RCEA
(SUSSEX)

An Association for Retired Professional Engineers

NEWSLETTER December 2024

President's Message

Hello everyone, it's that time of year again.

The year disappears so quickly these days and Christmas is only a few weeks away.

We have had a successful session of talks starting in September with the AGM and a talk on 'The Bloodhound Car'.

Attendance has settled down at around 30 / 33 each month, so always room for more!!!

Regrettably we recently lost our long-standing Newsletter editor, Malcolm Hind after a long illness, David James has stepped up and agreed to compose the Newsletter with input from the rest of the committee.

A thing that came up at the AGM was the RCEA Facebook page. Were you aware that it existed???

Why not try it out, from Facebook search RCEA and request to join.

You will be allowed in and then it can be used to communicate with each other, notify of talks, events etc.

The Christmas Lunch is again at the Findon Manor with numbers down from previous years, but that is probably a sign of the times.

Mike has done a sterling job in allocating speakers for all the slots, including up until April next year and beyond, so going forward I hope to see as many of you as possible on the 2nd Tuesday of each month.

I would like at this point to thank all the existing committee members for the help and support they have given me in this my 4th term as your President.

Finally may I wish you all and your families a very Merry Christmas and a Happy and Healthy New Year, and many thanks for the support of you all which keeps our association up and running.

George Woollard
President

PROGRAMME OF EVENTS December 2024 – March 2025

19th Dec	Thursday	Coffee – at Spotted Cow, Angmering
14th Jan	Tuesday	Talk – Exploring the End of the Dark Ages
16th Jan	Thursday	Coffee – at Spotted Cow, Angmering
30th Jan	Thursday	Coffee – with Partners at Swallow's Return
11th Feb	Tuesday	Talk – Why Water Engineering?
20th Feb	Thursday	Coffee – at Spotted Cow, Angmering
27th Feb	Thursday	Coffee – with Partners at Swallow's Return
11th Mar	Tuesday	Talk - A Naval Weapons Engineer's Life Story
20th Mar	Thursday	Coffee – at Spotted Cow, Angmering
27th Mar	Thursday	Coffee – with Partners at Swallow's Return
8th Apr	Tuesday	Talk - I Remember
17th Apr	Thursday	Coffee – at Spotted Cow, Angmering
24th Apr	Thursday	Coffee – with Partners at Swallow's Return

All Talks and Meetings will commence at 2.30 pm and be held in the Pavilion, Field Place, Worthing, unless another venue or time is indicated. Timings for visits and outings, along with details of talks, are as shown on the RCEA web site.

Coffee mornings commence at 10.30 am.

We do sometimes have to cancel/rearrange talks and visits, in which case we will inform our members of changes to our programme by email. Members can always look on our website for up-to-date details of events.

Website of the RCEA

Our website, www.rceasussex.org.uk carries the very latest information on all our events.

New Members and Speakers for Talks

The RCEA needs new members and speakers 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 speakers to give talks to us at our monthly meetings on Tuesday afternoons from September to April.

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.

New Members

Peter Midgeley, Yapton; Graham Bird, Pevensey.

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.

Brief Details – Talks, Outings and other activities. January 2025 – April 2025

Talk

Tuesday, 14th January 2025 - Exploring the End of the Dark Ages.

S Wilkins - Professor of Astronomy, University of Sussex.

In our current understanding, our Universe emerged from an incredibly hot, dense state roughly 14 billion years ago. While so hot and full of light, as the Universe expanded, it cooled, eventually becoming dark, and entering a period known as the "cosmological dark ages". During this period dark matter and gas, attracted by the force of gravity, developed into structures, eventually leading to the formation of the first stars and galaxies, lighting up the Universe. This earliest period of galaxy formation is now accessible thanks to the James Webb Space Telescope (Webb). Webb not only allows us to identify examples of early galaxies but learn about their detailed physical properties. Webb has already thrown up surprising results including many more super-massive black holes in the early Universe than expected.

Stephen Wilkins is a Professor of Astronomy and Public Understanding of Science at the University of Sussex, just outside Brighton. Stephen obtained his Masters in Physics from the University of Durham before receiving his PhD from the University of Cambridge. Stephen then worked as a research fellow at the University of Oxford before joining the faculty at Sussex in 2013. Stephen's main research focuses on understanding the formation and evolution of galaxies, particularly the first stages in the distant early Universe. To do this Stephen combines observations from telescopes including Webb and Hubble with supercomputer simulations. Outside his research Stephen is also a keen advocate of public understanding of science. Highlights include his leadership of three exhibits at the prestigious Royal Society Summer Science Exhibition and dozens of talks.

Talk

Tuesday, 11th February 2025 – Why water engineering?

Geoff Gibbs – member

Geoff's presentation will consist mainly of picture slides illustrating his career as a Civil Engineer almost entirely involved with water.

He will explain how his early experience led to a degree in Civil Engineering and the need to obtain suitable experience to get Chartered. This was the design and construction supervision of a large tunnelled sewer, part of a major wastewater treatment plant extension in Worthing. This experience developed into an interest in the marine treatment of sewage between 1975 and 1990 including an MSc in Water Engineering. He will talk about European standards of the time and what he learnt from the way Americans dealt with these issues.

With the privatisation of English Water Companies he moved to the Environment Agency to work on flood risk management. He will explain his involvement in major sea defence and fluvial schemes to reduce flood risk to existing development.

He will then talk about his part in drafting guidance to influence new development and flood risk, including Planning Policy Statements, Building Regulations and British Standards.

Finally he will mention education in that he encouraged STEM initiatives as a school governor and, for several years, taught civil engineering fluid mechanics part time at University.

Talk

Tuesday, 11th March 2025 – A Naval Weapons Engineer's life story.

Philip Sherwin – member

Philip Sherwin was employed by the Ministry of Defence for 44 years principally as a Weapons Engineer Officer but latterly as a Scientist in Whitehall. Despite his first Ship being the Dispatch Vessel (Yacht) HMS SURPRISE, armed with 4x 3pdr saluting guns and driven by triple expansion reciprocating machinery, the Navy subsequently required him to take an Electrical Degree and qualify as a professionally recognised Weapons Engineer. After 3 years learning the trade at sea, the Navy sent him to the Underwater Research Establishment in a civilian Scientific Officer's post. Here he learned machine code programming and researched digital command and control systems for future nuclear submarines. The Navy, then unaware of the difference of software and hardware, next appointed him to design and teach the six-month digital conversion courses for senior Electrical Artificers.

There followed six years with the first fully digital and all missile, gas turbine propelled, frigate. He was initially one of three crew when the hull was launched at Yarrows shipbuilders in Glasgow. Philip will describe the process of 'first-of-class' ship and weapon acceptance trials which included 33 increasingly challenging missile firings. Staff Officer Engineering in Chatham Dockyard during the Falkland war, he then transferred to MoD Whitehall as 'sponsor' of the proposed Defence Satellite Communications System, SKYNET 4, a rapid learning curve!

A Squadron Weapons Engineer posting, mainly in the Gulf, was followed by a Procurement job investigating possible future weapons and then Naval research customer desk officer in MoD. Final Naval appointments were at the 'Privatising' Defence Research Establishments at Malvern and Portsdown. On retirement from the RN he became a Civil Servant, staff assistant to the Chief Scientist at DERA HQ Farnborough, moving to Whitehall as a scientific advisor to the Naval Operational Requirement staff.

Talk

Tuesday 8th April – I remember, do you?

Ray Parsons – member

Ray is probably our oldest Member, and has entitled his talk 'I Remember'. It doesn't have a synopsis as such, but I know some of his memories cover a) boyhood experiences before and during WW2 and b) operations at both Brighton A and B power stations. We await to hear more.

Reports

Talk

Tuesday 17th September 2024

The Journey of Bloodhound SSC (supersonic car) so far

Chris Rickard - Member

Chris provided a running commentary to a number of video recordings of the Bloodhound car, both under development and being tested. He also answered a number of questions from the audience.

In 1997, Thrust SSC broke the Land Speed Record, travelling at an average speed of 763 mph. The head of the project was Richard Noble and Andy Green, an ex RAF jet pilot, was the driver.

The team then asked "Could we go faster?"

Their answer was yes, they could aim for 1000 mph, but they would need to borrow a jet engine from the RAF and a rocket engine from someone so as to produce 135,000 bhp needed. But the answer from the Government and the RAF was no!

However, by the time we got to 2007 a number of companies, including GE, Siemens, BAE and Rolls Royce, recognised that there was a huge shortage of engineers and engineering technicians. Lord Drayson, the Minister for Defence Equipment and Procurement, was also acutely aware of the shortage.

Richard and Andy met with Lord Drayson to look at what could be done to address the shortage and the possibility of creating a new, iconic, British, high technology project. A deal was struck that Richard would get an EJ200 Eurofighter jet engine and Paul Drayson would get the largest STEM education programme ever seen. In October 2008 Lord Drayson announced the project.

Chris Joined the STEM team as a volunteer in 2011 and was later asked to join the build team.

Bloodhound SSC (later LSR)

There was a view that the Bloodhound company was top heavy and was spending a lot of money without making much progress. The Chinese automotive manufacturing company Geely provided of the order of £4M, but this was used to pay off debt and so Geely walked away. To progress, the project needed a lot of sponsors and collaboration with various companies. For example, the Engineering and Physical Sciences Research Council (EPSRC) provided funding for the aerodynamic research and there was input from the F1 industry to help design and build the carbon fibre monocoque body.

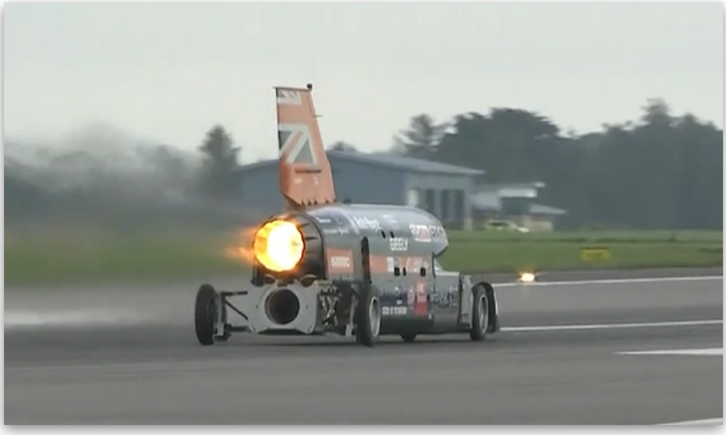
In order to achieve the required 135,000 bhp, the car was designed around an EJ200 Eurofighter jet engine from Roll Royce, supplemented by a space rocket engine from the Norwegian company Nammo. The Raufoss AS 30 kN hybrid rocket engine uses solid HTBP (hydroxyl-terminated polybutadiene) with a liquid hydrogen peroxide oxidiser and produces an 800 times increase in volume of the propellant. The original plan was to use a Jaguar 5 litre V8 engine to drive the fuel pump for the rocket engine (to deliver 47 litres per second), but a revised plan is to use an electric motor. Since the rocket engine would only need to run for 20 seconds, the battery for the electric motor would not be too heavy. If and when the next test run is carried out (at 800 mph) Rolls Royce plan to use a 'green' jet fuel manufactured in South Africa, thus enabling the car to claim running fully on 'green' fuel.

Chris said that special consideration needed to be given to the wheels. For the speed at which they would be running, the rim would be experiencing 50,000 times the normal force of gravity. Consequently, the wheels were forged from an aluminium alloy (7073), the forging resulting in a much finer structure than would be found in cast material and thus would produce extra strength. Each wheel was then balanced in a laboratory, polishing off minute amounts so as to get the perfect balance.

In response to a question Chris said that the car had two parachutes, but the intention was not to use them. Since there was limited time (one hour) for the turn-around between the two runs, they did not want to spend time repacking the parachutes. The air and ground resistance was enough to slow the car down.

The First Test Run

The first low speed tests of the car took place on Newquay Airport runway in November 2017. Since this was on a hard surface, the car was run on rubber tyres, but accelerated to 200 mph, the limit for both the tyres and the length of the runway. According to Chris, the car's acceleration was equivalent to 0-60 in two seconds!



However, a year later the project was in financial difficulties and the receivers were called in. Their intent was to break up the car and sell the assets. However, in December 2018 the son of Ian Warhurst, a Yorkshire entrepreneur, persuaded his father not to let the car be broken up, so Ian came up with the £250,000 needed to pay the receivers. A week or two later he decided to spend up to £5 million to take the project to the next stage. He formed a new company, became the legal owner of the car and set up a new factory in the old Berkley power station (now a technical college). The project was renamed Bloodhound LSR (Land Speed Record), but because of the change of ownership there was some difficulty in getting a license to use the Rolls Royce engine.

High Speed Testing of Bloodhound LSR

In 2019, with new ownership and sponsorship, the team took Bloodhound LSR to the Hakskeen Pan in South Africa for some high-speed testing, using only the Rolls Royce engine. The car was flown from the UK to South Africa, and then delivered by road. Chris commented that the delivery driver felt he had to be well armed and carried 3 guns!

According to Wikipedia, the local community cleared 16,500 tonnes of stones by hand from an area measuring 22 million square metres to create space for 20 tracks each 10 metres wide, as the car cannot run twice on the same strip of desert. Chris said that these stones were transported from the site by lorry. 1000mph is faster than the muzzle velocity of hand guns, and many rifles. Any stones thrown up at high speed effectively travel at a relative 'ballistic' speed, hence the flanks and underside of the car are strengthened with Kevlar.

In response to a question, Chris commented that the site was chosen because the surface was soft, rather than the hard surface of salt flats. The wheels needed to make tracks in the surface to aid stability. He said that there was no damage to the wheels or to their balance. However, the car is sensitive to cross winds, with 22 mph found to be the maximum tolerable side wind.

Andy Green drove (piloted) Bloodhound LSR to an average speed of 628 mph (1,011kph), which is in the transonic region (but still about 140 mph below Mach 1), over an 11 mile length of track.

They did, however, have a fire warning in the car. It was necessary to remove the jet engine in order to inspect the fire detection cables. There was no fire, but the cables had got too hot, possibly due to some leaking gases.

Roadshow

Ian Warhurst stepped down as CEO of the company and in December 2023, with the aim of looking for a new driver and obtaining more sponsorship, a full scale model of Bloodhound LSR was taken on a tour of southern England. The actual car is, for the moment, displayed in the Coventry Transport Museum.

According to Chris there has been a mass of applications for a new driver and the selection process is in progress. Also, it seems that engineering degree applications at Bristol University jumped up after the car was exhibited locally.

Other Questions

1. When asked if the car could be driven by a machine, rather than a human, Chris said that the Land Speed Record rules say that the vehicle has to be manually driven.
2. Asked about the potential for the car to lift off the ground, Chris replied that it was designed to be aerodynamically neutral and the test runs at 600 mph showed that there was no up force or down force.
3. In the video you could see Andy Green making small steering corrections. Chris said that the car is wholly steered from the front wheels. The fin is there to keep the car stabilised and pointing forward.
4. The videos showed a lot of dust being kicked up by the car. It seems that this is not a problem for the driver as it gets left behind at speeds above 80 mph.
5. When asked about the next step in testing, Chris said that the plan was to return to South Africa and take the speed up to 800 mph. They would only need to use a mono propellant to achieve this.

The audience, who were enthralled by the videos and the commentary given by Chris, thanked him for the talk in the usual way.

David James

Talk

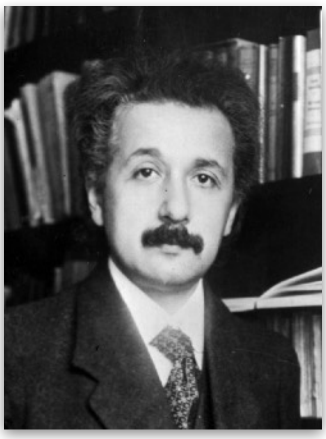
Tuesday 8th October 2024

Where are all the nuclear fusion power stations?

David James - Member

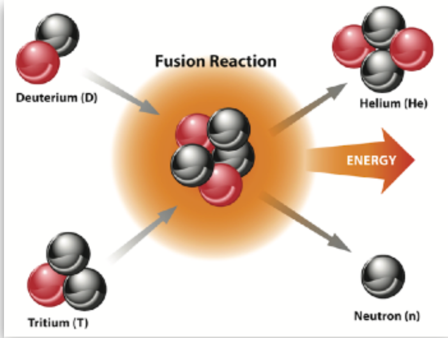
In the late 1960s it was said that within 20 years we would have commercial nuclear fusion power stations. We would have so much energy that it would be practically given away! So 55 years later, David asked where are all these power stations?

He started by looking back at how it all started, before reminding the audience about a few of the basics that underlie nuclear fusion. Then the audience were given an introduction to some of the technologies that have been and are being used to try to extract energy from a controlled fusion process, before looking at some of the research and some of the private company developments associated with each technology. Finally David looked at the progress that has been made and various people's predictions for the future.



Where It All Started

In 1905 Albert Einstein published four papers, the last of which included equations that could be reduced to what is probably the most famous equation of all time; $E = mc^2$. In other words, energy is related to mass by the square of the velocity of light. However, it wasn't until 1920 that it was discovered that the mass of two protons and two neutrons was greaser than the mass of a helium atom (whose nucleus is made up of two protons and two neutrons). So where has the mass gone? At the time, astrophysicists were trying to work out how the sun produced its energy.

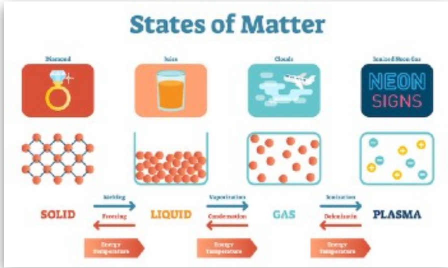


Some Basics

Taking a step back, David reminded people of some of the basics. For example, an atom consists of a tiny nucleus made up of positively charged protons and neutrons (with no electric charge), surrounded by a 'haze' of negatively charged electrons. It is those electrons that give the elements that we see in the periodic table their chemical properties.

We're all familiar with the fission process, where heavy atoms, such as Uranium, are split apart to release energy in the form of heat. But this talk was about fusion, where very light nuclei are 'smashed' together to form a heavier nucleus and release energy. Popular nuclei used for fusion are Deuterium and Tritium. The former is a hydrogen nucleus (a single proton) plus a neutron and Tritium is a proton plus two neutrons. Deuterium replaces hydrogen in 'heavy water', but Tritium is unstable such that after about 12 years you only have half the Tritium you started with.

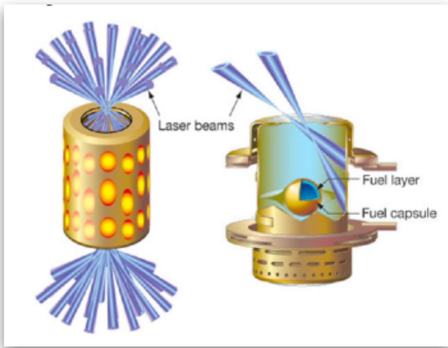
The sun, of course, is a big fusion reactor. However, the pressure (plasma density) at the centre of the sun is estimated to be 26.5 million gigapascal (3.84×10^{12} psi) and the temperature ~15 million °C. These pressures can't be achieved on the earth, so in order to achieve fusion it is necessary to increase the temperature to over 100 million °C.



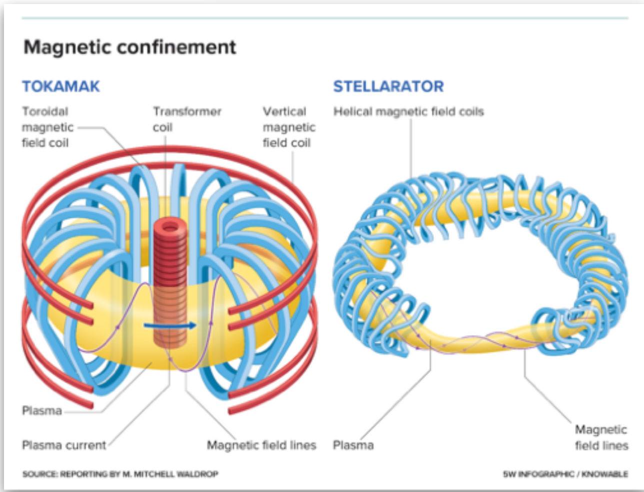
We are all familiar with solids, liquids and gasses, but all the fusion technologies use the fourth state of matter, plasma. Just as we add energy to a solid to convert it to a liquid and add more energy to convert it to a gas, so adding further energy strips the electrons from atoms to produce a soup of positively charged nuclei and negatively charged electrons. This is known as a plasma.

The Major Technologies

Research into nuclear fusion has mainly been based around the following technologies:

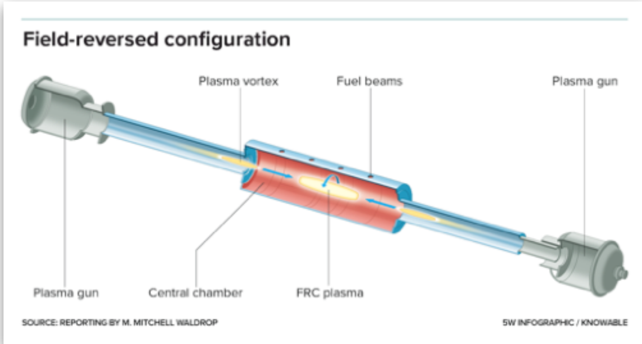


- Z-pinch - An electric current is passed through the plasma, which induces a magnetic field that squeezes the plasma perpendicular to the direction of the current. The squeezing increases the temperature of the plasma.
- Magnetic Mirror - External magnets squeeze the plasma at either end, such that the plasma is reflected back into the body. The movement of the plasma heats it.
- Inertial Confinement - There are two types of inertial confinement, one using lasers and the other using a physical projectile. In both cases, a small fuel capsule, of only a few millimetres in diameter, is used. Compressing this capsule increases the temperature of the fuel, firstly converting it into a plasma and then raising its temperature to the point where fusion occurs. In this method, a new capsule is added and either the lasers are pulsed or a projectile is fired at the capsule. Then the heat needs to be removed and the process repeated.

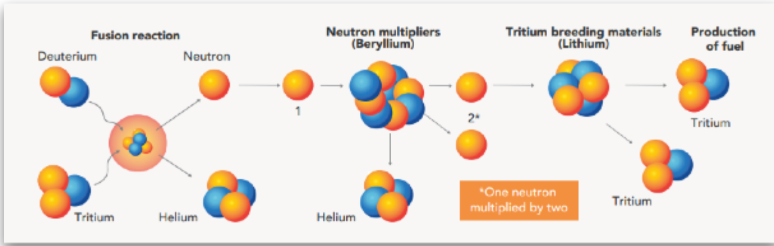


- Magnetic Confinement - This is the technology into which most research and development has taken place. Strong external magnets are used to constrain the plasma into a torus, keeping it well away from the walls. The vessel is evacuated, plasma is introduced and heated by inducing a current in it until fusion occurs and the process becomes self-sustaining. Most work has been put into the Tokamak design, although an alternative configuration is the Stellarator. If you image the torus of the Tokamak being cut vertically in one place, each end rotated through 180° in opposite directions and joined back together, then this is the plasma shape produced by the Stellarator. The magnets are more complex, but apparently the plasma is more stable.

- Magnetic Target - In this approach, a small toroid of plasma is made to rotate. This magnetised plasma is compressed by, for example, hydraulic rams or plasma guns, causing the temperature to rise to where fusion occurs. The process is pulsed.
- Pulsed Field-Reversed Configuration - This is another pulsed approach to fusion energy production. ‘Balls’ of plasma are fired from either end of the device, colliding at the centre, where it is compressed by powerful magnets. When fusion occurs, the plasma pushes back against the magnetic field, generating an electrical pulse. Whereas those technologies that generate heat need to use that heat to generate steam to turn a turbine, which turns a generator to produce electricity, the Field Reversed Configuration generates an electric current directly, provided that it is pulsed at a suitable frequency.



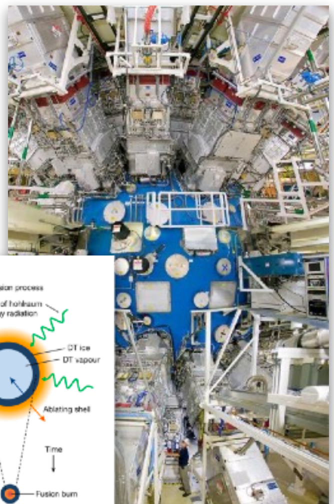
Although not a fusion technology for producing power, an important technology for most approaches is that of Tritium breeding. Whereas Deuterium is stable and available at a very small percentage in water, Tritium is radioactive with a half-life of about 12 years. So if Tritium is to be used as fuel in nuclear fusion it needs to be produced.

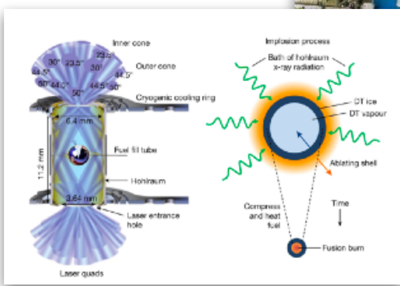


The fusion of Deuterium and Tritium produces Helium plus a neutron. If that neutron is captured by a Beryllium nucleus then that will decay into Helium plus two neutrons and those neutrons can be captured by Lithium to produce two Tritium atoms. Consequently, many practical approaches to generating power by nuclear fusion also include a ‘breeding blanket’ to generate Tritium.

Government Funded Research

Research into nuclear fusion has been taking place since the 1950s by countries such as the USA, Russia, Germany, China, India, Japan and Italy. The UK has also taken a major role in research on fusion and continues to do so. The major technology has been magnetic confinement, mainly in the form of Tokamaks, although the USA has put effort into inertial confinement using lasers. David covered each of the technology types as follows:

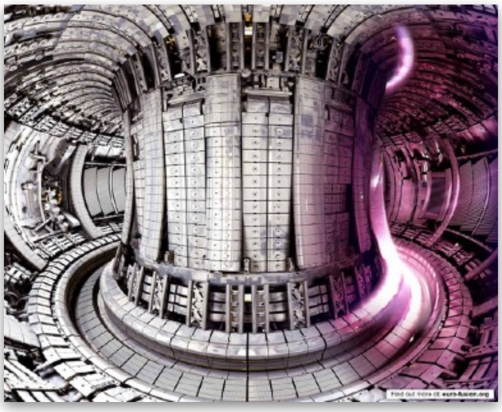




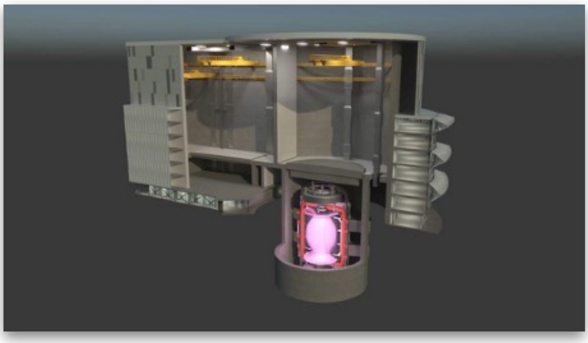
- Z-pinch - Early (late 1950s) experimentation in the UK with the Zeta (Harwell) and Sceptre (Aldermaston) machines did not produce the anticipated results.
- Magnetic Mirror - Experimental machines were build in the USA (at the Lawrence Livermore National Laboratory) and in Russian during the 1970s and 80s, but again the results were disappointing.
- Inertial Confinement - More recently at the

Lawrence Livermore National Laboratory in the USA, 192 laser beams were used to compress peppercorn-sized fuel capsules, containing Deuterium and Tritium, in an eraser-sized tube. They achieved a plasma temperature of over 3,000,000 °C and in December 2022 they got more energy out than was put in. This has since been repeated several times. The infrastructure to provide the lasers and the target chamber (shown on the right) are enormous, compared to the 11mm container and the few millimetre diameter fuel capsule.

- Magnetic Confinement - This is probably the area where most of the research into fusion power has taken place. A lot of this has happened in the UK, but with significant work being done in Germany, Japan, China, India and Italy, as well as international efforts.
    - At Culham in the UK, JET (Joint European Tokamak), the world's largest and most advanced tokamak, first produced plasma in 1983. JET produced 69 Megajoules of energy over five seconds in 2024 and is now undergoing repurposing and decommissioning until circa 2040. The photo shows the inside of the toroidal chamber where the plasma is confined by magnetic fields.



    - Also at Culham, the MAST (Mega Amp Spherical Tokamak) machine, which ran from 2000 to 2013, is in the process of being upgraded. Rather than confining the plasma into a conventional toroidal, the Spherical Tokamak uses a different aspect ratio, making it more like an apple with the core removed.



    - The next stage of development in the UK is STEP, Spherical Tokamak for Energy Production. Although still a research machine, STEP is designed to be a complete power plant and the site in north Nottinghamshire is currently being surveyed in preparation for construction, which is forecast to be completed in 2040.
    - As far as a Stellarator configuration is concerned, the Wendelstein 7-X at the Max Plank Institute for Plasma Physics in Germany is the largest device built to date. In 2023 it achieved 1.3 Gigajoules during a plasma discharge that lasted eight minutes. The second-largest superconducting stellarator is the Large Helical Device in Japan, which has been operational since 1998.

    - The largest Tokamak development is ITER, the International Thermonuclear Experimental Reactor being built in France. ITER Members are China, the European Union, India, Japan, Korea, Russia and the United States. The UK was excluded when we left the EU. Building has been underway since 2010 and the start of the Deuterium-Tritium operation phase is now expected in 2039. It will be the world's largest tokamak, with an output of 500 MW. However, the cost and timescale, like

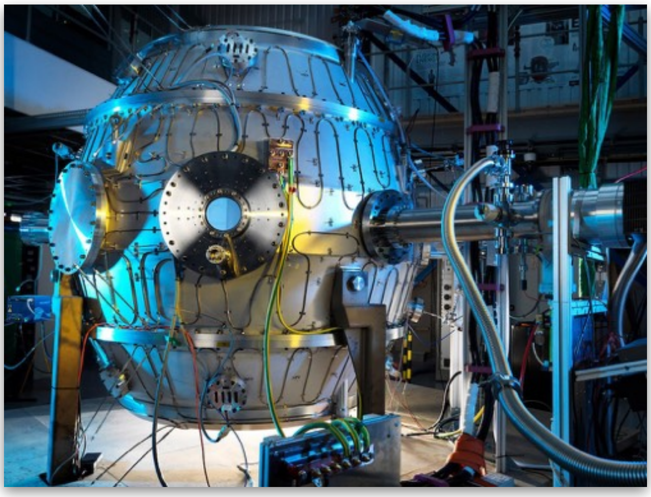
many projects of this size, keep increasing.

- Magnetic Target - The only research on this technology seems to have been in the USA, but has remained distinctly lab-scale.
- Pulsed Field-Reversed Configuration - Once again, research on this technology seems to have been lab-scale in Princeton in the USA.

Private Companies

Over the last ten years or so private money has been invested in a growing number of private companies, mainly spin-offs from universities or research establishments. It must be assumed that these investors believe that there is a good chance of them making money out of these companies.

- Z-pinch - Zap Energy in Seattle are developing a design based on this technology. It is modular and does not require external magnets, but is pulsed, being designed to use ten pulses per second. This year they claim to have achieved a plasma temperature of 10 million °C. So they still have a way to go.
- Magnetic Mirror - There do not seem to be any start-ups trying to use this technology.
- Inertial Confinement - First Light Fusion in Oxford, with what they claim is the largest pulsed power facility in Europe, achieved projectile fusion in 2022. They accelerate an aluminium projectile using 10,000 bar hydrogen pressure towards a fuel capsule, the design of which amplifies the compression. Energy is absorbed by the lithium flowing inside the chamber. However, so far they have only been able to ‘fire’ their device once every other day!



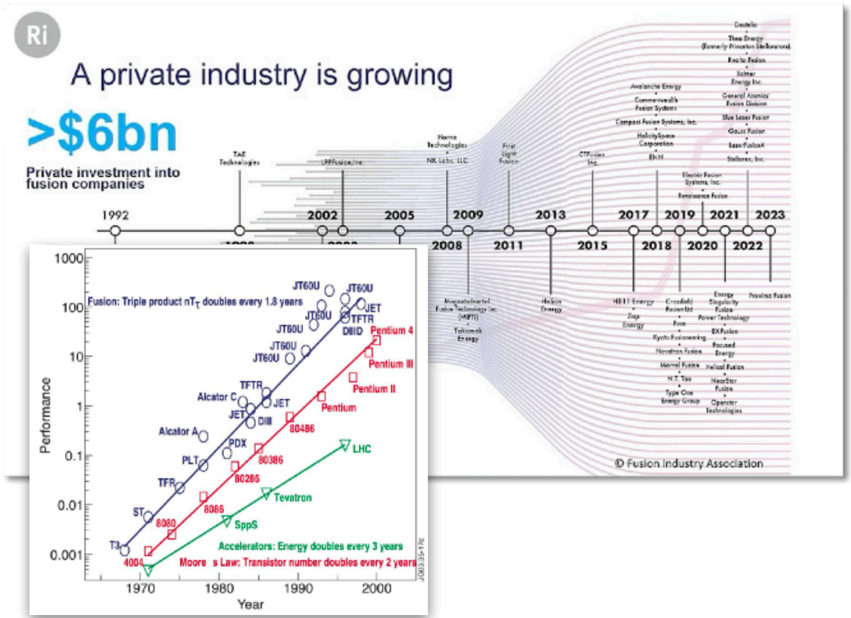
- Magnetic Confinement - Tokamak Energy in Oxfordshire have produced a compact spherical tokamak using high temperature superconducting (HTS) magnets and have achieved a fusion threshold plasma temperature of 100 million °C. Their next device is to be built at UK Atomic Energy Authority’s Culham Campus in 2026. Their plan is then to build a pilot plant that will demonstrate the capability of delivering electricity into the grid in the early 2030s. Commonwealth Fusion Systems in Massachusetts are building a similar device, which they claim is 40 times smaller than ITER.
- Magnetic Target - General Fusion in Richmond, British Columbia are building a machine that uses Deuterium fuel and electromagnetic compression of a liquid Lithium liner. Steam-driven pistons compress the liquid metal container to achieve fusion. The metal, which contains Lithium to breed Tritium, transfers the heat.

- Pulsed Field-Reversed Configuration - Two companies, Helion in Washington State and TAE Fusion in California are building devices based on this approach. The former, currently on its sixth prototype, is hoping to produce electricity by 2028. D/T plasma is created at each end and magnets accelerate them towards each other at 1 million mph. At the centre, powerful magnets further compress the plasma until it reaches more than 100 million °C to initiate fusion. The plasma expands and pushes back against the magnetic field to induce a current. In 2023 TAE Fusion achieved their first measurement of Hydrogen/Boron fusion in a magnetically confined fusion plasma. They also plan to produce a series of prototypes, going into the early 2030s.

Recent Expansion of Interest

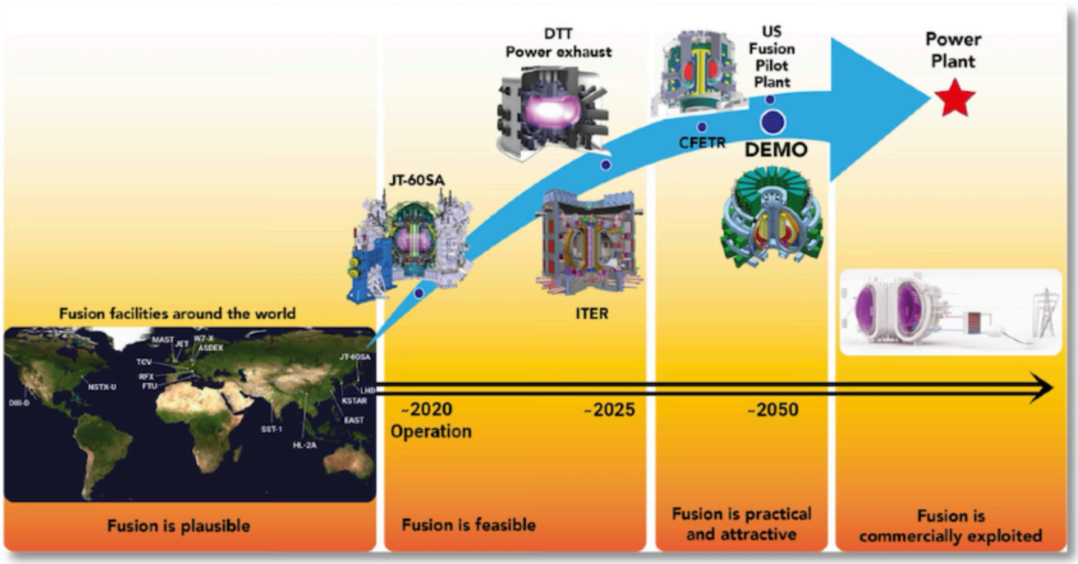
The 'Fusion Industries Association' produced this graphic showing the increase in the number of private companies engaged in fusion power development. The growth in private enterprises has been particularly marked over the past ten years.

An interesting chart has been presented by Professor Potter at the University of Cambridge, comparing the performance of particle accelerators (green), Intel processors (red) and fusion devices (black) over a 30-year period.



When?

When will we have commercial fusion power plants? DEMO, the successor to ITER is only at the 'considerations for conceptual design' phase. The Chinese Fusion Engineering Test Reactor is also still in the design phase, although China does expect to have nuclear fusion energy within the next six years with their new 'Mega Lab'.



Some private companies tend to be a little more optimistic. For example, General Fusion have stated "Our fusion machine – LM26 – is underway and is on the path to achieving breakeven equivalent conditions using MTF technology by 2026."

Professor Potter's view is consistent with the graphic above, taken from the DTT web site.

"Commercial fusion power can't realistically be expected before 2050."

So in 55 years, the prospect of nuclear fusion power has moved from 20 years in the future to 30 years in the future!

Questions

There were a few 'clarification' questions, although someone did ask about 'Cold Fusion'. This came to prominence in 1989 when two American physicists, Fleischman and Pons, published results from their experiments on the electrolysis of heavy water using Palladium electrodes. After applying a current continuously for many weeks they claimed to have observed neutrons and a 20°C rise in temperature (sometimes), both indicative of fusion. However, others were not able to repeat their results and their neutron detector was shown to give false positives. Later in that year a US DoE Special Panel concluded that their results could not be substantiated.

David James

Visit

Tuesday 15th October 2024

Visit to Brighton Network Rail Electrical Control Room

Organised by Derek Webb - Member

Sixteen RCEA members (plus one visitor) met at the end of Platform 2 at Brighton Station, waiting to be escorted across the track and into the Electrical Control Room (ECR). Traction power to the lines is controlled from here. High-vis jackets were mandatory and so groups were taken across in turn.

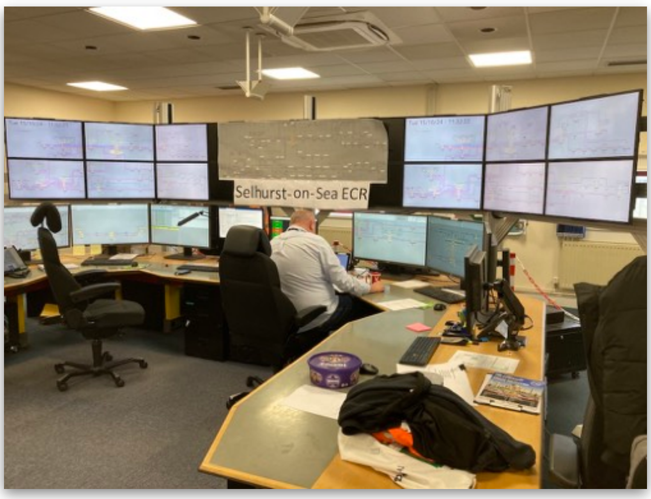
We were split into two groups. While one group was given a tour of the ECR by Peter Bryant (formerly of Network Rail), Derek gave the other group an outline of the history of traction power control in the UK. Then we swapped over.

The Brighton ECR

When Brighton ECR was originally built in 1987 to replace the ASEA electro-mechanical systems at Three Bridges and Havant ECRs, it used a SCADA (Supervisory Control and Data Acquisition) system constructed by GEC, unfortunately this system could not easily be expanded.

The electrification of the Redhill to Tonbridge line as a freight B route for Channel Tunnel traffic back in the 90s resulted in this being replaced by a company called Transmitton. The system is dual-redundant. That is, it has two computers, with the Standby computer following and monitoring the Main computer. If the Main fails, then the Standby takes over. Both computers are located in the ECR at Brighton, along with the input/output electronics. The software platform for this system is called CROMOS. All those who know how to program the system have now retired and the system electronic modules are no longer available.

The photo shows this 'old' system still in use in the ECR, being used to monitor and control traction power for the area originally handled by the Brighton ECR. The new (blank) screens are part of a new, replacement system.



The closing of Selhurst ECR in 2023, that also used an obsolete electro-mechanical system by GEC and based on Strowger mechanical telephone equipment, resulted in supervisory control being transferred to Brighton ECR using a new SCADA system.

The new SCADA system (currently running only the Selhurst part of the network in the Brighton ECR) is part of a Network Rail Traction Power Control System (TPCMS). It is based on Codra Panorama SCADA software, implemented by a services company called Telent. RTUs (Remote Telemetry Units), which are distributed around the network and connected to the field devices, use fibre optic based communications to two 'super computers'. These are in geographically different locations and act as the dual-redundant pair of servers. Each ECR has a set of Windows workstations, each connected to the two remote servers via a high-speed fibre optic network. To help maintain security, nothing is connected to the internet. This system will soon be expanded to combine the Brighton and Selhurst areas as one under TPCMS. The banner 'Selhurst on Sea ECR' is a little lightheartedness on the part of the operators.

As a back-up to the old SCADA system, wall boards are manually updated whenever a change to the power distribution is made. The new TPCMS, however, can be operated from a remote location if necessary, making the wall boards redundant.

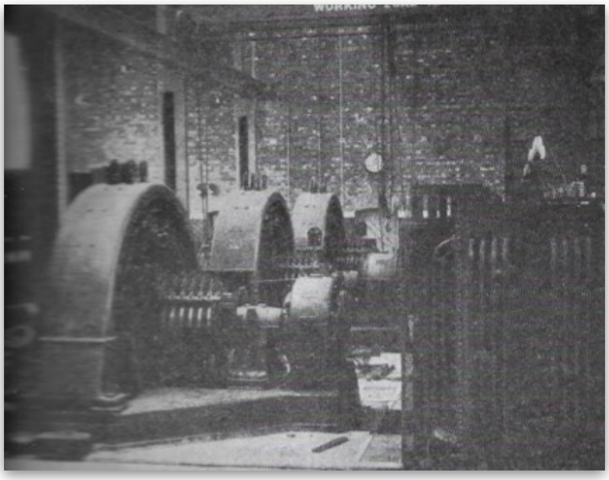
The History of Electrical Control in the South

Derek provided the following extracts from various sources, including from 'Brief History of Southern ECRs' produced by Ian Whetherell (RCEA ex member now in a care home).

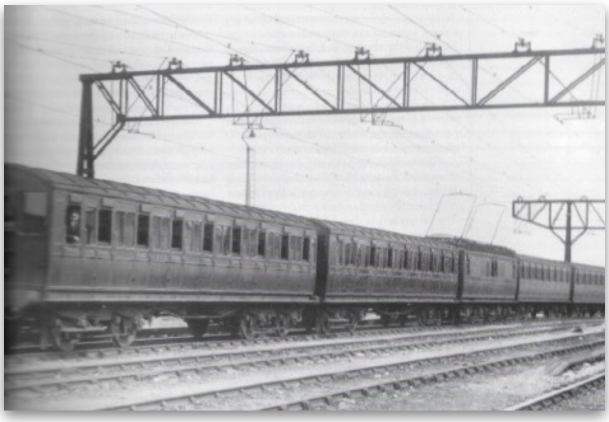
Royals at Three Bridges ECR in1930

Standing in front of the new control panels at Three Bridges, HRH The Prince of Wales is flanked by Crown Prince Gustaf Adolph of Sweden on his left, and by Sir Herbert Walker to his right. Alfred Raworth, on the left of this group, maintains a respectful distance, smoking a cigarette. (ABB)

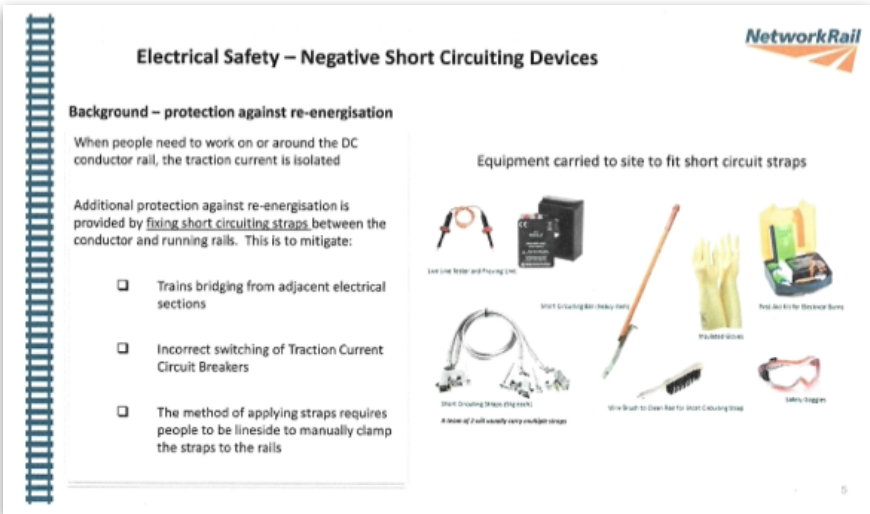
A twenty-first century view of Waterloo substation. Note the 'new' transformers outside, these would have been at least the third set installed since the substation was built for the original LSWR electrification. (Peter Winchester)

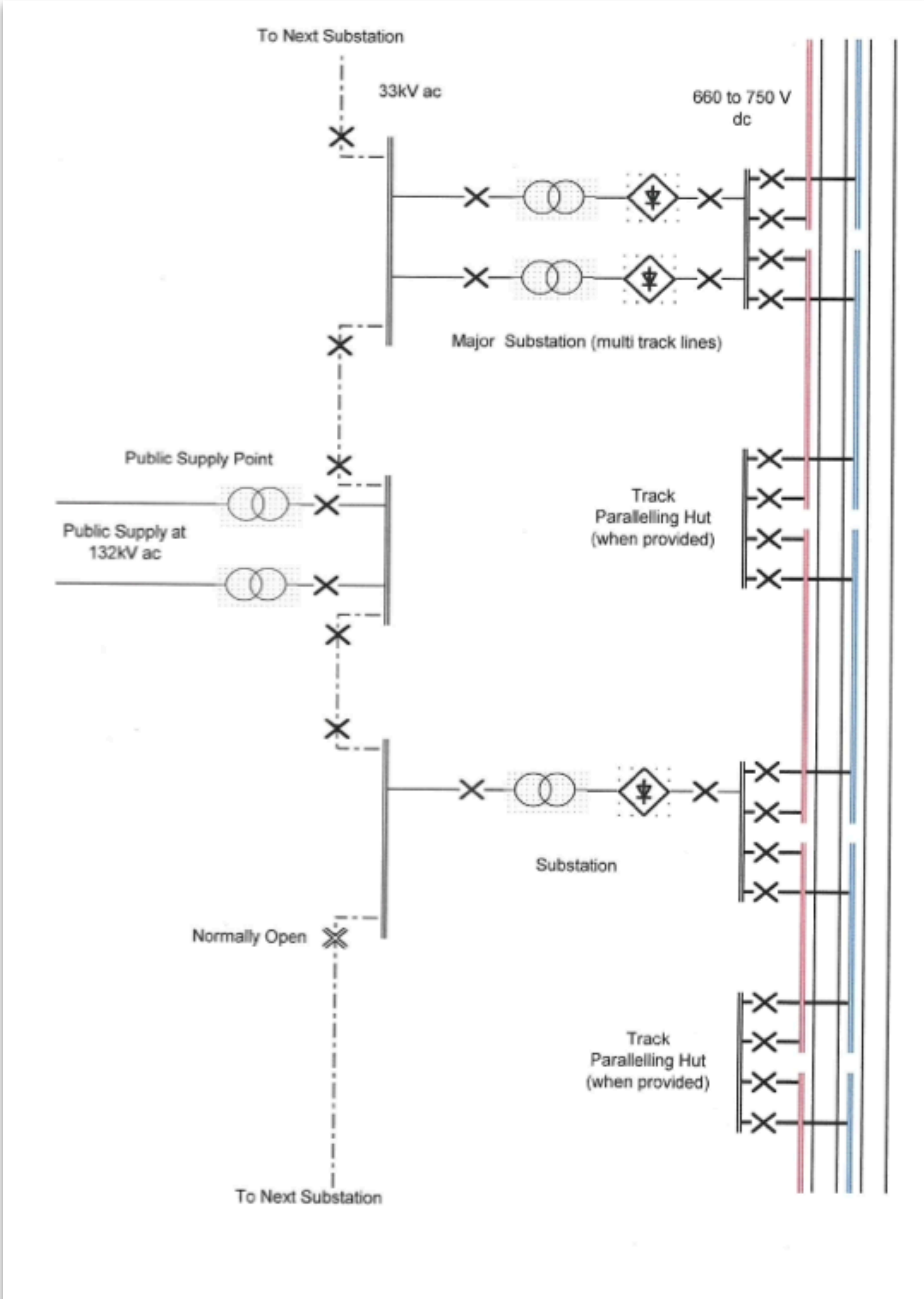


Interior of Waterloo substation. On the left of this view is the direct current switchboard and, in the centre, three of the rotary converters. At the right hand ends of the converter shafts can be seen the the small synchronous motors used to start the machines, and in the centre there are the six slip rings. Just visible is one of the substations transformers. (Railway Magazine Archive)



A five-vehicle, 6,700V train comprised of four trailers and a centre motor van on its way to Coulsdon. This service was introduced by the Southern Railway, but nonetheless the train is in full LBSCR livery. (John Scott-Morgan Collection)





DC Traction System- power feeding arrangements

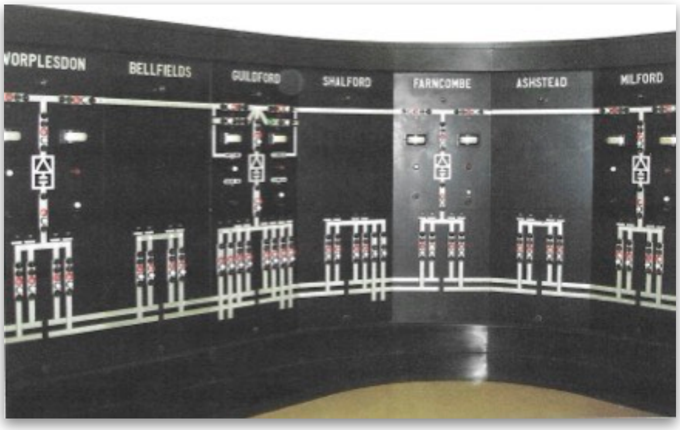
SOUTHERN ELECTRICAL CONTROL ROOMS - BRIEF HISTORY

Early Years in the London Suburban Area

By the late 30's, the majority of this area was electrified on the 660V dc conductor rail system, including the conversion of the original LB&SCR 6.6kV OHL system. There was no overall control system in use. Individual substations were either manned 24hrs a day or controlled by an adjacent manned substation. HV supplies at 11kV, 25Hz, were derived from the ex-L&SWR power station at Durnsford Road (Wimbledon) or from Deptford power station. The substations were equipped with rotary converters to produce the 660V dc supply to the conductor rails.

Main Line Electrification

From 1933 onwards, the Southern Railway electrified the main lines to Brighton, Worthing, Eastbourne, Ore (Hastings), Portsmouth, Reading, Sevenoaks, Maidstone and Gillingham. HV supplies at 33kV, 50Hz, were derived from the Central Electricity Board Grid system. The introduction of "automatic" pumped, water-cooled, mercury arc rectifiers for ac to dc conversion and remote control from centralised Electrical Control Rooms (ECRs) allowed the substations to be left unmanned. ECRs were provided at Three Bridges, Woking, Havant, Swanley and Ore. The control system was provided by ASEA and this was the first remotely controlled electric railway system in the world.



The picture shows the Woking ECR panel.

The Change of Frequency Scheme

In the 1950's, the suburban area was modernised, HV supplies from the CEGB at 33kV, 50Hz, replaced the 11kV 25Hz supply system. Substations were equipped with pump-less mercury arc rectifiers. Three new ECRs were built at Lewisham, Selhurst and Raynes Park. The supervisory control system was provided by GEC and relied upon current telephone technology, based on the Strowger system to automatically select and remotely operate the equipment. The change from 25Hz to 50Hz HV supplies led to the "Change of Frequency" nametag for this area.

Raynes Park ECR

Kent Coast Electrification

The lines to Canterbury, Ramsgate, Folkestone and Dover were electrified by 1960 using similar equipment to the Change of Frequency area. New ECRs were provided at Canterbury and Paddock Wood.

Bournemouth Electrification

The line to Bournemouth was electrified in 1967. Silicon rectifiers were used throughout and a new ECR was provided at Eastleigh.

The picture shows part of the Eastleigh mimic panel.

Isle of Wight

The remaining Isle of Wight line from Ryde to Shanklin was also electrified in 1967, a new ECR being provided in Ryde substation to control the 2 remote substations. Control of this line was subsequently transferred to Havant ECR, and finally to Eastleigh ECR.

Operation at the ECRs

Up to 1967, the ECRs were equipped with an operable "mimic" panel, the selection and operation of remote equipment being carried out on the panel, using control keys, which not only allowed the operation to take place but gave an indication of the status of the equipment under control. Later ECRs used a VDU/keyboard control system with a non-operable panel. Brighton is an example of this type of system.

Tonbridge to Hastings Electrification

Paddock Wood ECR was the first Southern ECR converted to VDU/keyboard operation for this electrification.

Further Electrifications

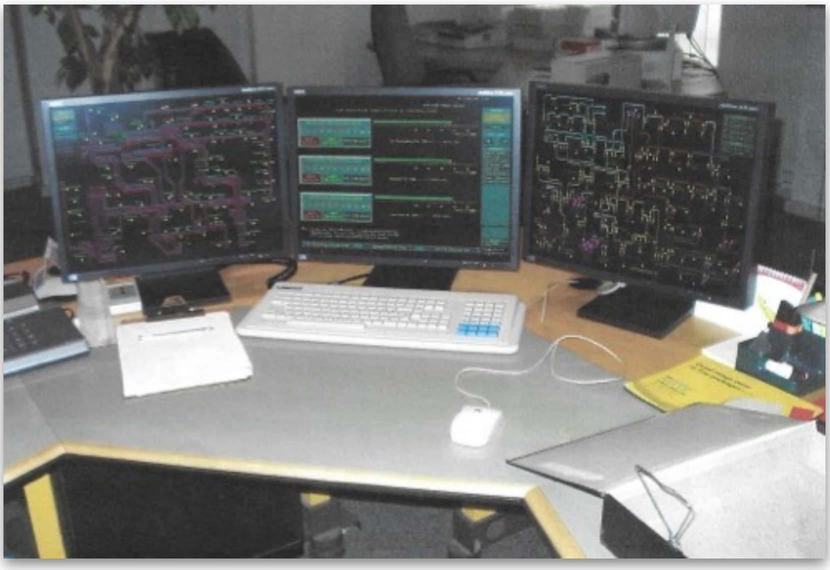
The electrification to Weymouth and the lines between Southampton and Portsmouth are controlled from Eastleigh ECR but the additional substations are controlled by a separate VDU/keyboard system. The East Grinstead Line was to be controlled from the new Brighton ECR, as was the Redhill - Tonbridge Line, electrified as part of the Channel Tunnel works.

The closure of the 1930's ECR at Three Bridges and transfer of control to the new ECR at Brighton marked the beginning of the end for the pre-war ASEA type ECRs and they have all been closed, with control transferred to the newer VDU/Keyboard type ECRs. The ECR at Woking is a listed building and is preserved in a working state, open to the public on 1 day/year during September.

Lewisham & Paddock Wood ECRs

Lewisham is the only one of the 3 "Change of Frequency" ECRs to be modernised. This was necessary to incorporate power supply reinforcements for the "Networker" scheme and electrification of the West London Line as part of the Channel Tunnel scheme.

In Kent, Paddock Wood ECR was expanded to control the additional substations and equipment, (including 25kV OHL at Ashford) for the Channel Tunnel scheme.



VDU/Keyboard Workstation at Lewisham ECR

Derek Webb

The group of RCEA members thanked Peter and Network Rail (and Derek) for an interesting and informative visit.

Talk

Tuesday 12th November 2024

The BP Magnus Oil Production Platform

Roy Allen - Member

Roy started his talk by showing a few statistics about Magnus.

The Magnus field was discovered in 1974, 99 miles NE of the Shetland Islands.

The oil is 2,700m below the sea bed, which, there has a depth of 210m (= 21 bar). (Google tells us the deepest non floating platform in the World is the Petronius in 550m, and the deepest floating platform is in 2,450m of sea water)

The field is large and contains 1.54 billion barrels of oil of which 869K should be recoverable. (Google also tells us that there are still 1,500 billion barrels of recoverable oil left in the World.)

The production platform was entirely funded by BP and cost £1.3 billion. The 'jacket' weighs 40,000 tonnes and at the time of construction was the largest movable steel structure in the World. The 21 modules subsequently placed on top weigh a further 35,000 tonnes.

Two more facts. Designed to withstand 32m waves (peak to trough). Power provided by three 24MW dual fuel gas-turbine generators (see below).

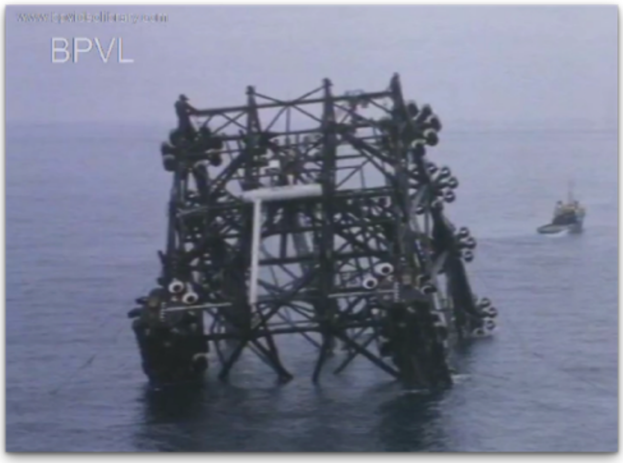
Though designed for a 40 year life, it is still functioning today and is now 25% owned by a company that specialises in extracting oil from depleted wells.

The following photos (extracted from the BP Magnus film) are mainly self explanatory.

Shows one of the mooring cables being released from the rig by explosive charge prior to the structure leaving its construction graving dock (trace of smoke still visible). Note the continuous splash in the bottom RH corner as the heavy cable falls into the sea. Note also, the pile guides which will guide the piles into the pile sleeves at the bottom of the legs. Sacrificial anodes were only fitted to the pile sleeves (not visible); the remainder of the structure was designed with a corrosion allowance.

Gives some idea of the scale of things.

Shows the rig being tipped into position. But something has just gone badly wrong, and operations have stopped pending inspections by divers. Apparently 10 of the 14 piles which were held in position during the journey out, by wooden wedges (!), have slipped free and fallen to the sea bed. (MW remembers as an apprentice, they were told never to use wooden packing pieces when setting up lathe cutting tools. Not stable enough.) Roy adds; But they were designed (incorrectly!) to come out during driving - wood would float to the surface for recovery. Note that the final number of piles was 36; the figure of 14 refers to the piles with capped ends which were pre-installed below the waterline at float-out because they were neutrally buoyant and could be transported for 'free'.



One of the piles being placed in position prior to driving. Roy recollects that the subsequent hammer count was about 10,000 per pile which suggests 10mm/blow, perhaps 250mm per minute.

The slings for one of the modules being attached to the crane hook. The rigger is manoeuvring the slings onto the hook using a smaller sling which is connected to the ear of the hook, passed round the main sling and winched up onto the hook.

View of final assembled platform. Note the helicopter pad – the only one in the North Sea at the time capable of taking a Chinook.

Roy also showed some of his own photos, including one taken when high up on a tiny 4-man platform hoisted by one of the cranes. He had a number of anecdotes and comments:

- He was once on a helicopter out-going journey flying into a strong headwind. After 1½ hours the pilot announced that they no longer had enough fuel to get there. So they turned round and got back in 15 minutes.
- The ten lost piles needed replacing fairly quickly. It was Easter time and Ravenscraig (the largest hot strip steel mill in Western Europe – since closed down in 1992 – and the only UK steelworks capable of rolling 63mm plate into cylinders) was on holiday. But senior figures in Prime Minister Thatcher's office contacted Ian McGregor (then head of British Steel) and persuaded the workers to come back in and make the replacements. Roy also commented that although ‘most of BP’ knew about the incident, it only got two column inches in the Daily Telegraph. This would appear to be due to the attention being given to the Falklands which were invaded that day.

- Roy commented that the build was completed on time and within budget. He reckons that this was partly because it was funded entirely by BP finance.
- The oil was taxed at 42% corporation tax plus 50% PRT (Petroleum Revenue Tax). However, investment in the North Sea could be set against PRT, encouraging further development of the North Sea. Roy has since produced some figures, quoted here, which give some idea of how the finances work. By investing the Forties oil revenue in Magnus, BP were saving 50% of Forties oil output. So if producing $30 million dollars a day, they could invest $15 million in Magnus or pay an additional $15 million to the Government - they chose Magnus! If Forties was producing about $30 million per day, PRT would have been $15 million/day, say £10 million/day = £3,650 million/year. If my estimation of oil revenues is too high, they would still have paid for Magnus in one year, so I am not sure if it counts as before or after tax.
- The Heerema floating crane alongside the platform was also pretty impressive. It could lift 2,300 tonnes with a single crane and about 3,800 tonnes with a tandem lift. And accommodate 500 people!
- Roy had an engineering audit job during final stages of the build. He had to check the surveys measuring the spacing of the module locating 'pins' on the newly placed structure. Each module weighed in the order of 2,000 tonnes, so the pins were large – 900mm diameter, with chamfered tops. Because it was recognised that the sea bed was not level and the structure would distort during piling, appropriate shims had to be placed around the pins, in order to accurately locate the modules. Interestingly Roy commented that the operation was greatly helped by the new invention of the time, VisiCalc – a spread sheet running on an Apple II (considered a killer application). (Google tells us that it just preceded Lotus 123. But nowadays we have Excel - although some of us use macOS Numbers!)
- The turbine generators were dual fuelled. They run on kerosine when there was no oil production (and hence no associated gas production) and then change (on load!) to run on gas once the process plant was producing gas. (The produced gas is practically free and does not need to be stored.) It is quite a challenge to 'black start' a platform if there has been a total shut-down!
- All gas produced offshore is treated, primarily to remove water, so the gas used on the platform is the same quality as the gas exported. Gas production is as predictable as oil production; the gas/oil ration does not change in the short-term. Regarding the flare stack; under normal operation the flare burns very little gas. Gas is exported through the gas pipeline system and sold. The flare must be kept alight in case of a shutdown, because the gas in the system must be burnt in a controlled way when it is vented.
- In those days telephones were not what we are used to now. Roy, in common with other staff, was allowed one brief personal call per visit offshore.
- Not related to Magnus, but still interesting. One audience questioner was interested to hear what had motivated Roy to subsequently become a school science teacher – indeed head of science. Apparently Roy's father lectured at North London Polytechnic (now City University for some years) and although the pay was less, his BP pension transferred very favourably to the State system.

Thanks to Roy for a most interesting talk. And thanks too for your detailed follow up points and corrections.

Mike Wooldridge with numerous corrections/additions by Roy

End of Newsletter