RCEA
(SUSSEX)

An Association for Retired Professional Engineers

NEWSLETTER December 2015

President's Message

May I extend a warm welcome to this Newsletter, which is the first of my Presidency, and the first produced by Malcolm Hind.
We are well into our series of talks this session and I have been pleased with the high number of members attending. We have been successful in getting good speakers on some interesting subjects. We are always on the lookout for subjects with a contact for a speaker. If you have something we can follow up, please let Perry Eastaugh know.

Although we have been seeing many of you at the talks, we really do need to increase our membership so that the Association can thrive. Please think about friends, neighbours, and contacts that are retired engineers and might be interested in joining the Association. Bear in mind that full membership is open to Incorporated Engineers (I.Eng), who are a growing part of the engineering profession, and we also have associate membership for those not meeting the requirements for full membership.

I have been encouraged by some, as an electrical power engineer, to make reference to the concern about National Grid being unable to have sufficient generating capacity to meet peak demand this winter.

From my personal point of view, it is very sad that the good intentions of those pressing for sustainable energy generation and a rapid run down of fossil fuel burning have led to us 'cutting it fine' as a nation. Until we get new nuclear and gas fired generating capacity built to replace the existing and life-expired nuclear and coal fired plant we are at great risk. I support the recent announcement that new gas generation will now be constructed and coal generation run down in parallel with the installation of new offshore wind turbines (there is an excellent article about the Rampion offshore wind project later in this newsletter).

An unwelcome side effect of the demise of coal fired generation is the loss of a large part of the UK rail freight business. However, it will release locomotives and crews for other freight traffic.

I find the web site http://www.gridwatch.templar.co.uk very interesting as it shows exactly what type of generation is being used at any time as well as use of the interconnecting links to other countries. It demonstrates how little wind generation is available when high pressure is sitting over the UK.

I wish you and your family a Merry Christmas and a Happy New Year.

Derek Webb

PROGRAMME OF EVENTS 2016

Tuesday	**12th January**	**Talk – Syphons made in Sussex**
Thursday	**21st January**	**Coffee - at Spotted Cow, Angmering**
Thursday	**28th January**	**Coffee - with Partners at Swallow's Return**
Tuesday	**9th February**	**Talk – Vehicle Emission Matters**
Thursday	**18th February**	**Coffee - at Spotted Cow, Angmering**
Thursday	**25th February**	**Coffee - with Partners at Swallow's Return**
Tuesday	**8th March**	**Talk - Volk's Electric Railway - the Past and the Future**
Thursday	**17th March**	**Coffee - at Spotted Cow, Angmering**
Thursday	**31st March**	**Coffee - with Partners at Swallow's Return**
Wednesday	**20th April**	**Spring Lunch at Northbrook College, 12.00 for 12.30pm**
Thursday	**21st April**	**Coffee - at Spotted Cow, Angmering**
Thursday	**28th April**	**Coffee - with Partners at Swallow's Return**
Tuesday	**10th May**	**Outing – Foulkes Halbard Collection at Filching Motor Museum**
Thursday	**19th May**	**Coffee - at Spotted Cow, Angmering**
Thursday	**26th May**	**Coffee - with Partners at Swallow's Return**
Wednesday	**15th June**	**Outing – Amberley Museum**
Thursday	**16th June**	**Coffee - at Spotted Cow, Angmering**
Thursday	**30th June**	**Coffee - with Partners at Swallow's Return**
Thursday	**21st July**	**Coffee - at Spotted Cow, Angmering**
Thursday	**28th July**	**Coffee - with Partners at Swallow's Return**
Thursday	**18th August**	**Coffee - at Spotted Cow, Angmering**
Thursday	**25th August**	**Coffee - with Partners at Swallow's Return**

All Talks and Meetings will commence at 2.30 pm and be held in the Chichester Room, Field Place, Worthing unless another venue or time is indicated.

Timings for visits and outings will be as printed in the detailed description of the activity.
Coffee mornings commence at 10.30 am.

Website of the RCEA

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

New Members and Speakers for Talks

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

New Members and Associates

Ivan.K.Farrow, Eur Ing, C.Eng, MIMechE, B.Sc(hons), DMS

Latest Member's Handbook

Would all members please check their entry in the Members Handbook which has just been issued to ensure their entry is correct in every detail i.e. address, telephone number, e-mail address, etc. Any errors or omissions should be communicated to **Malcolm Hind, Membership Secretary** so that the appropriate corrections can be made to the master copy ready for printing the next Members Handbook.
Please check the Newsletter and website for up to date details of events.

RCEA Insurance

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

Southern Retired Chartered Engineers (SRCE)

Events are arranged by the SRCE to which our members have a standing invitation. Currently we are waiting for information on their 2016 programme.

Brief Detail – Talks, Outings and other activities January – April 2016

Talk - Tuesday 12th January 2016 'Syphons made in Sussex'

David G. Jones, C.Eng, MIMechE
David will enlighten us on the largely unknown Eastbourne firm 'British Syphon Co. Ltd.' and its subsidiary 'Riley Manufacturing Ltd.'. This company, where David served his five year engineering apprenticeship, had moved down from London in the late 1950s and manufactured soda water syphons and associated bottling machinery for soft drink companies all over the world. Latterly moving into pre-mix dispensing equipment for bar use, they eventually merged with a Sheffield based firm and the Eastbourne premises were closed in September 1990.

Talk - Tuesday 9th February 2016 'Vehicle Emission Matters'

Ivan Farrow, Eur. Ing, C.Eng, MIMechE, BSc(hons), DMS
Reducing vehicle emissions has exercised the brains of vehicle and test engineers since the late 60's. During this period the permitted levels have been reduced by 99% as technology has developed. Ivan will provide a basic introduction to vehicle emissions and how they were, and are, tested in the laboratory and on the road. No complicated chemistry or mathematics is included!
Ivan will examine the difficulties and variabilities encountered, as well as reviewing the difference between official laboratory tests and real-world emissions and fuel consumption.
With the current attention that Volkswagen is receiving on this matter, we anticipate that this talk will be very popular and encourage you to bring along interested colleagues.

Talk - Tuesday 8th March 2016 'Volk's Electric Railway - the Past and the Future'

Peter Williams of Volk's Electric Railway Association, Brighton.
Our speaker will cover the history of the world's oldest operating electric railway, which runs along the Brighton seafront.
From 1883-1940 the Volk family were very much involved in the creation and running of the railway, and there will be pictures of the famous 'Daddy Long Legs' which enabled the railway to travel through the sea at its eastern end.
From 1940 – 2015, the railway was owned and operated by Brighton Council.
There will be a look into the future with emphasis on the recent Heritage Lottery Grant, which it is hoped will allow the Volk's Electric Railway Association to build a new Aquarium Station and Visitor Centre, new sheds at Banjo Groyne, and to restore three cars.
We hope to arrange a visit to the railway and the maintenance sheds in 2017, as the sheds are undergoing refurbishment during 2016.

Perry Eastaugh

Spring Lunch – Wednesday 20th April 2016, Northbrook College, Worthing, 12.00 for 12.30

This occasion is not only an opportunity for new and existing members to meet socially, but also provides 'work experience' to chefs and waiters studying at the college.
There will be a bar for pre-lunch drinks, the cost to be settled individually by members and guests. The cost of the three course meal is the same as last year at £14.00 per head including a tip, which in the past has proved to be very good value. Applications should be made by 17th April.
Should the numbers exceed the maximum seating allowed there will be a waiting list made, as in previous years, so please book early to avoid disappointment. The committee look forward to seeing you there.
Booking form is at the end of this newsletter.
Contact George Woollard 01903 523640, e-mail Georgewoollard1@hotmail.co.uk

Reports

Talk - Tuesday 15th September 2015 'RAF Tangmere and the Special Operations Executive'

Mr Dudley Hooley
This talk followed our AGM, and our speaker began by giving us some background to the Special Operations Executive (SOE), which was a British World War II organization. It was officially formed by Minister of Economic Warfare Hugh Dalton on 22 July 1940, to conduct espionage, sabotage and reconnaissance in occupied Europe (and later, in occupied Southeast Asia also) against the Axis powers, and to aid local resistance movements.
At the time very few people were aware of SOE's existence or its activities, and even to those who were part of it or liaised with it, it was sometimes referred to as "Churchill's Secret Army" or the "Ministry of Ungentlemanly Warfare".
The organization directly employed or controlled just over 13,000 people, about 3,200 of whom were women.
Many of SOE's employees eventually became agents who were sent to occupied Europe, and RAF Tangmere was one of the airfields used to send them to and receive them back from their 'postings'. By far the majority of the SOE pick-up operations conducted during the Second World War from Tangmere by No 161 Specials Duties Squadron was undertaken by Westland Lysander aircraft.

The Lysander had originally been designed for Army cooperation work. It was described by pilots as "a beautiful little plane to fly and very maneuverable and ideal for getting in and out of small landing grounds". For Special Duties work, all armament was removed and the normal variable pitch propeller was replaced by a constant speed three bladed version.
A 150 gallon, permanently fixed, fuel tank was added under the fuselage which increased the aircraft's range from 600 miles to about 1000 miles with an endurance of 10 hours flying. The normal gunner's compartment was modified considerably.

The canopy was replaced with a one-piece unit that slid rearwards on rails to allow quick entry and exit. A ladder was permanently fitted to the port side to allow ease of access and the floor was lengthened and strengthened. The bulky radio was replaced with a much smaller one and a rearward facing bench for two passengers was installed with a locker underneath. A shelf was also built at the rear of the compartment which could also serve as a seat

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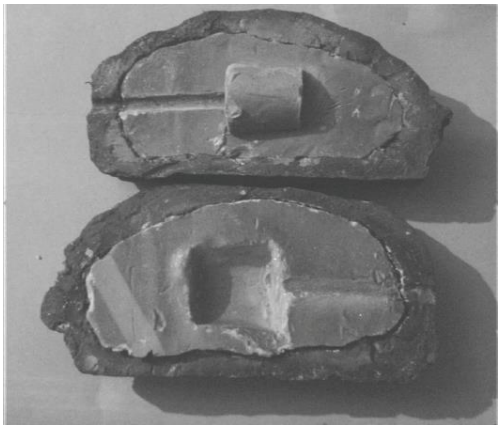
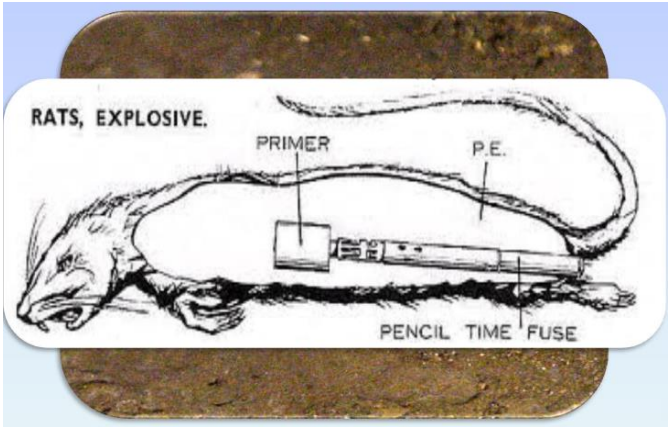
Special Operations Executive (SOE) agents were required to keep in touch with London by sending and receiving Morse Code messages on a wireless set. To avoid their detection the wireless sets had to be portable and light enough to be carried by hand or on a bicycle without attracting attention. SOE conceived the idea of placing the wireless transmitter and receiver in an ordinary looking continental suitcase.
The average survival time for an SOE radio operator behind enemy lines was 6 weeks.

Our speaker described some of SOE's 'unusual' arsenal of sabotage devices, two examples of which are shown below.



Exploding lump of coal



Exploding rat

He also made particular mention of two of the incredibly brave women employed on SOE duties, Noor Inayat Khan (executed at Dachau in 1944) and Violette Szabo, captured by the SS and executed at Ravensbruck concentration camp, and later awarded a posthumous George Cross.

The museum at Tangmere contains a lot more information on the role that the airfield played during the Second World War and the exploits of the SOE - see www.tangmere-museum.org.uk.

Malcolm Hind

Talk - Tuesday 13th October 2015 'Rampion Offshore Wind Farm'

Mr Naren Mistry and Mr Richard Carpenter

Naren Mistry is the e.on Rampion Project Offshore Engineering Manager and gave an overview of the general and off-shore elements of the project. Richard Carpenter is the Onshore Cabling Contract Manager and covered the onshore elements.

General Following development consent by the Secretary of State on 16 July 2014 work commenced on the offshore wind farm project in July 2015. The Project is jointly funded by German utility e.on and the UK Green Investment Bank (GIB) and is expected to be operational in 2018.

Offshore The offshore element comprises the wind turbines and interconnecting cabling, the offshore power station and main supply cable to shore.

Foundations The foundations for each turbine are Grounded Monopile. These utilize a single, large-diameter, foundation structural element to support all the loads (weight, wind, etc.) of the turbine. Construction includes driving a large hollow steel pile 4 m in diameter with approximately 50mm thick walls, some 25 m deep into the seabed. A "transition piece" (complete with pre-installed features such as boat-landing arrangement, cable ducts for submarine cables, turbine tower flange, etc.) is attached and sand and water are removed from the centre of the pile and replaced with concrete.

Turbines There will be 116 (V112-3.45 MW) MHI Vestas Offshore Wind turbines in a regular grid matrix with a minimum spacing between the turbines of 750m with the nearest turbine to shore being 13km (8 miles). Each turbine has a capacity of between 3MW and 7MW giving an overall generating capacity of 400MW.The turbines are 85m tall to the hub height, and 140M to blade tip.

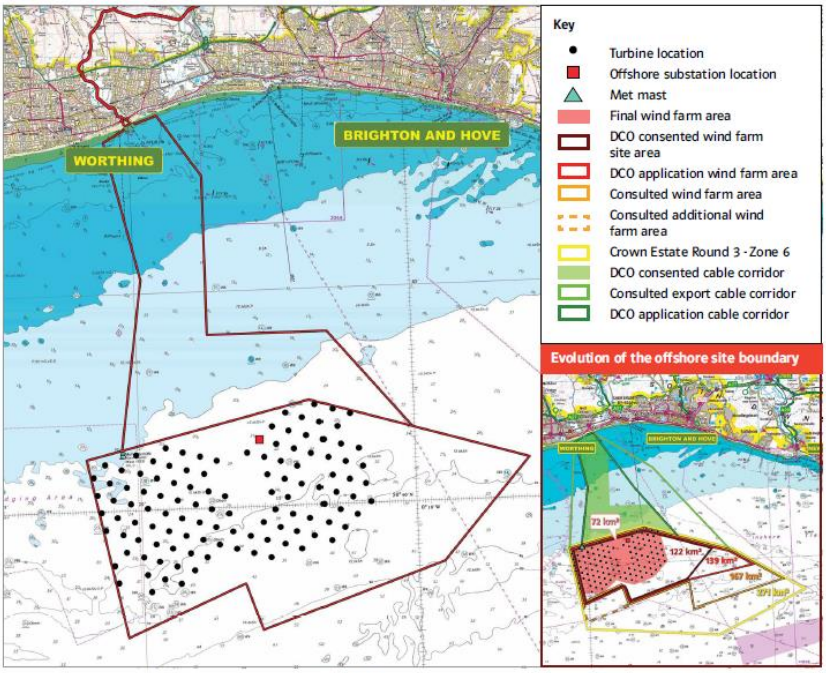
Inter-Turbine Cabling The UK Company JDR is responsible for designing, manufacturing and pre-commissioning the 142km of 36kV inter-array cables. They will also supply the hang-offs, electrical t-connectors, inner cone connectors, cable cleats and cable protection system for the project.

The Dutch company Fugro will be responsible for the installation and burial of the array cables using the construction and installation vessels *Fugro Symphony* and *Fugro Saltire.* A Q1400 trenching system will be used lay the cables.

Offshore Substation Babcock International are responsible for the design and construction of the 2500-tonne offshore substation platform topside and jacket at its facility at Rosyth. ABB will supply the offshore substations, plus "related power infrastructure", such as medium-voltage switchgear, power transformers and protection and control systems.

The farm has an installed generating capacity of up to 700MW and is situated approximately 13 - 23km off the Sussex coast, together with an offshore and onshore electrical infrastructure, including a 26.4Km underground cable from the coast to a new substation situated at the 400Kv National Grid Substation near Bolney Mid Sussex.

Based on the current expectations of the area's wind resource over the long-term, e.on estimate the site could generate more than 2,100 gigawatt hours (GWh) of electricity each year. This is enough to power the equivalent of around 450,000 homes, more than two-thirds of the homes in Sussex, including the city of Brighton and Hove.



Undersea Supply VBMS, a Netherlands company that specialises in subsea power cable installation will be responsible for the installation (lay and simultaneous bury) at a depth of 1.5 to 2.0m two 16 kilometre-long, 3 core aluminium, 150kV High Voltage Alternating Current (HVAC) export cables from the offshore substation to the onshore cable junction at Brooklands Pleasure Park using the DP2 cable-laying vessel *Stemat Spirit*.

Onshore The onshore elements comprise an Onshore Power Station being built as an "add-on" to the existing power station at Bolney, an Operations and Maintenance base at New Haven and the on-shore cable route. The cable route is designed to take account of the fact that the cable route passes through the South Downs National Park and other ecologically sensitive areas. Construction methods are being tailored to reduce impacts, one example being at Tottington Mount where there is sensitive chalk grassland.

Operations and Maintenance Base The base will accommodate up to 65 full time, permanent staff for the lifetime of the project (25 years) and will be the main project management hub during offshore construction.

On-shore Cable Route Carillion has been awarded the contract to design, supply, install and test the twin circuit 150kV cable system**.** The cable system will connect to the subsea cable from landfall near Shoreham-on-Sea to Bolney Substation, a distance of approximately 26km. The onshore cabling project has commenced and comprises 12 Stages. It is scheduled for completion in late 2016.
Cable laying will utilise the Ducting installation method with a Horizontal Directional Drill (HDD) being used for rivers, roads and railway.

Onshore Power Station Work commenced in June 2015 and be complete in December 2016. The construction comprises three main activities; civil and enabling works, mechanical and electrical build, and commissioning. The substation transforms the 150kV output from the offshore power station to 400kV for connection to the National Grid. ABB will supply the substation including high-voltage air-insulated switchgear (AIS), gas-insulated switchgear (GIS), transformers and substation automation as well as control and protection systems. The substation will also be equipped with four STATCOM (static compensator) units to ensure grid stability. These will provide reactive power compensation by detecting and instantly compensating for voltage fluctuations associated with the intermittent nature of wind energy.

Randy Keir

Talk - Tuesday 10th November 2015 - Cooch Memorial Lecture 'Rosetta and Philae - unlocking the secrets of comets'

Professor Andrew Coates - Head of Planetary Science, Mullard Space Science Laboratory - University College, London.

Overview

Comets are ancient members of our solar system – the surviving 'building blocks' of outer planet cores. Last year, ESA's Rosetta spacecraft was the first to go into orbit around a comet (67P) and Philae landed after bouncing initially, sending back historic images and data from the surface of the comet. The comet's closest approach to the Sun was on 13 August 2015 and the orbiter continues to send spectacular results about the increasing activity of the comet with end of mission now expected in September 2016. After a brief re-awakening with increased illumination, Philae fell silent again.

Already, Rosetta results have shown us that these types of comets are unlikely to have brought much water to Earth, molecular nitrogen and oxygen has been detected, and we have seen the best images of a comet so far. A major surprise was the 'rubber duck-like shape of comet 67P Churyumov-Gerasimenko, this has now been shown to be due to the collision of two bodies in the early solar system. The talk included why comets, ancient building blocks of our solar system, are important, what they are made of, comet tails, the design of the mission and instrumentation, the mission profile and some of the key scientific discoveries so far. The effect on solar system formation ideas was mentioned.

Programme Details

The Rosetta mission was conceived as a result of the success of earlier projects to explore Halley's comet during a close proximity in its orbit to Earth in 1986. Most prominent of a number of these international space probes was ESA's Giotto which along with the others returned valuable scientific information. In the light of this it became obvious that, to shed more light on cometary composition and answer new questions posed by these results, further missions to survey comets would be necessary.

On this background it was decided that ESA should proceed with further investigations into the composition of comets and so planning began and the mission was named Rosetta. After 30 years of work and scientific innovation together with an expenditure of some £1billion information began to flow from Rosetta as it orbited comet 67P/Churyumov-Gerasimenko. In order to fund a project of this magnitude required international cooperation on a grand scale. Astrium, a company with a large representation in the UK and facilities in Portsmouth, Stevenage and Surrey University was

selected as prime contractor for the spacecraft. The UK's contribution was for the supply of the spacecraft platform which was derived from those used for communications projects by Astrium. It was manufactured in their Stevenage plant. Many other outfits and universities in the UK provided specialist parts and scientific instrumentation for a range of experiments to be conducted in the analysis of the makeup of a comet. The whole spacecraft was integrated and tested in Astrium's German facility at Friedrichshafen on the shores of Lake Constance (of Zeppelin fame!). The comet lander "Philae" was provided by the German Aerospace Research Institute (DLR) with contributions from across Europe. This was attached to Rosetta and travelled piggyback during flight to the comet and was released for comet landing once in orbit around it. Landing on a comet had never before been attempted and posed the greatest risk to the mission. Overall Rosetta carried a payload of 16 experiments with Philae housing a further 12.

Much more could be said about the spacecraft, but to put it into perspective it's probably better to highlight the main features of the mission in order to acquaint one with the enormity of the task presented. Those who wish to know more detail should visit ESA's website at http://sci.esa.int/rosetta.

Rosetta and it's lander was to spend 10 years in orbit making many manoeuvres and planetary fly-bys during which it changed its velocity and trajectory as it extracted vital energy from the gravitational fields of Earth and Mars to enable it to complete its journey to the comet.

On the following pages are diagrams of both the Rosetta spacecraft and its attached lander together with a list of the scientific instrumentation carried by each of them. It was prudent to place instrumentation on both as one of the riskiest aspects of the mission was the landing of Philae on the comet. At least all would not be lost. Also shown are details of the mission.

Comet Selection

There are hundreds of comets flying around the Solar System, each of them a potential target for ESA's comet-chasing Rosetta mission. As the mission took shape, the science team was faced with the difficult task of sifting through these candidates until they identified a handful of suitable objects.

Of particular interest were comets that had been observed over at least several orbits of the Sun, and which were known to be fairly active. Ideally, they had to follow orbital paths near the ecliptic plane, so that a rendezvous, prolonged survey and landing would be easier to achieve. Furthermore, the comet's flight into the inner Solar System had to coincide with the mission timeline of Rosetta, so that they both arrived in the right place at the right time for the historic rendezvous. The favoured target for Rosetta was the periodic comet 46P/Wirtanen, but, after a previous launch failure of the latest version of the Ariane 5 vehicle to be used, it wasn't deemed safe to proceed until the failure had been fully investigated. It was to be nearly 2 years before a suitable replacement could be found. One of the greatest risks to space programmes and they hit it!.

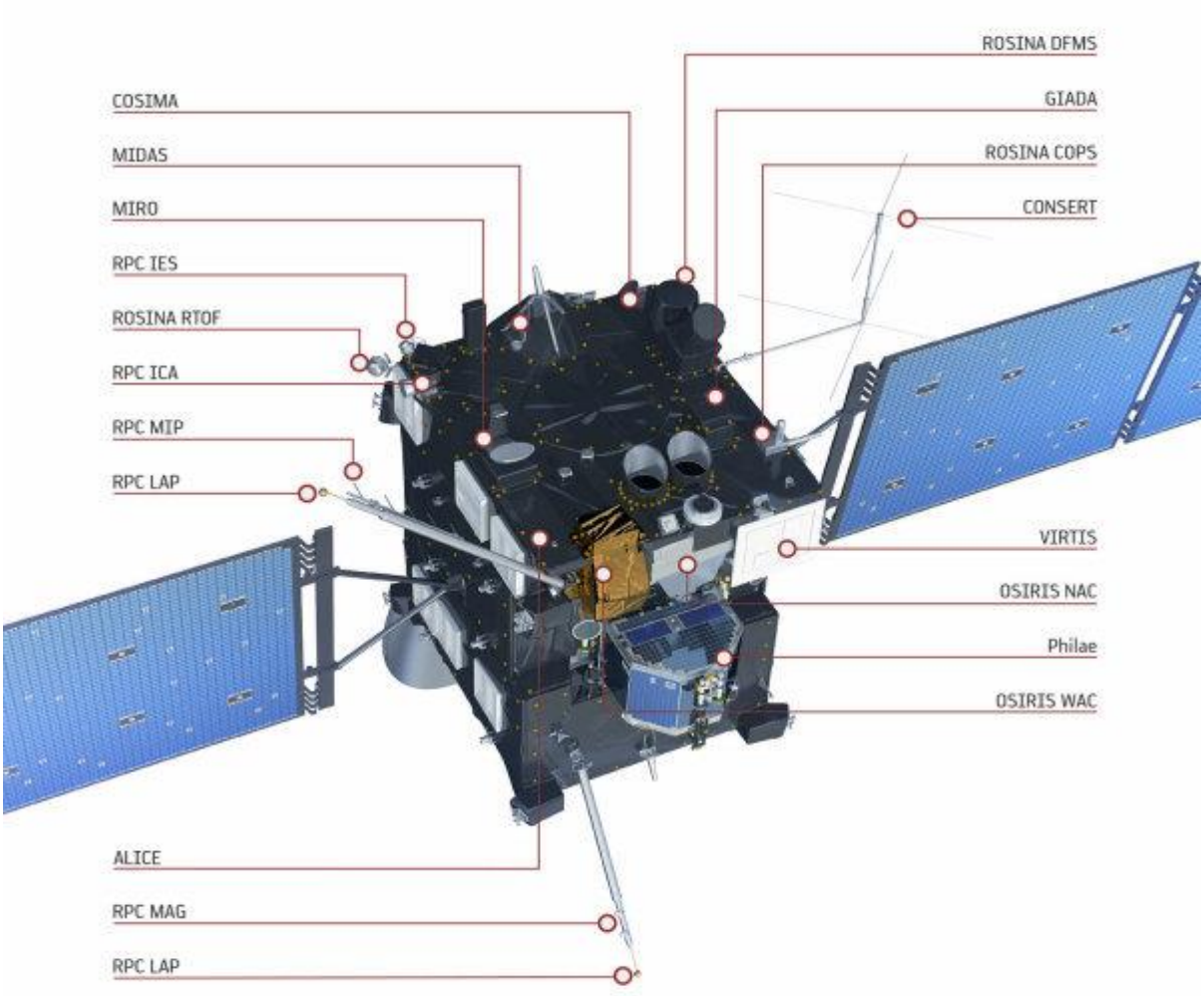
A delay of this length meant that comet 46P/Wirtanen could no longer be considered a suitable candidate as it would no longer be in a suitable part of its orbit to satisfy the constraints put on the programme by both timescale and spacecraft life cycle. Consequently, another regular visitor to the inner Solar System, 67P/Churyumov-Gerasimenko, was selected as a suitable replacement.

Comet 67P is one of numerous short period comets which have orbital periods of less than 20 years and a low orbital inclination. Since their orbits are controlled by Jupiter's gravity, they are also called Jupiter Family comets.
At this point very little was known about the surface properties of the nucleus, so the selection of a suitable landing site for the Philae probe was only possible after the arrival of Rosetta in August 2014 when a detailed survey from close quarters was made.

When Rosetta arrived at the comet it was at a distance of about three Astronomical Units (450 million km) from the Sun. As it moved towards the Sun, the ice in the nucleus began to sublimate and the comet started to eject increasing amounts of dust.

Ejection of micron-sized grains starts at about 4.3 AU, but millimetre-sized grains are more likely to appear between 3.4 and 3.2 AU. This leads to the development of a coma (a diffuse cloud of dust and gas surrounding the solid nucleus) and subsequently a tail of dust that trails away from the Sun. Early observations of the comet showed some evidence for variable activity between April and June 2014, with the coma brightening rapidly and then dying down again over a period of about six weeks. The spacecraft approached from the sunward side of the comet's orbit, in order to minimise the risk of damage from a possible large impact with the dust.

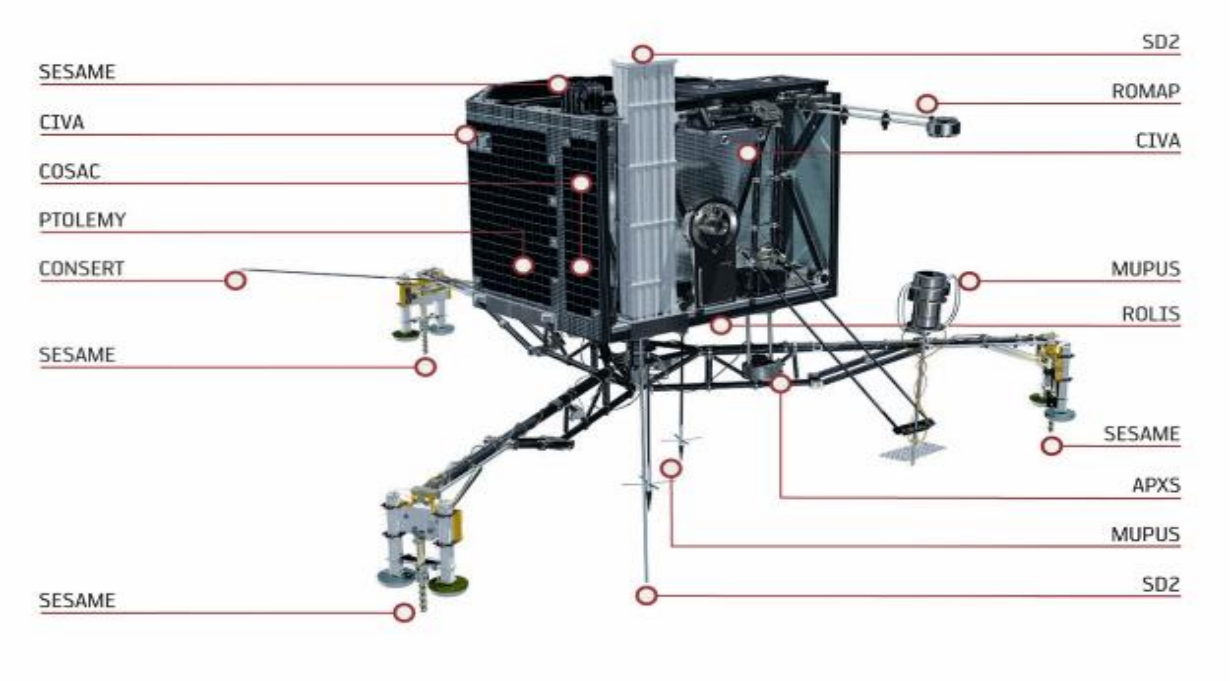
Rosetta Orbitor



Alice	Ultraviolet Imaging Spectrometer
CONSERT	Comet Nucleus Sounding Experiment by Radio wave Transmission
COSIMA	Cometary Secondary Ion Mass Analyser
GIADA	Grain Impact Analyser and Dust Accumulator
MIDAS	Micro-Imaging Dust Analysis System
MIRO	Microwave Instrument for the Rosetta Orbiter
OSIRIS	Optical, Spectroscopic, and Infrared Remote Imaging System
ROSINA	Rosetta Orbiter Spectrometer for Ion and Neutral Analysis
RPC	Rosetta Plasma Consortium
RSI	Radio Science Investigation
VIRTIS	Visible and Infrared Thermal Imaging Spectrometer

These comets are believed to originate from the Kuiper Belt, a large reservoir of small icy bodies located just beyond Neptune. As a result of collisions or gravitational perturbations, some of these icy objects are ejected from the Kuiper Belt and fall towards the Sun.
When they cross the orbit of Jupiter, the comets gravitationally interact with the massive planet. Their orbits gradually change as a result of these interactions until they are eventually thrown out of the Solar System or collide with a planet or the Sun.
The comet had now been observed from Earth on seven approaches to the Sun - 1969 (discovery), 1976, 1982, 1989, 1996, 2002 and 2009. Like all comets, it has a fairly small, solid nucleus which is thought to resemble a dirty snowball. The density of the nucleus seems to be much lower than that of water, indicating a loosely packed or porous object. Like other comets, its nucleus is generally blacker than coal, indicating a surface layer or crust of carbon-rich organic material.

Philae Lander



APXS	Alpha Proton X-ray Spectrometer
ÇIVA and ROLIS	Panoramic and microscopic imaging system
CONSERT	Comet Nucleus Sounding Experiment by Radio wave Transmission
COSAC	Cometary Sampling and Composition experiment
PTOLEMY	Evolved Gas Analyser
MUPUS	Multi-Purpose Sensor for Surface and Subsurface Science
ROMAP	Rosetta lander Magnetometer and Plasma Monitor
SD2	Sample and Distribution Device
SESAME	Surface Electric Sounding and Acoustic Monitoring Experiment

Below is a condensed description of the mission. This is the part of the programme that attracts most interest after all the hard work has been completed!

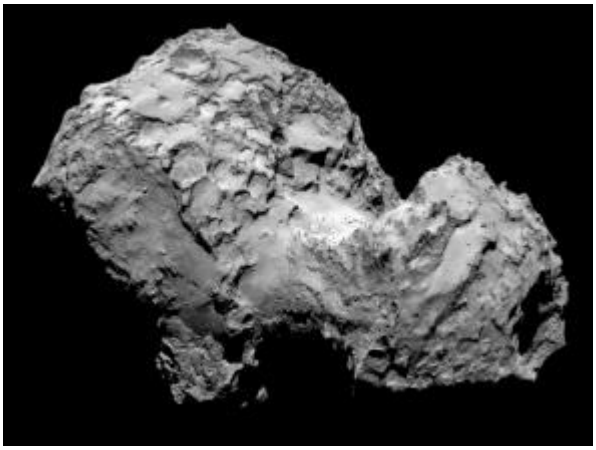
Launch date:	2 March 2004 07:17 UT
Mission end:	end September 2016 (extended mission)
Launch vehicle:	Ariane 5 G+ from Kourou, French Guiana
Launch mass:	3000 kg (fully fuelled); Orbiter: 2900 kg (including 1670 kg propellant and 165 kg science payload); Lander: 100 kg
Mission phase:	At Comet 67P/Churyumov-Gerasimenko
Orbit:	En route to Comet 67P/Churyumov-Gerasimenko, Rosetta completed a complex trajectory that included four gravity assist manoeuvres (3 × Earth, 1 × Mars). The spacecraft arrived at the comet on 6 August 2014. Since then, the spacecraft has been orbiting the comet. It will accompany the comet on its journey around the Sun.
Objectives:	To study the origin of comets, the relationship between cometary and interstellar material, and its implications with regard to the origin of the Solar System. The measurements to be made to achieve this are:

- Global characterisation of the nucleus, determination of dynamic properties, surface morphology and composition;
- Determination of the chemical, mineralogical and isotopic compositions of volatiles and refractories in a cometary nucleus;
- Determination of the physical properties and interrelation of volatiles and refractories in a cometary nucleus;
- Study of the development of cometary activity and the processes in the surface layer of the nucleus and the inner coma (dust/gas interaction);
- Global characterisation of asteroids, including determination of dynamic properties, surface morphology and composition.

Comet 67P is classed as a dusty comet, with a dust to gas emission ratio of approximately 2:1. The peak dust production rate in 2002/03 was estimated at approximately 60 kg per second, although values as high as 220 kg per second were reported in 1982/83.

Sixty-one images of comet 67P/Churyumov-Gerasimenko were taken with the Wide Field Planetary Camera 2 on board the Hubble Space Telescope (HST) on 11-12 March 2003. The HST's sharp vision enabled astronomers to isolate the comet's nucleus from the coma. The images showed that the nucleus measures roughly five by three kilometres and has an approximately ellipsoidal (rugby ball) shape.

Changes in its light curve appear to be closely linked with the effective radius of the nucleus as it rotates, rather than with variations in its surface albedo (brightness). These observations indicate that it spins once in approximately 12 hours.



Comet 67P by Rosetta's OSIRIS narrow-angle camera on 3 August 2014.

Comet Rendezvous

The most difficult phase of the Rosetta mission was the final rendezvous with the fast-moving comet. After the braking manoeuvre in May 2014, the priority was to edge closer to the nucleus.Since this took place before Rosetta's cameras had imaged the comet, accurate calculations of Comet 67P/Churyumov-Gerasimenko's orbit, based on ground-based observations, were essential.

Comet approach (January – May 2014)

The spacecraft was re-activated prior to the comet rendezvous manoeuvre, during which the thrusters fire for several hours to slow the relative drift rate of the spacecraft and comet to about 25 metres per second.
As Rosetta drifts towards the heart of the comet, the mission team had to avoid any comet dust and achieve good comet illumination conditions. The first camera images dramatically improved calculations of the comet's position and orbit, as well as its size, shape and rotation. The relative speeds of the spacecraft and comet was gradually reduced, slowing to 2 metres per second after about 90 days.

Comet mapping and characterisation (August 2014)

Less than 200 kilometres from the nucleus, images from Rosetta showed the comet's spin-axis orientation, angular velocity, major landmarks and other basic characteristics.
Eventually, the spacecraft was inserted into orbit around the nucleus at a distance of about 25 kilometres. Their relative speed is now down to a few centimetres per second.
The orbiter mapped the nucleus in great detail. Eventually, five potential landing sites were selected for close observation.

Landing on the comet (November 2014)

Once a suitable landing site was chosen, the lander was released from a height of about one kilometre. Touchdown took place at walking speed — less than one metre per second. Unfortunately it bounced and drifted across the comet before finally coming to rest in the shadow of a mountain. This deprived it of the power needed for a complete analysis of the surface via the installed experiments but nevertheless much valuable information was gained before the batteries were finally exhausted.

Data from Philae was transmitted back via the communication systems of Rosetta which is continuing with observations using its own installed experiments. However by the end of September 2016 with its propellant largely depleted it is

currently planned to end the mission with a touchdown of Rosetta on the comet thus ending one of the most extraordinary pieces of space exploration.

Ground Segment
Data processing of the scientific information although quite complex is almost straightforward compared with the equipment needed to ensure raw data receipt from deep space and its subsequent safe delivery to the various laboratories. Cooperation was needed from many different space entities around the globe to ensure maximum visibility and hence communication with Rosetta.

35M Antenna - New Norcia – W. Austalia

All of the scientific data collected by the instruments on board the spacecraft are sent to Earth via a radio link. The operations centre, in turn, remotely controls the spacecraft and its scientific instruments via the same radio link.

The Mission Operations Centre during Rosetta's entire 12-year journey is the European Space Operations Centre (ESOC) in Darmstadt, Germany. ESOC is responsible for all mission operations, including:-

- Mission planning, monitoring and control of the spacecraft and its payload
- Determination and control of the spacecraft trajectory
- Distribution of the scientific data received from the spacecraft to the Rosetta scientific community and the Principal Investigators

A Science Operations Centre will also be located at ESOC during the active phases of the mission. Its task will be to coordinate the requests for scientific operations received from the scientific teams supporting both the orbiter and the lander instruments.
Lander operations will be coordinated through the German Aerospace Research Centre (DLR) control centre in Cologne, and the scientific control centre of CNES, the French space agency, in Toulouse.

Deep-space communications
Radio communications between Rosetta and the ground will use a newly developed deep-space antenna which was built by ESA at New Norcia, near Perth in Western Australia. This 35-metre diameter parabolic antenna concentrates the energy of the radio signal in a narrow beam, allowing it to reach distances of more than 1000 million kilometres from Earth.
Signals are transmitted and received in two radio frequency bands: S-band (2 GHz) and X-band (8 GHz). The radio signals, travelling at the speed of light, will take up to 50 minutes to cover the distance between the spacecraft and Earth!
ESA is building another 35-metre parabolic antenna at Cebreros in Spain. It will begin to operate in 2005 providing further coverage for Rosetta.

Massive memory
During the mission, the rate at which data can be sent from Rosetta to Earth will vary from 10 to 22 000 bits per second. However, the rotation of the Earth means that real-time communications will not always be possible.
The spacecraft will be visible from the New Norcia antenna for an average of 12 hours per day. In addition, there will be several periods of communications black-out when the spacecraft passes behind the Sun.
To overcome these breaks in communication, Rosetta's solid-state memory of 25 Gbits capacity is able to store all scientific data and then transmit them to Earth at the next opportunity.

Conclusion
The talk was given by an excellent speaker who had the benefit of being intimately involved with the project and contributed as a scientist during its implementation. It was very well received by those present with quite a lively question time following tea.
The above description is, quite clearly, a condensed version of what was a 30 year project. So, for those who would like to have more detail, there is masses of information to be found on the web pages of the European Space Agency by using the following links :
http://sci.esa.int/rosetta
http://blogs.esa.int/rosetta

David Thomas

Visit - Tuesday 24th November 2015 – Ricardo UK Shoreham Technical Centre

This particular visit had been over 1 year in the planning, as we particularly wanted to visit Ricardo in the year of the anniversary of their founding in 1915, but at the same time avoid the construction work that had been taking place on their Shoreham site throughout most of 2015. In the event the visit was limited to 25 attendees: apologies again to all those members unable to get a place on what proved to be an extremely interesting visit.

We initially heard something of the history and current capability of the company, which has expanded very considerably from its creation by Harry (later Sir Harry) Ricardo as Engine Patents Ltd on 8th February 1915.

Today the company employs over 2,700 engineers, scientists and consultants, not only serving the automotive and motorsport industries for which the company is perhaps best known, but also aerospace, rail transport, defence, energy, scarce resources and waste.
Ricardo's facilities are now spread across the US, Europe and Asia where an increasing amount of the company's customers are based.
Fortunately the rain had abated by the time the site tour started, and we were initially shown some of the test fleet of diesel-electric hybrid vehicles parked outside.

This was followed by a visit to the newly opened Vehicle Emission Research Centre (VERC) where whole vehicle emissions could be accurately measured on a rolling road with variable wheelbase, able to simultaneously absorb power from both axles in the case of 4WD vehicles. The test cell, which is capable of simulating all current vehicle driving test cycles, is housed in an environmental chamber such that the vehicle under test can be run under conditions of extreme cold and heat.

In 2006 the JCB Dieselmax took the world diesel land speed record to 350.092 mph at the Bonneville Salt Flats. The vehicle was powered by two JCB off-highway engines designed in collaboration with Ricardo and upgraded for the purpose of the record-breaking attempt. We were able to examine one of the JCB diesel engines on our way to the Exhibition area.

Our final visit was to the Mclaren engine build centre. Visitors could not fail to be impressed by the cleanliness and very low noise levels in the 'factory' area of the facility – a far cry from my own time on the engine manufacturing lines in the Midlands! Following final assembly, each engine is run up on an engine dynamometer before shipment to McLaren. Also on show within the engine build centre were a number of part - built engines starting at the 'V' block with its cylinder liners, through the crankshaft, head and valve gear to the complete 'dressed' engine ready for shipment.

On the way out members were able to admire a complete McLaren supercar in the entrance hall – one idea perhaps for a Christmas present this year?

The picture opposite (unfortunately the only photograph permitted during the entire visit) shows our group standing in the exhibition area.

In the foreground is a Mclaren supercar engine, all of which are built by Ricardo for Mclaren, in Shoreham.

The exhibition area houses a number of other engines that Ricardo have been involved with over the years, in addition to gearboxes and an energy recovery system used in earth moving equipment.

Malcolm Hind

End of Newsletter

REPLY SLIP

To: George Woollard, 18 St Lawrence Ave, Worthing, West Sussex, BN14 7JF (01903 523640)
E Mail : Georgewoollard1@hotmail.co.uk

Can you please reserve me …….. places for the Spring Lunch at Northbrook Collage, Worthing on ***Wednesday 20th April 2016.*** 12.00 for 12.30.

Full name:…….(Block capitals)

Address………
……
……

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

E mail address……

I enclose a cheque made payable to RCEA for **£…….(£14.00) per person**
(Separate cheque for this event please)

Applications by Sunday 17TH April

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