintain a traction supply to the train at all times. Figure 11 below shows example of a 12 car train passing through the AC / DC contactors where the train is located within the contactor zone and the open point is in the process of changing over from the front of the train (C3) to the rear (C1).

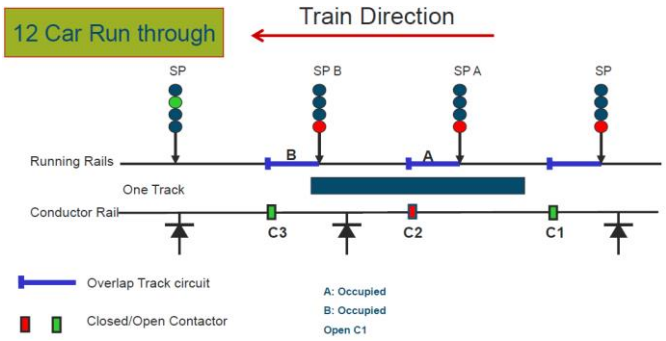


Figure 11 –AC / DC interface contactor arrangement

Following the train position shown in figure 11, as the train moves forward the contactor C2 then opens and C1 closes, with the final state being C3 open and C2 / C1 closed and leaving the AC / DC interface ready for another train to enter.

An additional issue that needed to be considered with the AC / DC interface control was the introduction of the European Train Control (ETCS) overlay that is required in the same vicinity to allow for a robust 24 train per hour service. While the trains are detected via the track circuits, in some case the limit of movement of the trains can move beyond fixed signalling to a virtual point called a Block Marker. The positioning of the block markers had to be coordinated with the allowable positions of the trains passing through the AC / DC interface. This coordination is shown in figure 11 below.

Primarily this was to prevent a train that had intentional stopped in the interface sections and then allowing a train to move into the same electrical sections crossing an open contactor, that would likely result in damaging the IRJs as the wheels cross the insulated sections allow traction current to bridge the gaps.

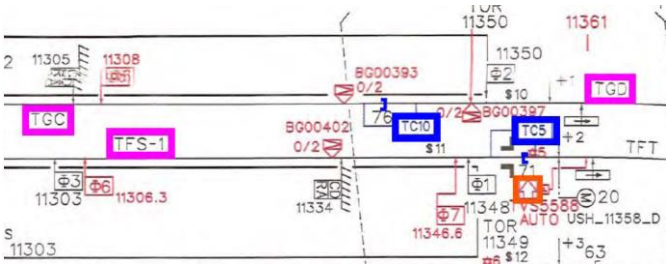


Figure 12 – Signalling Plan showing coordination of block markers (brown) and AC / DC interface equipment (blue)

3.3.2 25kV Overhead Line Extension

In addition to the creation of a new AC / DC interface at Blackfriars, the 25kV overhead line extension was also required to take the AC electrification to City Thameslink to allow the operational requirements to be met.

One of the largest concerns for the overhead line was the existing Victorian soffit heights in Snowhill Tunnel as these were exceptionally low and special electrical clearance assessments were required to confirm if it was possible to install the overhead line system through these tunnels.

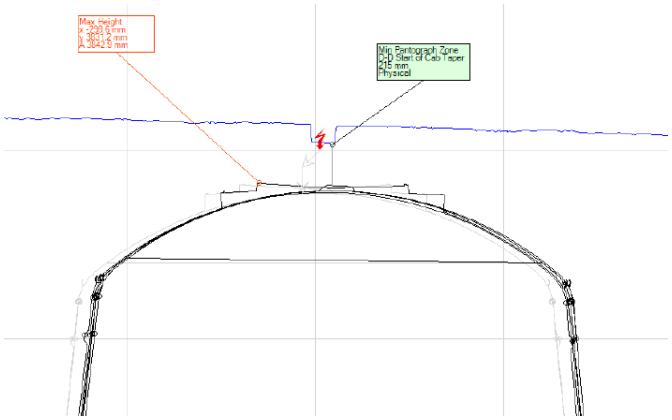


Figure 13 – 25kV Electrical Clearance issues in Snowhill tunnel between Farringdon and City Thameslink Stations

The reason the electrical clearance assessments were carried out was that solutions to increase the available height for the Overhead Line Equipment (OLE) like lowering the track or changing the soffit, were not practical in this location due to other constraints. So every effort was made to see if the OLE could be installed without changing any infrastructure.

3.3.3 DC Stray Currents

One of the other considerations of extending the DEA between Farringdon and City Thameslink Stations was the thought that implementing a longer DEA would lead to an increase in the levels of DC stray current in the area.

This was a known issue along the route as DC stray currents had first been observed when the railway line was reinstated during the first Thameslink Project during the late 1980's. The DC stray currents are produced due to the rail to earth voltages created by the DC traction system to the south and when these are connected, via the running rails, to the earthed 25kV return system this allows DC current to flow to earth before returning to the source of supply in the south.

In the original Thameslink scheme this created the need for the DC separation contactors located in Snowhill Tunnel, to mitigate the flow of DC currents that at the time had been observed in the region of 160A.

Following the installation of the new DC contactor separation system at Ludgate Cellars, various monitoring has been undertaken to review the levels of DC stray currents. It should be noted that mitigation can only be provided as the stray currents cannot be removed completely due to the presence of the DC traction system.

These tests undertaken have shown that while the stray currents can be present when the two traction systems (AC & DC) are connected together, the levels are comparable to those seen during the original Thameslink project in the late 1980's and that the new contactor system still provides suitable separation. This can be seen in the following graph in figure 14 of one of the tests undertaken when the AC / DC system was put into Bypass.

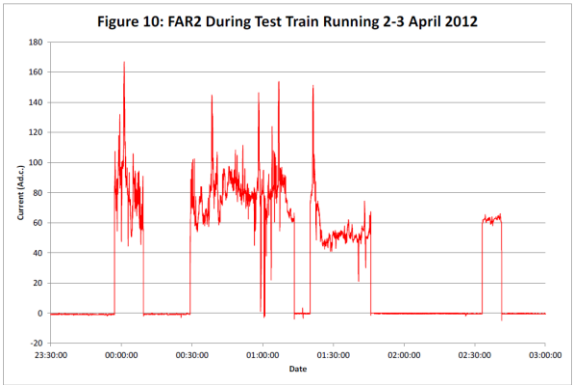


Figure 14 – Stray Current testing showing level of stray current when the AC/DC interface is in Bypass

The Bypass condition for the AC/DC interface had to be tested to confirm the levels, as this operating mode had to be in place to cover either faults on the equipment or if longer than normal trains were required to traverse the interface. The peaks in the graph are when all contactors are closed, which connects the AC & DC systems together and the sections in

between the peaks are when the contactors are working normally and providing the correct level of separation. From these tests we have also shown that the levels of DC stray currents are similar to those previously recorded and peaks of between 150-200A have been recorded. Below is a diagram, figure 15, showing a summary of the results seen through the DEA, this includes both the rail to earth voltages which drive the current and the approximate values of conducted DC currents seen in the DEA.

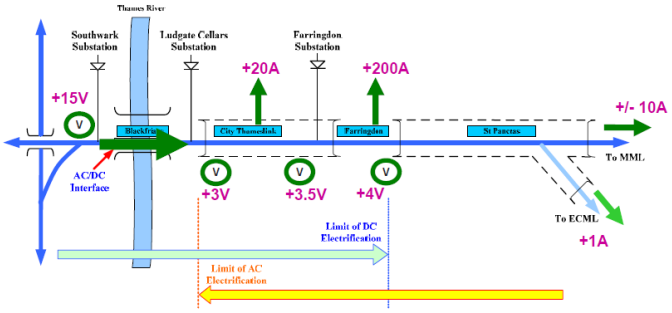


Figure 15 – Typical values of rail to earth voltages & stray DC currents while the AC/DC interface is in Bypass

3.3.4 Insulated Rail Joint (IRJ) rail head arcing

One of the unforeseen issues of the new AC / DC interface was the level of rail head arcing seen on the IRJs that provide the separation in the running rails, see figure 16

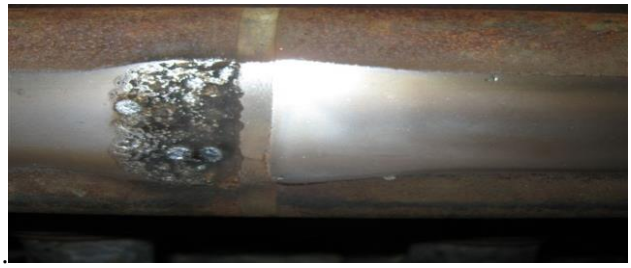


Figure 16 – Typical example of IRJ rail head arcing

The arcing seen on the IRJs initially was not known about and was only revealed when following the originally commissioning a track circuit failed, due to the insulation barrier of the IRJ, breaking down and the two rails effectively joining.

Following a number of investigations, the cause of the arcing was identified as the inductance of the long DC negative return cables that run from the IRJs back to the main contactors located within Ludgate Cellars. These cables are approximately 500 to 600m in length, so as the wheel crosses the IRJ, with the contactor closed at Ludgate Cellars, current flows through the wheel across the IRJ. However as the wheel starts to break the connection over the IRJ, the DC current tries to maintain the path through the wheel, rather than changing to flow through the cables to the conductors due to the cable inductance, see figure 17 below.

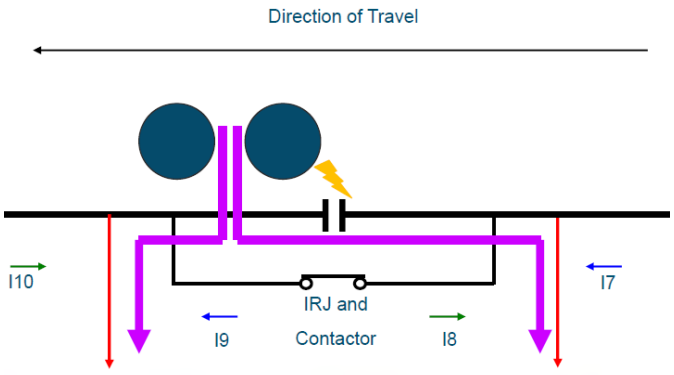


Figure 17 – Simplified diagram showing the arcing when the wheel crosses the IRJ

There have been a number of proposed solutions considered to remove or reduce the arcing to an acceptance level to allow normal maintenance levels to be achieved. These solutions have included:

- Relocation of the complete main contactors closer to the IRJ locations, not consider as insufficient space due to Blackfriars Station;
- Use of capacitors to counteract the effect of the cable inductance, not considered due to the high currents involved and the estimated size of capacitance required as insufficient space due to Blackfriars Station
- Developed of Thyristor technology to provide a localised switch around the IRJ, not considered due to the high currents involved and time required to develop the solution;
- Use of a simple mechanical device to divert the arc onto a sacrificial plate adjacent to the IRJ. This solution was trialled and worked successfully in reducing the arcing, but unfortunately could not be made robust enough to cater for the continuous number of wheel passes from each train and thus could not be considered as a long term solution.
- Use of a simple contactor slaved off and connected in parallel to the main contactors and located as close to the IRJs as position as possible. This solution was successfully trialled and a full scheme will be commissioning into service before the Thameslink full timetable is implemented, see figure 18 below.

Figure 18 – Trial Slave Contactor located adjacent to the IRJs used for AC / DC interface separation

4. Other Electrification Works

On top of all the main electrification works to either upgrade the existing traction supply capability or provision of new functionality, such as the AC / DC interface, there have been various works that have either modified or provided changes to the electrification equipment. These changes are not necessarily associated with the provision of more power, but more a reconfiguration of the railway to allow the railway service enhancements; it is these enhancements that then impact on the existing traction supply arrangements such that they have to be re-aligned to the new track or station layouts.

All for these works were carried out in parallel to the main upgrade works and have included:

- Platform extensions to allow longer trains that have affected overhead lines masts or contact wire positions;
- Stabling facilities and the provision of new or modified traction supplied equipment;
- New Depot facilities and the provision of supplies to enable traction and depot supplies;
- Fit out of the new Canal Tunnels between the Midland Main Line (St Pancras) and the East Coast Main Line;
- London Bridge area remodelling to allow of the revised track layouts and for the station rebuild.

While these works are not primarily electrification there is an impact in the electrification infrastructure. A good example of this is the new railway connection between the Midland Main Line and the East Coast Main Line through the Canal Tunnels, where new 25kV overhead line equipment was required.

In this case the 25kV system did not consider of a normal contact / catenary wire, but a conductor beam that holds the contact wire in place, see next page

Figure 19 – Conductor Beam Neutral section located within Canal Tunnel

Other works include the re-development and re-build of London Bridge station. The stage works for this part of the project have been ongoing over the past three years and are due of for completion around Christmas 2017. These particular works have meant continual change on all the railway systems including the electrification infrastructure associated with the conductor rails, return bonding, substation equipment and remote control equipment (Supervisory Control and Data Acquisition – SCADA).

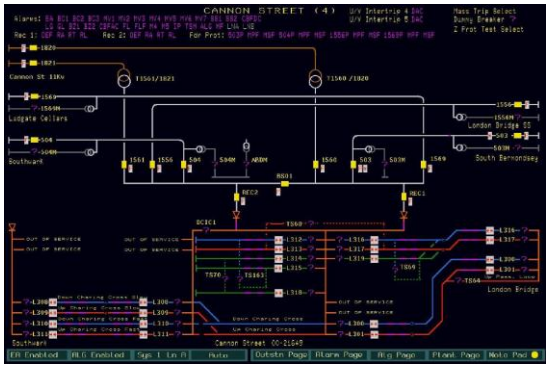


Figure 20 – SCADA screen used for remote control that has to mirror the operational railway through the stageworks

5. Summary

The electrical challenges on the Thameslink Project have varied considerably from designing and specifying the requirements for upgrading the power availability, to resolving unforeseen technical issues such as rail head arcing.

Throughout all of these electrical engineering challenges, the main programme milestones of KO0 and KO1 have been met. In addition the final milestone of KO2 for December 2018 is still on target to be achieved.

Talk

Tuesday 14th March 2017 – Talk – Industrial Process Automation; Skimming the Surface of 40 Years

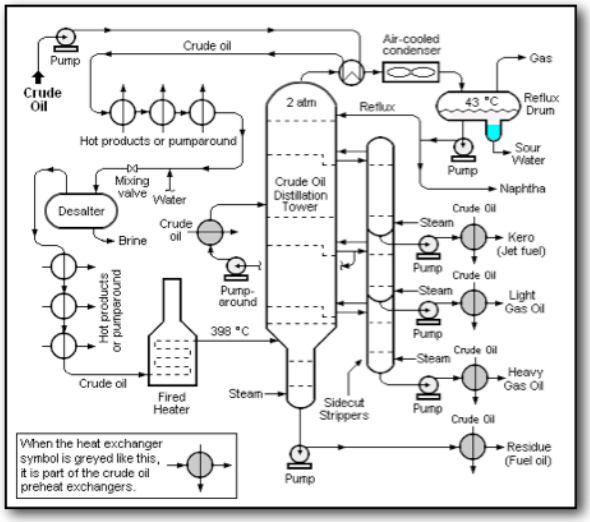
Dr David James RCEA

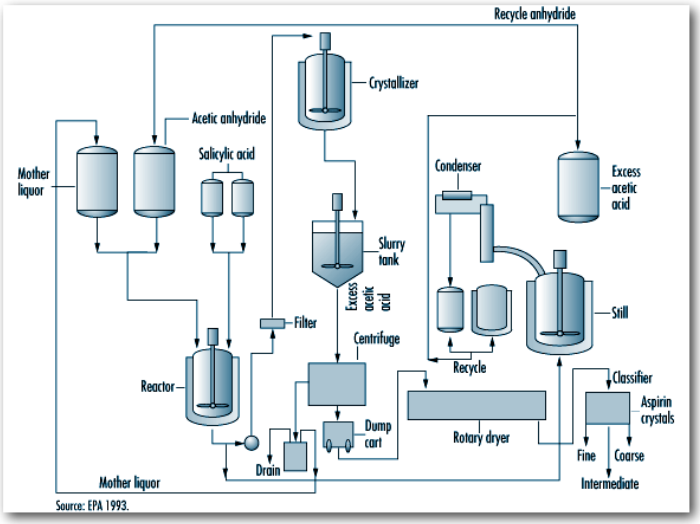
David started his talk by giving a quick background to his career and interests. Initially, he trained as a physicist, went on to become a Chartered Engineer and gained a PhD in Business Research. He had worked on nuclear reactor design (both submarine and civil) before moving on to process automation. He is Chairperson of the IET Sussex Local Network and a STEM Ambassador. His hobbies include building and flying radio controlled model aircraft, as well as restoring and driving a classic MG.

Industrial Processes

When one looks at automated processes, they can be divided into two main types: Assembly Processes and Industrial Processes. Assembly processes manufacture a product that can subsequently be disassembled; they generally use robots or 'pick and place' machines. Examples include assembly of TVs, cars and phones. Industrial Processes, on the other hand, cannot easily be 'undone'. Fluids and/ or powders are piped around the process plant and subjected to chemical, blending or separation processes. Examples include the production of plastics, soup, medicines, petrol and chemicals.

Industrial processes in turn fall into two main types: *Continuous Production*, which uses a constant feed of raw materials with the aim of achieving a 'steady state' output. Examples include refineries and bulk chemical production. The accompanying diagram shows a crude oil distillation process.



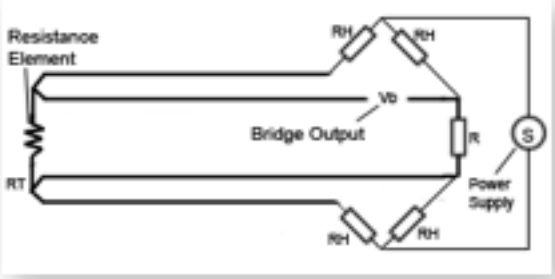


Batch Production processes are designed to make a specified quantity of a product and are similar to using a recipe to cook food: the process has a list of ingredients and a production procedure. It is used for products such as cheese or pharmaceuticals – the diagram shows a process for producing aspirin.

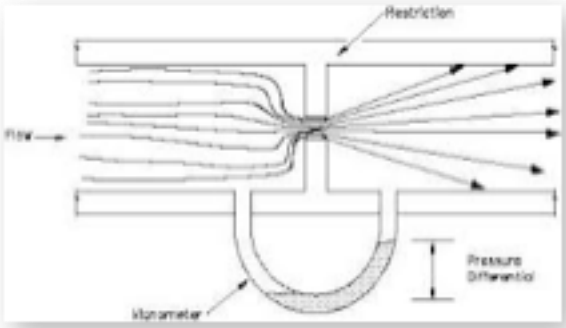
Sensors and Actuators

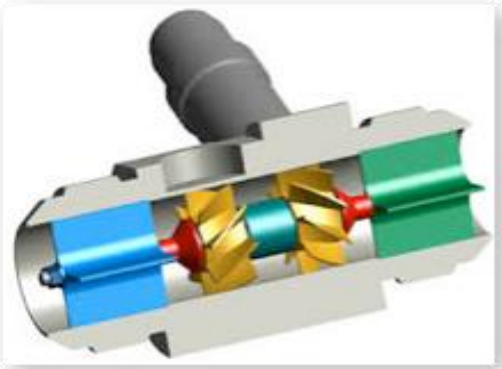
In general terms, sensors measure a parameter such as temperature, level, flow rate, pressure or pH; they pass the information to a control system which is used to vary the demand signal to an actuator such as a valve or motor.

- Temperature sensors include devices such as thermocouples or resistance temperature detectors (RTDs):



- Flow meters include orifice plates and turbine meters:



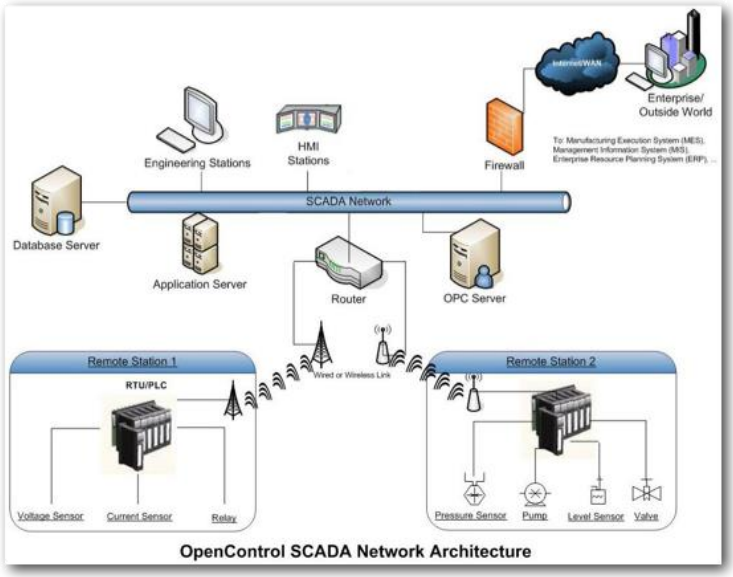


- Valves can include solenoid or pneumatically operated designs:

- Motors may be on/off or variable speed, and may drive devices such as pumps or agitators:

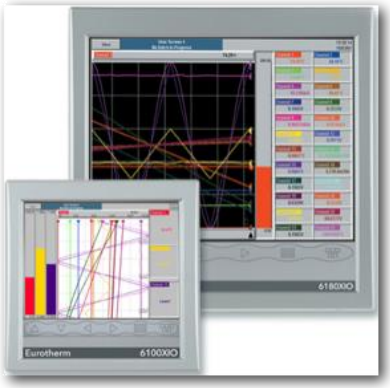
Control/ Monitoring Systems

These may vary from basic, manually controlled systems through simple, single loop controllers to more complex, distributed control systems such as SCADA (Supervisory Control And Data Acquisition) using computers, networked data communications and Graphical User Interfaces (GUIs) for high level process supervisory management. An example of a SCADA system is shown in the accompanying diagram.



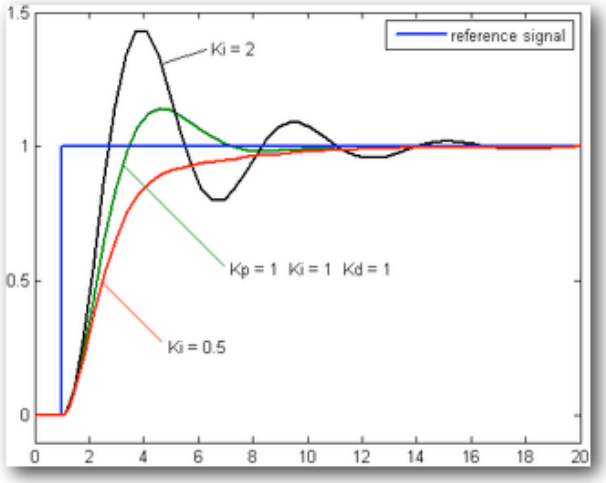
Operator Interfaces and Process Alarms

These will vary widely depending on the complexity of the process being monitored and controlled. Two interfaces and a relatively simple process alarm are shown below.



Control Concepts

Single loop controllers can use feedback or feedforward control, or more sophisticated PID (Proportional, Integral and Derivative) control to improve the response of a process variable to a change in reference signal. The accompanying diagram shows how simple integral control tends to give either a sluggish response to the change in reference signal ($K_i = 0.5$), or one which overshoots the new value significantly and then oscillates about it for some time before settling ($K_i = 2$). The use of Proportional, Integral and Derivative terms ($K_p = 1$, $K_i = 1$, $K_d = 1$) makes the system responsive with only a modest overshoot before settling to the desired value.



Multivariable Control

Multivariable Control provides the most sophisticated form of control system, where each manipulated variable can depend on two or more controlled variables. Inevitably, the complexity of the underlying mathematics is much more complex than for single loop control systems. However, modern computer-based design techniques (eg MATLAB) help designers to tailor designs to satisfy more complex system demands, or ones where single loop controllers cannot guarantee optimal operation and, in some cases, may become unstable.

Conclusion

In conclusion, the ability to control complex industrial processes by combining the outputs of multiple sensors and actuators using control and monitoring systems operating in accordance with a range of control concepts and schemes, and providing information to operator interfaces of varying complexity, underpins the manufacture of high quality, affordable products that meet a wide variety of needs.

Our thanks to David James for providing us with such a comprehensive overview of Industrial Process Automation. My apologies that, in drafting this report, I have not covered every area that David addressed; I hope that I have given you enough information to get a feel for the breadth and complexity of his subject.

Perry Eastaugh

Talk
Tuesday 11th April 2017 – 'The early days of the Buccaneer'

Commander Geoff Meekums OBE MA Royal Navy Retired

Geoff commenced his talk with a brief resume of his career in the Fleet Air Arm (FAA) - from artificer apprentice in 1951 to electrical engineer with an operational squadron of carrier born Buccaneers. He moved to BAe Dynamics in 1988.

The Buccaneer was built in response to the MoD NA39 requirement for a high speed, low level attack aircraft that could carry a nuclear bomb capable of disabling the then new threat posed by Russian Sverdlov cruisers. The order was placed with Blackburn in 1955 and the aircraft made its first land based flight in 1958, leading to its first deck landing in 1960. Initially 6 were ordered for Navy operations, with a further 14 being ordered for test and development purposes.

The aircraft was well liked by pilots, being very smooth in operation. Britain's famous FAA pilot, Eric (Winkle) Brown compared it to the Spitfire. Reasons for this are thought to be the design attention to the 'area rule' (i.e. the aircraft displaces a steadily rising, then falling volume of air as it flies forward) and extensive use of boundary layer control (some 12% of the engine air flow being bled off the 13th compressor stage to promote laminar flow over the wings and tail plane during takeoff and landing phases).

It is also interesting to note the internal structure of the aircraft. It has 3 transverse 'pierced beams', each in the shape of a pair of spectacles. These are joined to a strong internal yoke which provides the anchor points for the launch and arrester hooks respectively. Additional benefits of the 'spectacles' meant that the initial DH Gyron engines could subsequently be relatively easily replaced by more powerful RR Spey engines. And the arrester hook 'chassis' strength meant that the aircraft could be towed (backwards, wings folded etc) on the road, at speeds up to 30 mph, by coupling the towing vehicle directly to this point!

We were privileged to hear Geoff's many service anecdotes. These should be taken in context; during Geoff's time serving on carriers, he only witnessed one serious accident (crew survived) at sea, together with several land based ones. There are too many stories to be all recorded here, but here are eight of them:

1) One day an urgent call came from the control tower asking for an engineer to proceed ASAP to the tower. There was a pilot in the air who was having difficulty with the elevator trim (a secondary control which adjusts the force on the stick to be neutral when one is flying at a given speed.) Geoff was on the other side of the airfield, so one of his chief artificers, c/w with Buccaneer manual volume 1, answered the call. Apparently the trim switch had effectively stuck in full 'nose up' and the only way the pilot could stop ascending 'ad astra' was to regularly alternate between inverted and non-inverted flight. The artificer instructed the observer to pull out fuse F7, which hence-forward disabled the trim, thus enabling the aircraft to descend! A subsequent investigation revealed that drips of rain were entering the rear canopy seal exactly above the rear stick position. From then on Buccaneers, were temporarily fitted with a condom over the stick! But this was subsequently replaced by a piece of string attached to fuse F7, or a longer piece from the front cockpit, if being flown solo.

2) During one carrier landing, after "hooking on", the starboard main undercarriage collapsed. Although designed for an up-to-14g deck landing force, during a "bolter" (going round again without hooking on) this was subsequently found (by a team from RAE) to be the result of the subsequent violent downwards movement. As the wheel subsequently pops over the front edge of the flight deck, the sudden undercarriage movement proved too severe for the collar retaining pin. These all had to be modified.

3) The pressures brought about by an inspection by the 'Admiral' could sometimes prove disruptive. On one occasion, as part of an effort to get the maximum number of aircraft flying for his visit, a semi u/s Buccaneer was pressed into service, albeit with a briefing to the pilot on how to work round the faulty fuel pump. Regrettably this did not suffice, and both engines cut out. The crew ejected and were picked up out of the Moray Firth unscathed.

4) During a test run to RAF Binbrook, in order to assess whether an RAF Lightning could detect a low level Buccaneer over the sea, it was discovered that the latter could indeed avoid radar detection. However the Lightning crew had no difficulty in visually spotting the incoming aircraft, as it was painted white all over. Anti-flash white was used to help

combat the effects of a potential nuclear weapon explosion, but after this trial, the upper surface of the aircraft was then painted in normal camouflage grey.

5) One day an artificer reported a 'fizzing' noise to Geoff. On closer inspection, it was found that the cockpit canopy slide had been made of magnesium. Magnesium is normally avoided on FAA machines, as the combination of salt atmosphere and proximity to other metals higher up the electrochemical scale, can lead to severe electrolytic action. On this occasion the magnesium had, quite properly, been encased in plastic, which would have been OK were it not for the fact that holes had been drilled in it! All the slides had to be changed.

6) And talking of corrosion, someone asked about the special problems presented to Buccaneers working, as they do, in a hostile salt atmosphere. Geoff replied that the airframes and engine intakes were regularly sprayed with fresh water, followed by a spray of WD40!

7) The salt atmosphere meant that the valve in the air line supplying boundary layer air to a given wing, where it bridged the folding wing hinge, often used to stick closed. This showed up during takeoff checks by the pilot. To combat this, Geoff used to carry a large screwdriver and a hammer, which, with the wing folded upwards, was used to persuade said valve to open. But he had to be careful, as the resulting opening released a blast of air at 600°C.

8) Another questioner recalled an earlier RCEA lecture on RAF Lightnings, where we were informed that a typical Lightning would leak well over 20 gallons of fuel whilst in the hangar over a bank holiday weekend. Apparently the Buccaneer exhibited no such problems, though its predecessor, the Scimitar used to p*** fuel everywhere!

Finally, for the record, a perusal of Wikipedia shows that although the FAA strike role of the Buccaneer was taken over by the Sea Harrier in 1978, the aircraft was then adopted (somewhat reluctantly, considering they had been expecting the TSR2) by the RAF, with the final operational flight being made in 1994. 211 aircraft were built.

MCW

Visit.
Thursday, 11th May 2017 – Bluebell Railway Atlantic Project and Sheffield Park Gardens.

In the morning, David Jones RCEA (who is also a volunteer with the Bluebell Railway) met us and showed us the 'restoration' of a Brighton Atlantic locomotive currently underway by the Bluebell Railway in the dedicated shed and workshop. The name is Beachy Head. It was originally built at Brighton in 1911 to a design by D.E.Marsh who had previously designed similar locomotives for the Great Northern. It was the last Brighton Atlantic to survive, being withdrawn in 1958.

David talked us through the various stages of the construction which apart from one item, the regulator handle, is a reproduction of the original Brighton locomotive. The boiler was recovered from a site where it was being used as a stationary boiler. Although originally from a GN locomotive, it was entirely appropriate to be used as a Brighton Atlantic. The work was approaching the stage when the boiler tubes can be installed. The boiler will then be pressure and steam tested before being placed on the already completed frames, wheels, and motion. This is expected to be in 2018.

The project is due for completion in 2020.

Members then had the opportunity to visit the locomotive sheds and museum.

In the afternoon we had a tour of the National Trust Gardens at Sheffield Park, hosted by one of their gardeners. We were fortunate that after an early shower, the sun came out and we had an enjoyable visit.

DEW

SUBSCRIPTION REQUEST: (2017/2018)

Subscriptions are due from 1 October. Please return this form with your cheque made payable to RCEA for £ 15.00
To: Treasurer, A J Tomkins, 2 Badger Drive, Haywards Heath, RH16 1EP
Full name:... ..... Telephone No .....
Address..... e-mail.....
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I enclose a cheque made payable to RCEA for £..... (£15.00) Please return this form by 1st October 2017 (**Separate cheque please from any other payments to RCEA**)

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REPLY SLIP
CHRISTMAS LUNCH

To: George Woollard 18 St Lawrence Ave, Worthing West Sussex BN14 7JF

(01903 523640 or 07541224769)

E Mail : Georgewoollard1@hotmail.co.uk

Can you please reserve me …….. places for the Christmas Lunch at the Windsor Hotel, Worthing on ***Wednesday 6th December 2017.*** 12.00 for 12.30.

Full name:……(Block capitals)

Address………

……

……

Telephone Number…….Name of guest/s …….

E mail address……

Car registration number for disabled parking ……..

I enclose a cheque made payable to RCEA for **£…….(£29.00) per person**

(Separate cheque for this event please)

Applications by Friday 1st December

If possible, I would like to be seated with……..

Menu choices

Name 1	Name 2	Menu choice
		Carrot, Coriander and Ginger Soup
		Ham Hock Terrine
		Prawn, Chilli and Tomato Bruschetta
		Brie and Onion Tart
		xxxxxxx
		Turkey
		Lamb
		Mushroom and Butternut Squash Wellington
		Salmon
		xxxxxxx
		Christmas Pudding
		Tiramisu
		Chocolate and Caramel Torte
		Trio of Cheese

******End******