RCEA
(SUSSEX)

An Association for Retired Professional Engineers

NEWSLETTER December 2025

President's Message

Hello everyone, hope this festive season finds you well.

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 'Small Modular Reactors'.

Attendance has settled down at around 30 / 35 each month, so always room for more!!!

At the AGM communication was discussed again and as you are aware a WhatsApp group has been set up for quick messages that need to go out, about 60% of the membership has joined up and if you haven't and would like to, please let me know.

Some of us are looking forward to the Christmas Lunch on 11th December at the Findon Manor and I am pleased to say that numbers have increased from last year.

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 5th 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 2025 – April 2026

9th December	Tuesday	Talk - Weather to be or not to be
18th December	Tuesday	Coffee – at Spotted Cow, Angmering
13th January	Tuesday	Talk - The varied and successful life of a 'failed' engineer.
15th January	Thursday	Coffee – at Spotted Cow, Angmering
29th January	Thursday	Coffee – with Partners at Swallow's Return
10th February	Tuesday	Talk - Ammonia Fuelling the Future
19th February	Thursday	Coffee – at Spotted Cow, Angmering
26th February	Thursday	Coffee – with Partners at Swallow's Return
10th March	Tuesday	Talk - Converting a 160ton concrete WW2 petrol carrying barge into a 6 bedroom houseboat
19th March	Thursday	Coffee – at Spotted Cow, Angmering
26th March	Thursday	Coffee – with Partners at Swallow's Return
14th April	Tuesday	Talk - Net Zero – Challenges for the National Grid
16th April	Thursday	Coffee – at Spotted Cow, Angmering
30th April	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 will be as printed in the detailed description of the activity.

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

- Frank Riddle, Pulborough

Member's Articles

Our newsletters are also a vehicle for our members to publish short articles on engineering related topics. Articles can be of any type, technical, review or opinion aimed to stimulate discussion. So if you've always wanted to put pen to paper (or today's equivalent) then please send your article to our editor, David James (dr.david.james@gmail.com).

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. December 2025 to April 2026

Talk

Tuesday, 9th December 2025 - Weather to be or not to be.

Bob Riddaway

The establishment of a network of telegraphs allowed the collection of weather observations in real time. This led to the issuing of the first public weather forecast in 1861. Since then technological developments and enhanced understanding of atmospheric processes have underpinned the increase in accuracy of weather forecasts. In particular, from the mid-1960s the use of increasingly sophisticated numerical models coupled with an enhanced availability of observations, especially using satellites, have led to modern five-day forecasts being as accurate as one-day forecasts 50 years ago. These developments will be discussed along with how numerical models are used to investigate climate change.

Bob Riddaway

After gaining a BSc in Physics and PhD in Meteorology from Edinburgh University, he joined the Met Office to do research. He soon found that training and operational meteorology were more to his liking, so his career included being Head of London Weather Centre, Head of Training, Joint Head of Forecasting and Head of Development Resourcing & Technology. Whilst at the Met Office he became involved in the education and training activities of World Meteorological Organization (WMO). After retiring from the Met Office his involvement with WMO continued and he also worked as a consultant at the European Centre for Medium-Range Weather Forecasts (ECMWF) for ten years.

For nearly fifty years Bob Riddaway has been involved in the activities of the Royal Meteorological Society (RMetS). These included running various educational activities, helping to establish professional meteorological qualifications and being the founding editor of the journal Meteorological Applications. For eight years he was the RMetS General Secretary and is currently a member of the Accreditation Board. He has also been the President of the European Meteorological Society (a society of meteorological societies).

Talk

Tuesday, 13th January 2026 - The varied and successful life of a 'failed' engineer.

Richard Sykes

Richard Sykes has had a very varied and interesting working life as a mechanical engineer, mainly working on internal combustion engines. He admits to not being an academic and left secondary education with no qualifications but continually learned during his working life to achieve a reasonable amount of success.

This talk will mention his career path but will concentrate on the stories, some interesting from the engineering aspect, others because they are humorous. Along the way there are some interesting observations about life and the behaviour of some people he has met.

Talk

Tuesday, 10th February 2026 - Ammonia Fuelling the Future

Jean-Pierre Pirault

Ammonia, in spite of its toxicity and choking pungency, has found many important applications in our lives, such as fertilisers, sanitation/hygiene, refrigeration, cold packs, explosives and for the treatment of exhaust gas NOx emissions of diesel engines.

And now 'Green' ammonia is being examined as a carbon neutral fuel for non-public transport applications, notably heavy shipping, off-highway vehicles and construction equipment.

Ammonia fuelling of internal combustion engines and/or fuel cells is viewed as a potential intermediate step towards hydrogen fuelling, although ironically the manufacture of ammonia is highly dependent on the availability of green hydrogen.

Jean-Pierre Pirault, with nearly 60 years of internal combustion engine experience, takes a brief look at ammonia and how its near to medium term use could significantly help the drive to Net Zero carbon emissions. The potential sources of green hydrogen will also be discussed. In summary, Jean-Pierre's talk will cover:

- What is ammonia
- Global warming/Greenhouse gases
- How is it made?
- Ammonia current uses
- Reasons for fuelling • Green ammonia
- Challenges & solutions
- The future.

Talk

Tuesday, 10th March 2026 - Converting a 160ton concrete WW2 petrol carrying barge into a 6 bedroom houseboat

Mike Wooldridge

In 1996 Mike and his wife Chris suddenly had an opportunity to purchase a freehold houseboat mooring plus a decaying 'gentleman's yacht' in Shoreham Harbour. After securing a family loan he bought the mooring and boat at auction the following week, and then had a challenging time:

- Disposing of the existing 'yacht'
- Finding a replacement in the form of a slightly damaged WW2 concrete petrol carrying barge moored at Torpoint, Plymouth
- Getting planning permission; definition of a Houseboat
- Preparing the site (which 'dries' out for 80% of the time)
- Arranging the tow from Plymouth
- Safely mooring the barge
- Doing the conversion work – including being the first Shoreham houseboat to connect to mains gas and sewerage.

Mike will address each of these points, and discuss the ongoing use, and subsequent sale, of the boat.

He will also mention how the same design engineers, and civil engineering companies were involved in the construction of the Mulberry Harbours – an essential component of the allied invasion of France in 1944.

Talk

Tuesday, 14th April 2026 - Net Zero – Challenges for the National Grid

Roger Arthur

Roger will open his talk with a brief review of his career covering the design and commissioning of large power systems – in particular a 360MW power station in Malaysia. He will take time to explain certain technical terms (such as Synchronous/Asynchronous operation, System Inertia, and other terms mentioned below).

Moving on to the Government's target for NZ (Net Zero carbon release to the atmosphere) he will highlight the UK's lack of money, materials (and associated lead times), and skilled resources to meet said Target. This will be illustrated with particular reference to:

1. Providing spinning reserve power, to meet Maximum Demand (MD) – (including droop control) - by the target date of 2035. By then around 40 GW of aging nuclear and gas powered generators will have been retired.
2. The portion of power capacity provided by 'Renewables' that must be backed up by non-Renewables to cater for sustained periods of calm, cloudy, cold UK (winter) weather.
3. Interconnectors (to other countries); capacity and availability.
4. More subtle engineering considerations such as: Rotational Inertia (aka Generator Stability), MVAR capacity, and fault clearance capability.
5. The role of Grid scale batteries and potential Hydrogen usage and storage.
6. Up to date Grid control to deal with Grid intermittency.

7. Sufficient distributed Black Start capability. (The RCEA visits to Shoreham Power Station touched on this.)

Such factors rudely came to the fore during the recent Iberian Blackout, and may well do so again if (and when?) a similar situation arises in the UK.

We continue to be told that wind and solar will be free, when the cost of electricity is already 30% higher than the wholesale price, (due to green levies) and wind capacity factors have been reduced by almost 30% relative to those quoted in the original NZ case for their use. Also the cost of back up capacity (see bullet 2 above) must be included when costing Renewables. The Royal Society estimates that 100TWh of energy will be needed pa for that.

Hydrogen is also cited as an alternative green energy storage medium but the technology is relatively new, expensive, and carries other challenges.

The ongoing availability of nuclear fuel has also been cited as an issue: Roger will touch on the under used possibilities of re-processing spent fuel.

Added to all this is the cost of the extra distribution lines and equipment. NG (National Grid) estimated £3trn, just for the U.K. grid upgrading. Then we need to add in costs of local network upgrading as well as potential subsidies for heat pumps, home insulation etc. McKinsey's (a well respected independent consultancy) estimated the TOTAL cost of UK Net Zero at £5 trn, which they equated to 7% of GDP pa through to 2050. However, DESNZ (Department for Energy Security and Net Zero) continues to quote <£1trn and, worryingly, say that they don't have a viability analysis as such, for Net Zero.

Reports

Click on a title to go to that report.

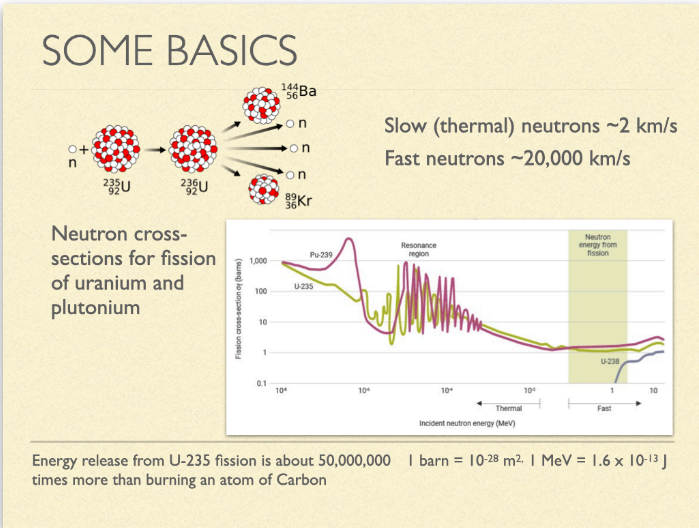
Talk

Tuesday 16th September

Small Modular Reactors

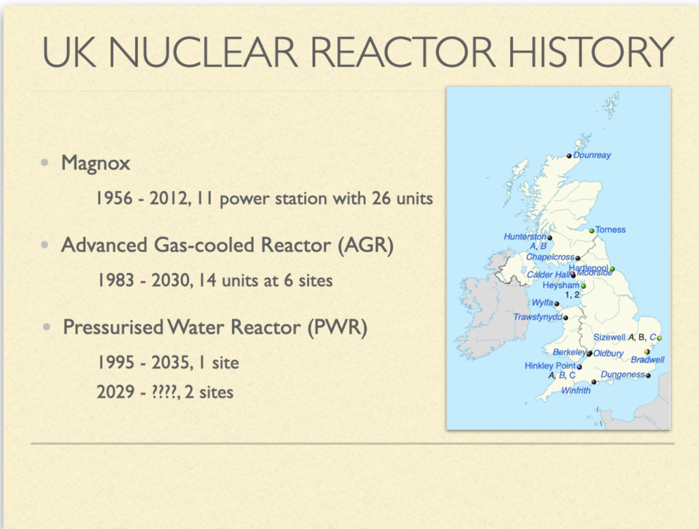
Dr David James - Member

The subject of Small Modular Reactors was topical due to the UK Governments selection of the first supplier of such systems. However, David started by refreshing the memory of the audience with a reminder of the nuclear fission process to produce a chain reaction and of the probability that a fast neutron (as produced in a fission of a Uranium nuclei) and a slow, or thermal, neutron.



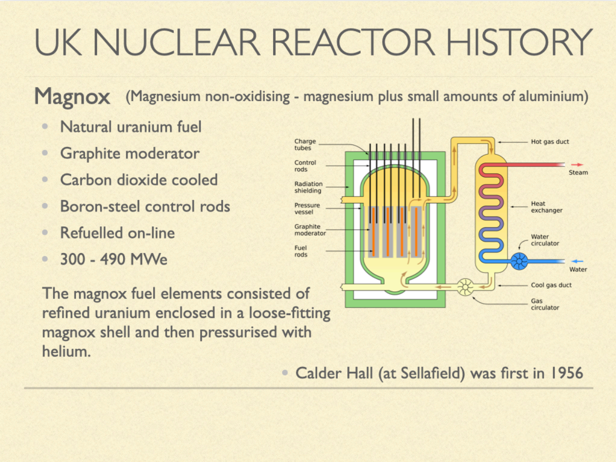
This led to a brief description of the Uranium and Thorium fuel cycles and of the basic types of nuclear reactor, fast and thermal. In the latter, neutrons are slowed down using a moderator such as water or graphite, thus increasing the probability of being captured.

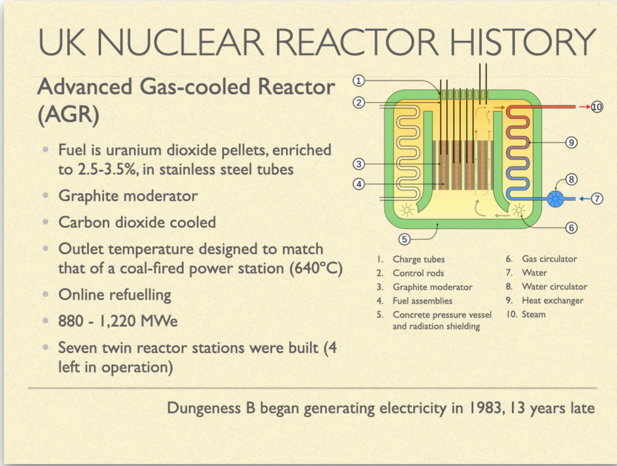
This led on to a brief description of the history of nuclear power in the UK, starting with Magnox reactors (carbon dioxide cooled, graphite moderated), followed by Advanced Gas-cooled Reactors and, more recently, Pressurised Water Reactors (water cooled and moderated).



None of the 11 Magnox stations are now in operation, although four of the seven twin-reactor AGR sites are still producing power. Operating experience and monitoring has led to a significant extension of their working life.

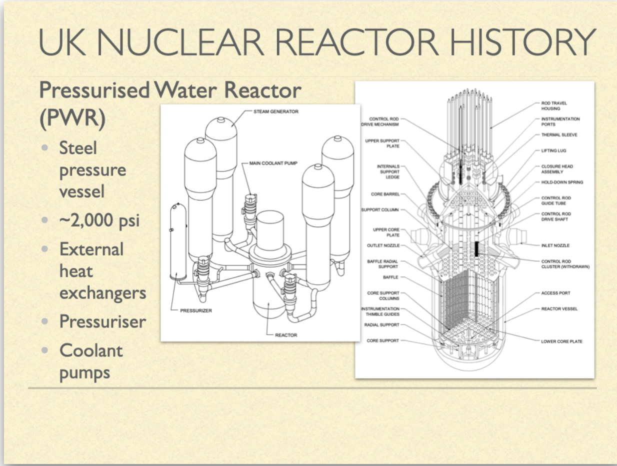
David briefly described each type as shown below.



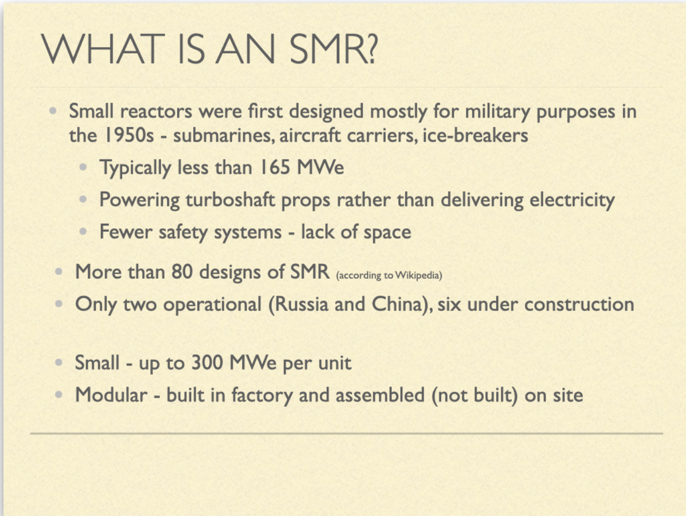


The Sizewell B PWR station on the Suffolk coast started operation in 1995 and is due to shut down in 2035, although this might be extended to 2055.

Unit one of the Hinkley Point C PWR was originally due to start operating in 2027, but is now claimed to start between 2029 and 2031. The construction of an 'identical' plant at Sizewell started construction in January 2024.



David then got to the main topic of the talk, Small Modular Reactors. He started by defining what is meant by an SMR, then outlined the UK competition and finally looked at the competing designs.

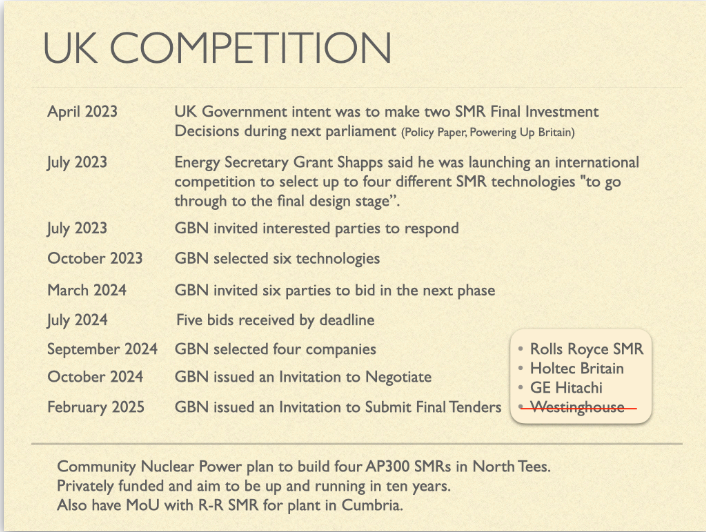


The key point is that component parts of the plant are manufactured in a factory and then assembled on site, unlike conventional power plants, which are constructed on site.

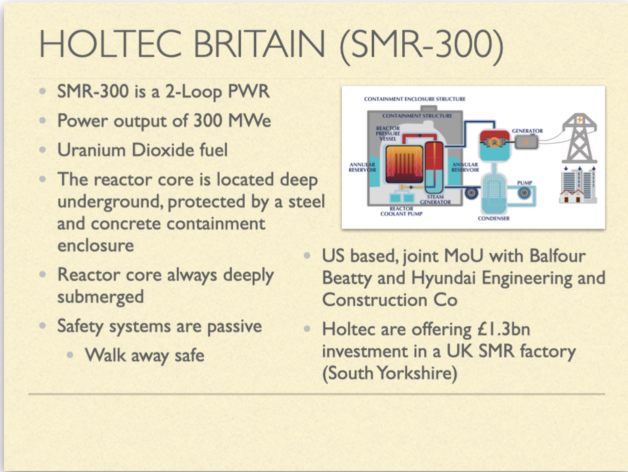
As you can see from the slide below, the UK Government stated in April of 2023 that it would aim to place contracts with two suppliers of SMRs. Later in the year the competition was launched to select four different SMR technologies. Initially, from the vendors expressing an interest, six technologies were selected and the vendors were invited to submit a bid for the next phase of the competition.

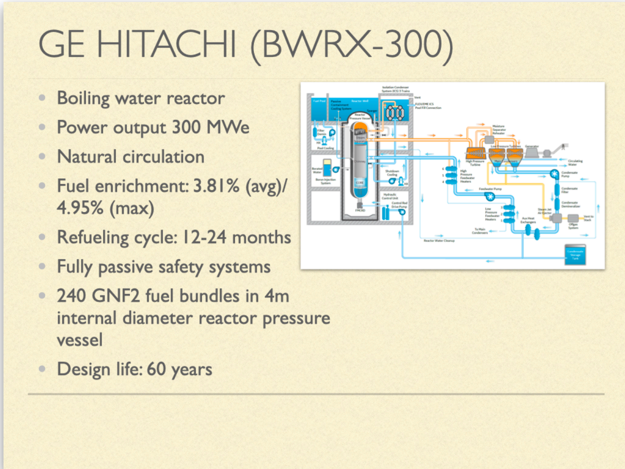
By July 2024 only five bids had been received and Great British Nuclear (which had been formed during the intervening period) selected four suppliers. As you can see from the slide, they were Rolls Royce SMR, Holtec Britain, GE Hitachi and Westinghouse. By February 2025, when GBN issued invitations to submit a final tender, Westinghouse had pull out. It looks as though their interest lay more with a privately funded project in North Tees.

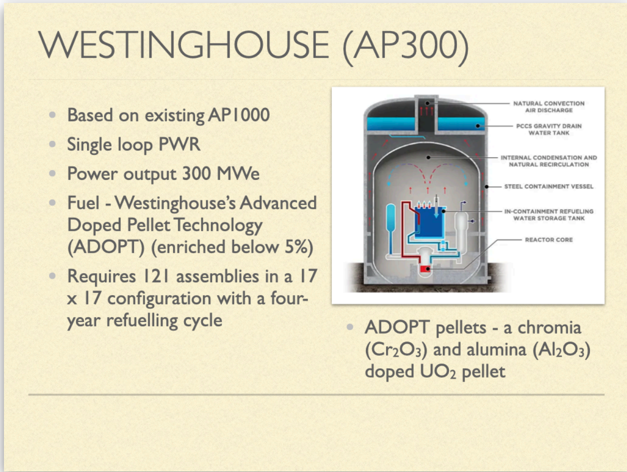
Nevertheless, David gave an overview of each of the designs being proposed, including that from Westinghouse. Holtec, Westinghouse and Rolls Royce proposed to use PWR technology, whereas GE Hitachi put forward a boiling water reactor design. The slide providing an overview of each of the proposed SMRs are shown below.

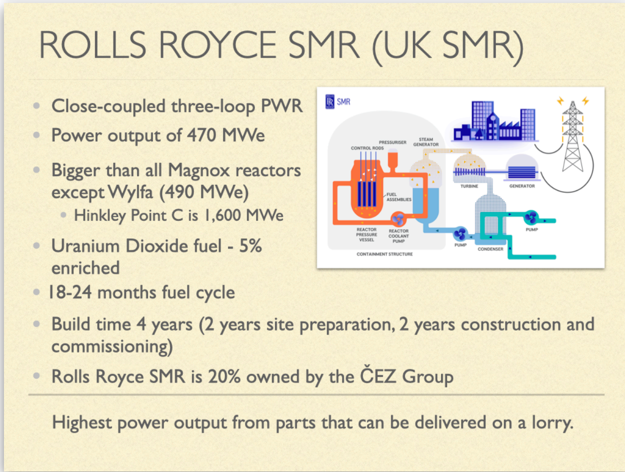


The total UK electricity usage has fallen over the past twenty years, mainly due to the closure of heavy industries. Coal-fired power stations have all closed, gas-fired station output has remained fairly steady, older nuclear stations have been shut down and renewables have increased dramatically. However, it takes a long time to bring new nuclear stations online. The UK Government's plan was to select two SMR vendors in the summer of this year, place final orders by the end of 2029 and have the first SMR operational some time in 2030.









The Government has already changed this by only selecting one vendor. In June of this year Rolls Royce SMR was chosen, with the intent to provide three SMRs, with the manufacturing sites and the deployment sites being selected by the end of this year.

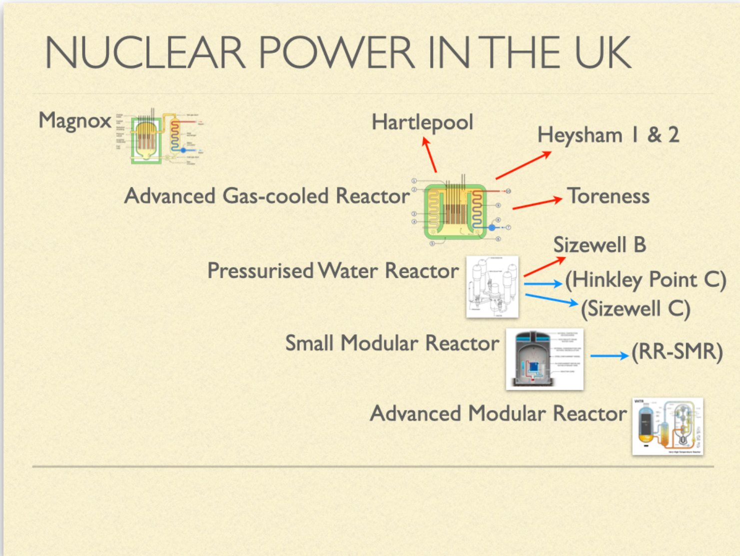
David pointed out that this is not the only activity with respect to SMRs in the UK. Community Nuclear Power plan to build four Westinghouse AP300 SMRs in North Tees. They hope to have a fully licensed site by 2027. The project is privately funded and aims to begin generating clean energy within ten years of the agreement. Also, Last Energy has formally launched the UK's nuclear site licensing (NSL) process for plans to develop four 20-MWe micro-reactors in South Wales. They hope to deploy four 20-MWe PWR power plants at the vacant site that housed the Llynfi Power Station, a coal-fired power plant in South Wales that operated from 1951 to 1977. Last Energy is working to deliver its first micro-reactor in Wales in 2027, pending the licensing, permitting, and planning processes.

David finished by giving an outline of what might happen beyond SMRs, so called Advanced Modular Reactors that come under the category of Generation IV reactors. In July 2021 the Nuclear Innovation and Research Office published their Advanced Modular Reactors Technical Assessment, which looked at six technologies:

1. High / Very High Temperature Gas Reactors (HTGR / VHTR)
2. Sodium-Cooled Fast Reactors (SFR)
3. Lead-Cooled Fast Reactors (LFR)
4. Molten Salt Reactors (MSR)
5. Supercritical Water-Cooled Reactors (SCWR)
6. Gas-cooled Fast Reactors (GFR)

David gave a brief overview of each of these before stating that the report concluded that High Temperature Gas Reactors were the preferred technology, having high technology readiness, that temperatures of 700°C - 950°C provides greater versatility in application and were an evolution of the existing AGRs.

His final slide summarised the UK's nuclear power journey, from Magnox reactors through to Small Modular Reactors, showing those still operating (red arrows) and those being built or proposed.



Update

Towards the end of August it was announced that Amazon had entered into a partnership with X-Energy to deploy a number of their Generation IV, Xe-100 High Temperature Gas Reactors to power Amazons Web Services (AWS) data centres.

Report by David James

Visit

Tuesday 30th September 2025

Shoreham Power Station

As you can see from the obligatory group photo, a dozen of our members attended the second visit to Shoreham Power Station this year.

Mike Wooldridge lead the first visit to the power station in June this year. You can read his report in our August 2025 Newsletter.

As on that first visit, we started with a talk from Gordon Walker, the station manager, followed by a 'royal' tour (no steel capped boots). Actually the first part was as much a question and answer session as Gordon went through his slides as it was a talk.

I'll not repeat what Mike wrote about the history of the power station and its operation, but just try to fill in additional material.

Mike spoke about a major upgrade in 2002 which increased the thermal efficiency of the plant to 58%, one of the highest for a CCGT station in the UK. Gordon emphasised this by saying that during the previous week they had run full time. The National Grid provide them with a schedule of what power they should produce agains time. This is displayed on a monitor in the control room. However, as could be seen during our visit, National Grid can make adjustments to the schedule every five minutes (using a different coloured line on the display) and, instead of being shut down as scheduled, the plant was at full power. The operator adjusts the gas input so as to change the torque and so follow the line. The frequency, off course, has to be kept within tightly prescribed limits.

It seems that this year was an 'interim year' and so they were only shut down for 12 days in the summer to carry out a minor schedule of work.

When asked if the plant could be run on hydrogen, Gordon said that the turbine supplier claims it could be run with 40% hydrogen in the fuel mix. However, this has not been tested with the whole system. Currently the NOx emissions are 25 mg/m^3, only half that of other types of CCGT plant.

The photo shows the louvres of the air intake unit, which incorporated

HEPA filters. This unit is on the seaward side of the station and so takes in salty air. It would be better if the station were rotated through 180 degrees so as to take air from the land side. However, the noise from the air intake would then be towards the houses, which wouldn't be acceptable.

As Mike reported, you can't see a great deal on the tour, since everything is enclosed. However, every member of our party thoroughly enjoyed the whole visit and thanked Gordon for his hospitality.

Report by David James.

Talk

Tuesday 14th October 2025

Industrial AI for Autonomous Operation

David Smith - Director Engineering Technology Adoption, AVEVA

David was introduced by his father-in-law (our hon treasurer) and started his talk with a brief resumé of his career. This featured a spectacular shot of huge vortices behind an airliner – a subject that he studied for his PhD. See Figure 1 – an internet photo different from David's, but equally impressive. He then worked on high pressure boilers before joining his present company, Aveva – not the insurance company – see the Google extract below.

Figure 1

ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic [?? I quote here an explanatory footnote taken from a Google definition - … The term can also be used to mean being noncommittal or not having a definitive opinion on other subjects.] and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Drivers Authority and Speed Control

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability. Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 *employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge - see UK. www.aveva.com.*

David outlined the essential principles of what his company uses to develop its products. A real time computer system takes in many signals gathered from many sensors (e.g. temperature, pressure, flow rates, vibrations) that are attached to an item of plant, and learns what is 'acceptable' and what presents a 'reason for concern'. Of course we have had instrumentation doing this since engineering began, but the clever bit now is that the computer becomes aware of certain combinations of readings, and maybe their trend over time, and is able to flag up interesting situations that probably would not register with a human operator until things get more serious and something fails. Hence the operational staff are able to take preventative action, or optimising action, in good time and under controlled conditions, instead of being faced with a more serious situation which could cost large amounts of time and money to put right.

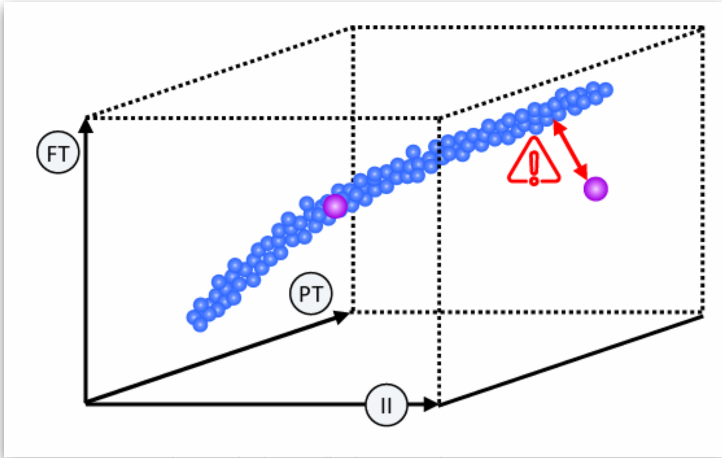


Figure 2

Figure 2 shows a 3-D plot of results for a given piece of plant (e.g. a boiler feed pump) which shows how three variables, PT [pressure transmitter], FT [flow transmitter], and II [current indicator], behave in combination when the plant is operating normally. The AVEVA system notes this, and then learns to recognise when said variables deviate by a certain amount from this plot, and displays an appropriate message to 'the operator' who may be based remotely. Figure 3 illustrates some of the complexity that may be involved and the apparent 'intelligence' that the system displays when assessing what to recommend, or do. The system can also forecast how long it will be before there is a failure, allowing maintenance to be scheduled.

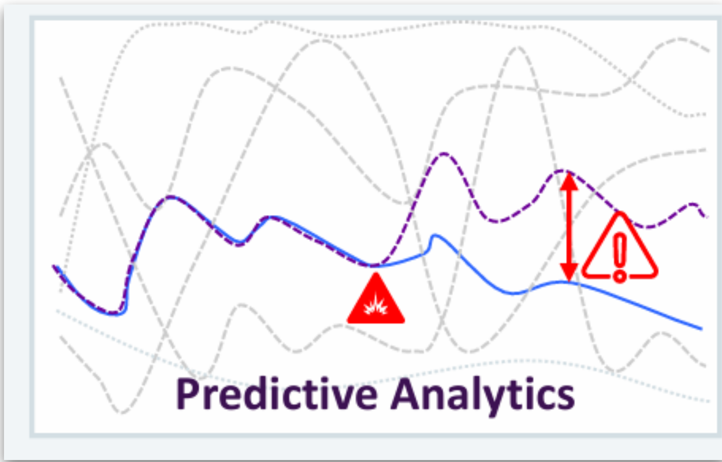


Figure 3

Figure 4

David showed several examples of real life applications. Fig 4 shows a photo of a particularly dramatic failure, where the software had (or 'would have' – had it been in proper operation) indicated ‘cause for concern’ long before the damage was done. The photo shows two rows of turbine blades completely broken off from a power station steam turbine shaft, which came to light during a maintenance inspection. Apparently some steam condensate had got into the main steam flow, and gradually caused the blades to break off over a period of a year. The operators were aware that something was not quite right, but had they been using the AVEVA system various sensors would have picked up the incipient damage at least a year before the situation shown here.

Figure 5 shows a simple but interesting graph which illustrates a further justification for AVEVA monitoring. The top graph shows power output from a power station operating under traditional conditions – i.e. ‘full’ output with occasional, probably planned, shut downs. But the lower graph shows a different operating regime some ten years later, where output demand is more carefully tuned to the economics of grid supply. It will be seen that the plant is now subject to far more stops and starts, and the power output varies far more. This presents a different set of stresses and strains to the plant, which, accordingly, presents different situations to the operator who may well not be sensitive to the corresponding new set of potential fault conditions. But the AVEVA system will be aware more quickly, and will provide valuable and early maintenance and operational information.

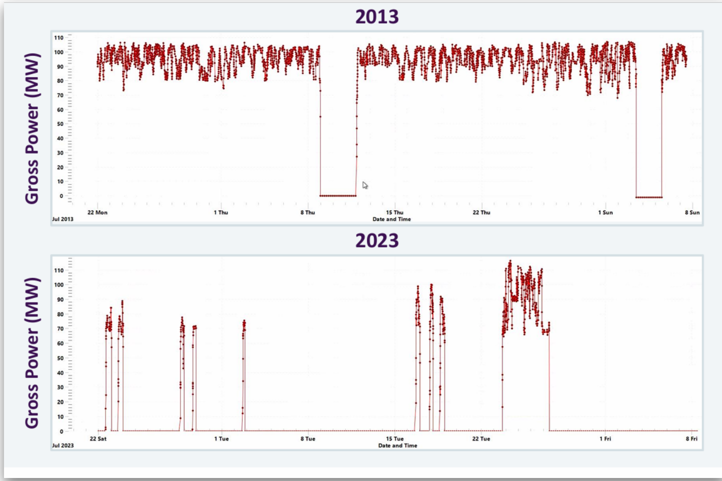


Figure 5

AVEVA also supply dynamic simulation software for process plant. Therefore they can use the plant simulation to help train the AI system. The trainer can reward or penalise the Artificial Neural Network according to how well it does.

David finished his talk with a slide showing what the public may recognise more readily as ‘modern AI’. When an operator, or engineer, needs to address a problem being flagged by the software, he may well need to consult appropriate manuals and past operational data. AVEVA provide a ‘Large Language Model’ (LLM) which takes normal, possibly vague, speech input and does its best to convert this to instructions that call up and present relevant information for use by said operator/engineer. To provide more accurate information the system uses Retrieval-Augmented Generation (RAG). According to an AI-based search engine, this works by retrieving relevant documents or data from an external knowledge base—such as databases, document repositories, or real-time data feeds—at query time and incorporating them into the prompt before generation. It seems that this approach addresses key limitations of LLMs, including hallucinations, outdated information due to static training data, and lack of source attribution, by grounding responses in verified, up-to-date content.

Thank you David for visiting us during ‘work time’ and giving us a most interesting and lucid talk.

Report by Mike Wooldridge

Talk

Tuesday 11th November 2025

Railway Signalling. What's it all About?

Clive Kessal

Many of us have those nostalgic memories of a signalman pulling a lever in a signal box by the side of the track and moving the semaphore signals and track points. However, Clive explained how things have changed and will continue to change into the future.

He started by saying that signal engineering covers the Command and Control System that glues together all the other parts of the railway. But the railway signalling system has moved on significantly through the decades and into the 21st century, through the Power Box, Control Centre and the Signalling Centre. Then to the Drivers Authority and Speed Control.

1960s Power Box

1980s Control Centre

Coloured Lights

21st Century Signalling Centre

Drivers Authority and Speed Control

Clive explained that the purpose and principles of the signalling system are:

- Safe Spacing of Trains
- No Conflicting Moves
- Prevention of Excess Speed
- Route Holding Until Train Passed

But Above All

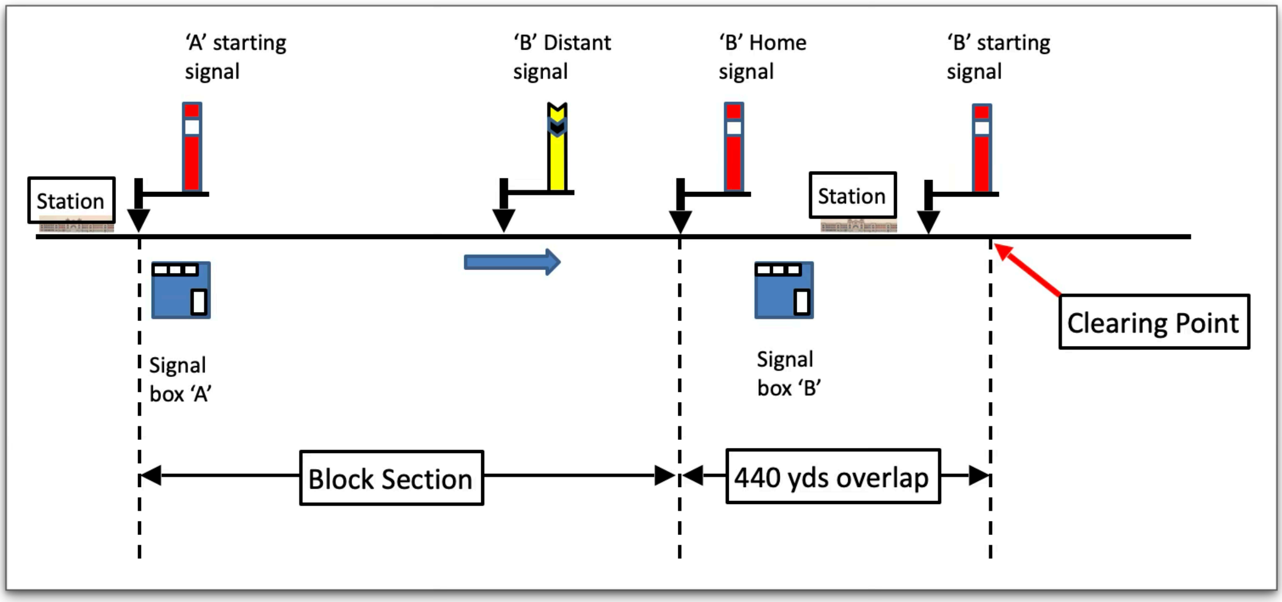
- Keeping Trains Moving

As shown above, signals have moved from mechanical semaphores to lights, the latter showing:

- RED - Stop
- YELLOW - Warning to stop
- DOUBLE YELLOW - Advance Warning
- GREEN - Clear to Proceed

Block Sections & Track Circuits

To keep trains apart, the concept of a Block Section is used. Originally this was the Distance between Adjacent Signal boxes, but nowadays is the section between adjacent signals (Track Circuit Block). In the future it will be the extent of a Movement Authority.



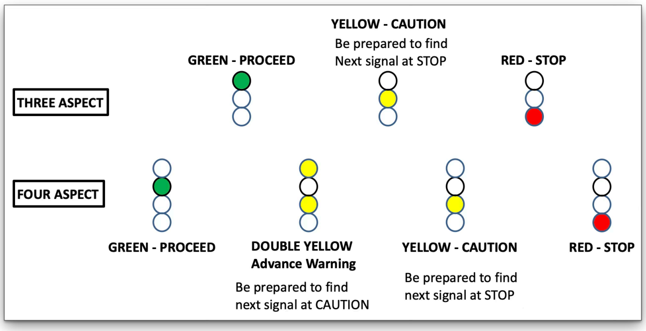
Block System

Clive explained the Block Instruments and Bells as follows:

- Block Instruments have three positions, Normal, Line Clear, Train on Line
- Signallers communicate by Block Bell codes – for example, single beat = Call Attention, 4 beats = Express Train
- Signaller moves block instrument to Line Clear once train is accepted
- When train leaves previous box, signaller moves instrument to Train on Line

- Signaller offers train to next box

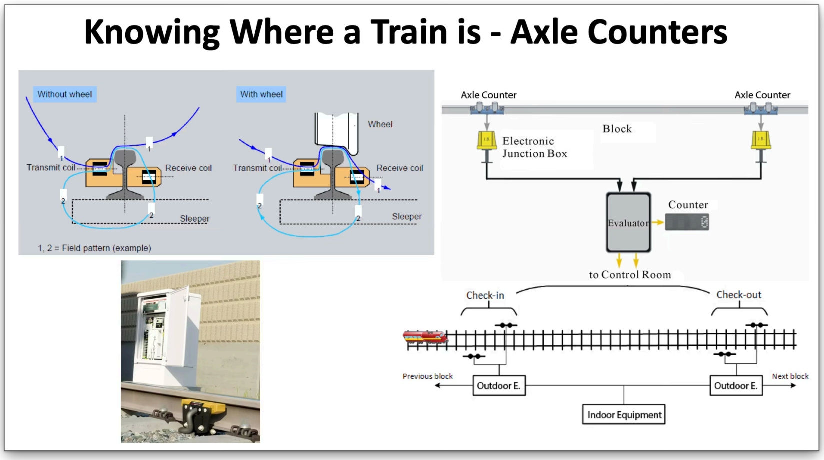
Example of mechanical block instruments



MULTI ASPECT Colour Light Signals

Two types of technology are used to determine where a train is on the track.

1. The 'simple track circuit' divides the track up into sections using insulated rail joints. A simple battery and relay is then used to determine if it is empty or there is a train completing the circuit.

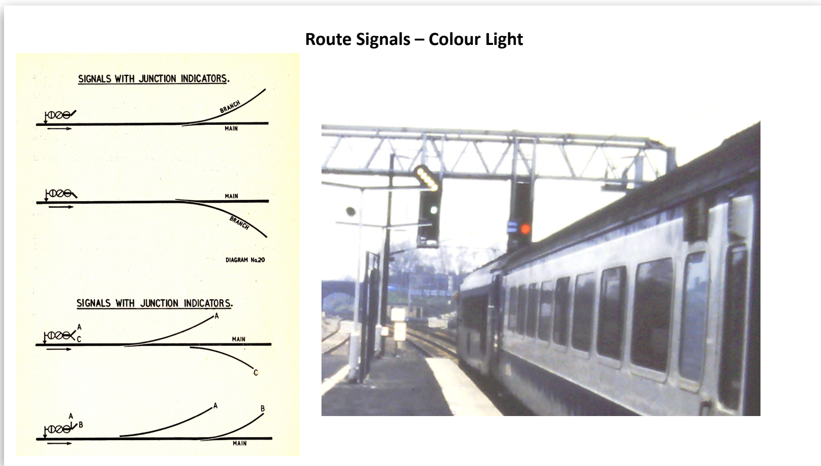


2. Axle counters use the deflection of a magnetic field to count how many wheels have crossed the detector. The system can then detect when a train enters and leaves a section of track.

When asked about today's continuously welded rails, Clive explained that the circuitry has been modified to deal with this.

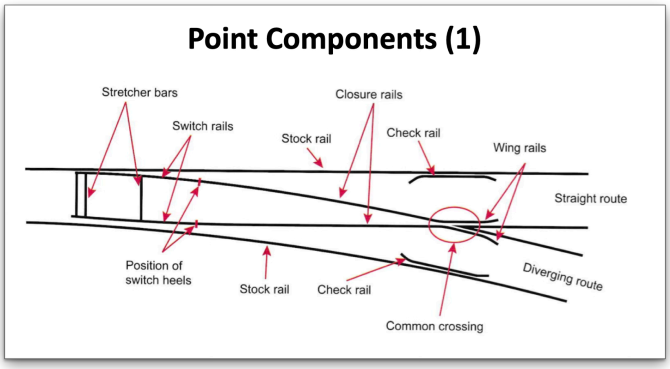
Route Signalling

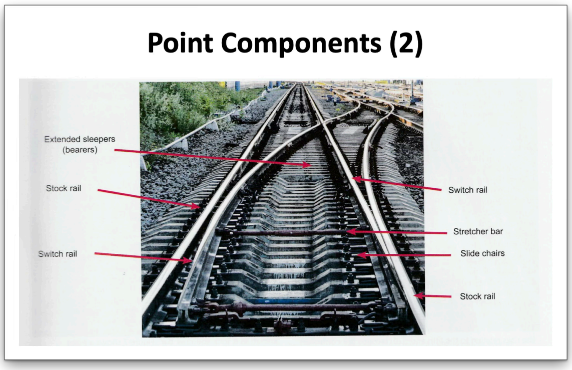
Clive went on to briefly explain how the various types of signal indicate to the driver what route has been set.

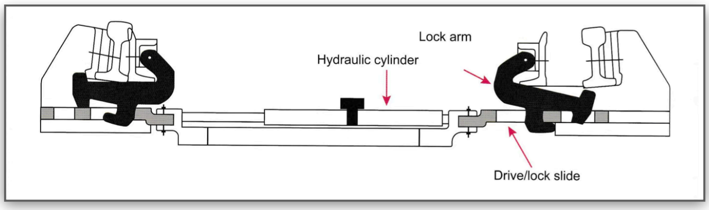


- On Mechanical Signalling, different signals are used for different routes
- A direction indicator at diverging junctions on colour light signalling (shown)
- 'Theatre' indicators are used into or out of platforms at terminals or large stations

Points





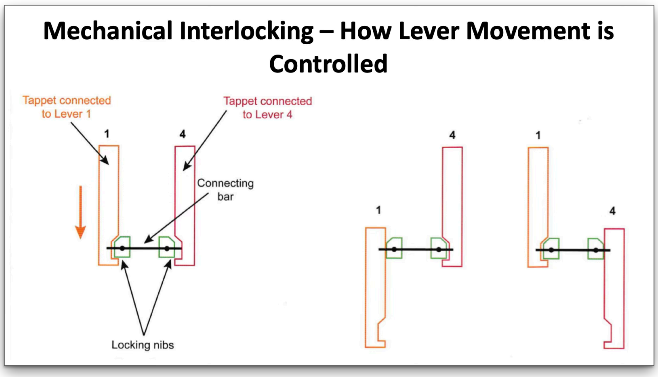


Clive pointed out that the manual system of changing the points is limited to about 100 yards. Otherwise they are electrically operated using a 110V DC motor. If a train is approaching from the left in the above diagram, then the points must be locked, whereas if approaching from the right then the points do not need to be locked. In all cases, however, the point position must be detected and the signals can only be cleared once the point position is proven.

Today the lock is operated by a hydraulic cylinder, with a G-shaped lock arm, called a claw, attached to a pivot on each switch rail.

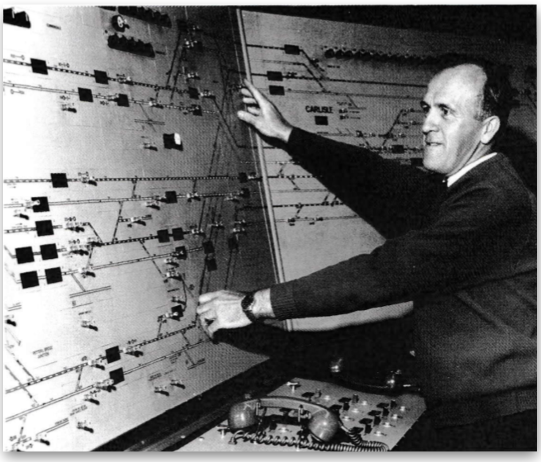
Keeping Trains Apart - Interlockings

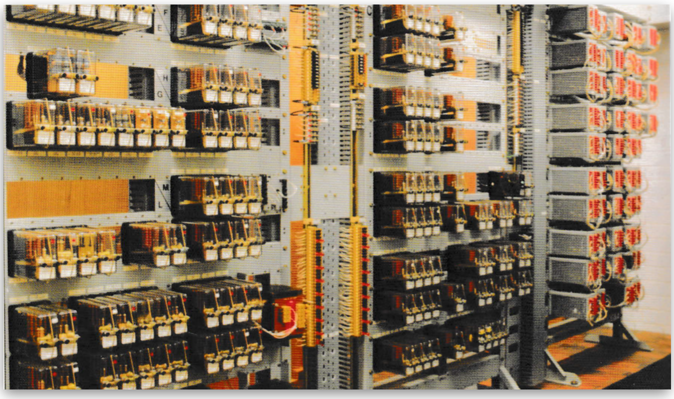
Interlocks are the ‘Safety Layer’ of a railway signalling system. They ensure that conflicting and opposing routes cannot be set and that points can only be moved when it is safe for them to do so. Also, signals can only clear when all points are set if the route and section ahead is unoccupied. The types of technology used for interlocking has moved over the decades from being applied to the mechanical lever frames, to 1950s electro-mechanical systems, to route relay systems in the 1960s and then to computer systems in the 1970s.



These two images show a typical lever frame and the way that interlocks are applied to the levers.

Then we come to the first stage of electrification. The photo shows a Miniature Lever Frame, typical of the 1950s. They have electrical contacts on the lever movements that give additional control facilities and safety measures. All lever frames work on the principle of one lever equates to one action, for example a signal or a point movement.





The next stage in electrification was to use route relay interlocking. The operator selects the entry point and the exit point on the panel and the relays provide interlocking functionality and safeguards, setting up all elements of the required route, for example points and signals.

Nowadays, these panels and relays have, or are being, replaced with computers and screens. Various controller configurations are used to ensure availability, the preferred one being ‘two out of three’ voting. Three controllers (the modules at the top of the cabinet) run the same software and if two of the three agree on the action to be taken then that output is used. The software essentially replicates the relay logic from the previous generation system.

Train Describers

A Signaller must know the identity of a train if he/she is to route it correctly.

Every Train has a Running Number (alpha numeric characters such as 1L46) for a particular journey - equivalent to airline flight number. This number moves on the display as the train moves. The Running Number is also linked to other systems such as the National Timetable, Passenger Information and Track to Train Radio.

Single Lines

Clearly a signalling system must ensure that only one train is in a section of single line track. Traditionally this was achieved by Token Instruments between adjacent signal boxes:

- Signallers communicate by bell codes and mutual pressing of a plunger allows token to be removed.
- The token is given to the driver in a leather pouch, engraved with the section of line. No further token can then be removed.
- At the end of the section the driver hands the token to the signaller and the token is reinserted into the machine. Another token from either end of the section of rail being controlled can then be removed if need be.

The photo shows an Internet Connected Token Machine. However, nowadays single track operation is controlled by Tokenless Block with continuous Track Circuits.

Clive pointed out that tokens are still used on a number of heritage lines.

Level Crossings

Level crossings are the one piece of railway infrastructure that rail operators would really like to remove due to their issues. For example:

- Significant Safety Concerns
- Involve Road Vehicles and Pedestrians
- Waiting Time Criticality
- Behaviour of General Public
- Communication Systems are Vital

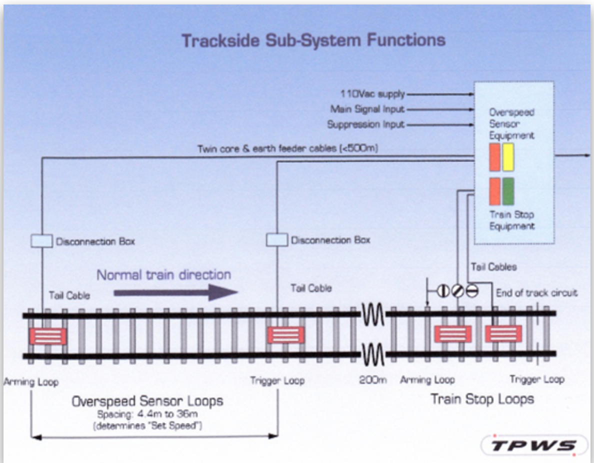
Clive pointed out the surprising number of different types of crossing:

- Traditional Wooden Gates, operated by Signaller
- 4 Barrier Locally Controlled by Signaller
- 4 Barrier Remotely Controlled – CCTV
- Automatic 4 Barrier – Obstacle Detection using radar and lidar
- Automatic Half Barrier (AHB)
- Automatic Barrier Crossing, Locally Monitored (ABCL)

- Automatic Open Crossing, Locally Monitored (AOCL)
- User Worked Crossings (UWC), for example, farm tracks
- Footpath Crossings, sometimes with warning lights (shown above)

Train Protection Systems

Reliance on the driver obeying signals was not good enough, so the Automatic Warning System (AWS) was introduced after the Harrow accident of 1952. It uses track-mounted magnets and a 'Sunflower' indicator in the cab. AWS was simple, but offered limited protection. Not only can the driver cancel the warning, but the system can only distinguish between Green and all other Aspects.



The Train Protection Warning System (TPWS) was then introduced after the Southall and Ladbroke Grove accidents, circa 2000. This system uses magnetic loops (grids) to measure the train speed.

It has both overspeed sensors and train stop sensors, and both sensors have arming grids and trigger sensors. If the speed does not drop then the train brakes are applied and the driver cannot override the warning.

The modern era is all about control and communication. Higher speeds make it more risky for drivers to observe line-side signals correctly and so driver instructions are moved into the cab. Also, radio communication enables constant train position and speed monitoring. The driver is given a 'Movement Authority' and target speed. If either are exceeded then the train is braked or brought to a stop. However, introducing such a system does mean that both the trains and the infrastructure have to be equipped.

The European Rail Traffic Management System (ERTMS), which is in the process of being rolled out by Network Rail, has three component parts:

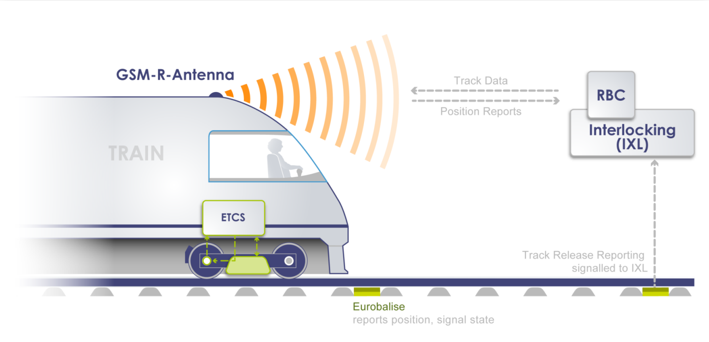
- ETCS – European Train Control System (The Signalling)
- GSM-R – Global System for Mobiles (Railways) (The Communications)
- ETML – European Traffic Management Level (Regulating Trains)

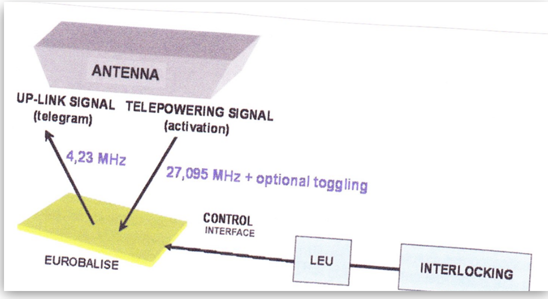
The first of these, ETCS, has three levels of sophistication:

- Level 1 – Standardised Automatic Train Protection (ATP) System
- Level 2 – Radio Based Commands with
  - Euro Balise Train Detection plus train Odometry
  - Issue of Movement Authorities
  - Option of Line-side signal retention (enables unfitted trains to continue to operate)

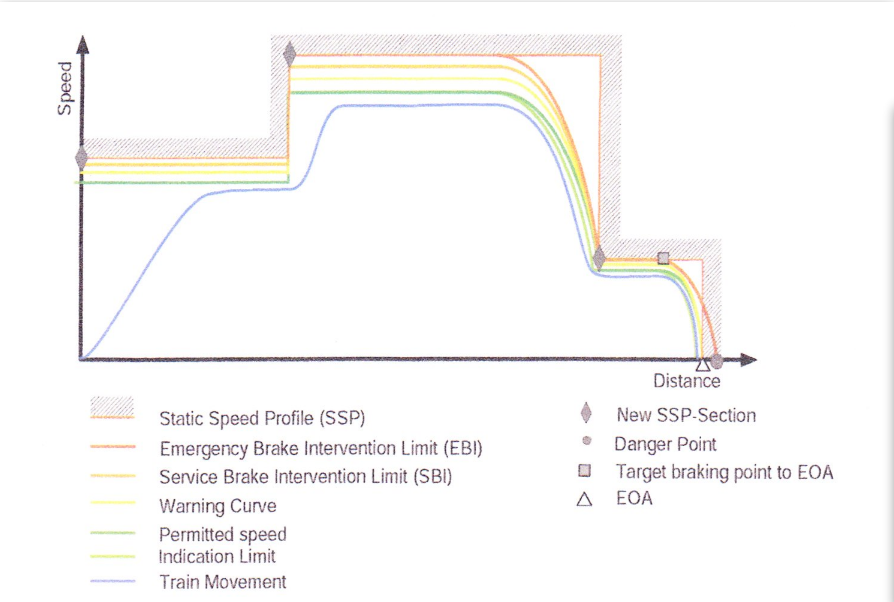
- Level 3 – Total Radio Solution
  - Not yet beyond the development stage for main lines

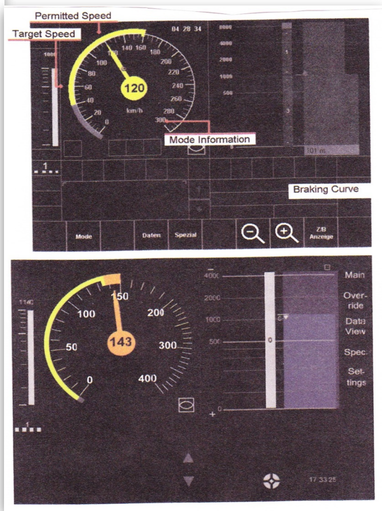
The following two diagrams illustrate the ETCS Level 2 configuration.





And this graph shows how the train speed is regulated.





Finally, this is a view of an ERTMS control room.

The Future

It seems that 12 Regional Operating Centres are planned for the UK. This will provide centralisation of Signalling, Operations and Power Control and will link to existing relay rooms and re-control the present signalling technology

In Summary

Clive summarised his talk as follows:

- Signalling controls the safe movement of trains
- Safety requirements dominate the engineer's thinking
- Get it wrong and accidents happen with possible fatalities
- Modern technology is slow to be adopted until safe operation is fully tested and proven
- Engineers and technicians have to be licensed as competent
- Technology in use spans 180 years of development

An audience member asked about the recent Huntingdon train incident, and how the modern signalling system had enabled an express train carrying a violent passenger who was stabbing passengers, including a brave train crew member, to be promptly diverted to a standstill at a Huntingdon station platform and a waiting police emergency team.

Our members found Clive's talk very informative and entertaining. Mike Wooldridge gave a vote of thanks and our members showed their thanks in the usual way.

Report by David James

Post meeting note: In Mike's vote of thanks he mentioned the fact that in his lifetime he had probably travelled on over 25,000 trains all without a serious safety incident. On reflection he wishes he had stressed what a huge taken-for-granted achievement this represents, when one considers the complexity of the system and the potential dangers of the many 400 ton trains doing maybe over 100mph all running simultaneously on the network, with the many, many smaller, slower trains.

End of Newsletter