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NEWSLETTER

of the

Coal Research Forum

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EDITOR'S COMMENTS:

It seems to have been a busy summer for the Coal Research Forum. There has been the 15th Annual Meeting held at Cottam Power Station, courtesy of EDF Energy and a meeting of the Coal Combustion Division was held at Longannet Power Station, courtesy of Scottish Power. By the time you read this, the 5th European Conference on Coal Research & Its Applications will have been held at the University of Edinburgh in early September.

STOP PRESS!! The 5th European Conference on Coal Research & Its Applications has been held in Edinburgh with a record number of attendees and papers presented! A full description of the proceedings will be in the January issue.

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15th Annual Meeting held at Edf Energy's Cottam Power Station, Wednesday 19th May 2004.

By courtesy of Edf Energy, the 15th AGM and Coal Characterisation Division meetings were held at Cottam Power Station in north Nottinghamshire. It was a very pleasant and tranquil venue and the proceedings were scheduled to start at 10am. However, the day got off to a bad start for the Newsletter editor as by a combination of bad traffic, bad planning and bad luck he contrived to arrive a quarter of an hour late, but just in time to give his report as Acting Treasurer!!

The first business was the AGM of the Coal Research Forum. Our Secretary, David McCaffrey reported the events of the year 2003 and actions arising from them. For further details of this section of the meeting, please see the Report of the Annual Meeting issued to Members by David McCaffrey with Coal Research Forum E-mailshot No. 13 (2004), on 28th May 2004.

Session 2 of the meeting was a presentation given by Tony Oliver of K-S Tech Ltd. entitled "APGTF strategy for technology RD&D in fossil power generation". As background it was explained that the Advanced Power Generation Technology Forum provides the focus for the power generation sector in the UK on the research and development activities on fossil fuel, including biomass and waste, together with associated technologies including carbon sequestration. In early 2003 the Energy White Paper set out the UK governments targets with regard to energy saving and global warming. Currently, the DTI are in the process of formulating the RD&D requirements for fossil energy and these are due to be released later in 2004. The strategy of the APGTF is to try to persuade the DTI to adopt the views of industry. Briefly, the strategy aims to provide affordable, acceptable and available low emissions power plant; to provide UK industry with global market opportunities to 2030; to contribute to the UK wealth creation and quality of life; to help to achieve the desired CO_2 reductions of 60% by 2050 ensuring security of energy supply and to address the critical issue of transition to clean fossil energy use.

The energy scene for 2020 envisaged by the White Paper has a grid of large power stations as its backbone, although there will be more local generation using wind power and biomass. There will be more CHP and microgeneration and gas will form a large part of the energy mix. The use of coal will be lower unless economic and with CO_2 reduction. The Large Combustion Plant Directive (LCPD) will apply to existing coal-fired stations, nuclear generation will be almost over and carbon emission trading will be a reality within the EU. These factors are expected to lead towards the CO_2 reduction target for 2050.

Although the future for coal in the UK is not good, the global view is quite different. The IEA World Energy Outlook predicts that from 2000 to 2030 new coal plant will amount to 1,400GW, second only to gas with 2,000GW. All other sources fell below 400GW. It is clearly necessary to recognise this different scenario when the UK actions are implemented. Globally, electricity production is growing and is the dominant source of CO_2. It is felt that by 2020 carbon capture and storage (CCS) will be a requirement, however there are legal and social issues and it is not clear whether developing countries would be willing to follow such paths. The use of hydrogen for transport fuels beyond 2020 is a moot point but it does seem likely that extensive use of hydrogen will arise from the gasification and conversion of fossil fuels, probably coal.

There are a number of research initiatives wherein the UK can operate in a proactive manner. Within Europe there is FENCO, which involves pan-EU

government action on Clean Fossil Power Generation. Power 21 is the European equivalent of the US project Vision 21. It is an EU industrial initiative to establish technology priorities for European critical mass programme on Clean Fossil PG including demonstration requirements. Other European activities include EU FP6 which gives indications of support for the definition of so-called `Lighthouse Projects` to follow on from new Integrated Projects (IPs). EU COST is a follow up to Materials RTD action for steam and gas plant and there are a number of EU Network projects. These include POWERCLEAN, aimed at clean power systems for the future, CAME-GT, looking at gas turbine systems and CO_2NET_2 for the capture and storage of carbon dioxide. An EU Technology Platform is looking at hydrogen and fuel cells.

US co-operative initiatives include the Carbon Sequestration Leadership Forum, which is a set of complementary demonstrations world-wide building from Futuregen with a link to similar hydrogen initiatives; the US-UK Energy Memorandum of Understanding including pilot materials and virtual demonstration projects. Longer term zero emission power generation co-operation is possible. Actions in countries outside Europe are: Australia, CCS technology roadmap and COAL21; Canada, Canadian Clean Power Coalition; USA, Clean Coal Power Initiative, Futuregen and CCS Regional Initiatives. Other relevant International Initiatives include the IEA : GHG RTD and Clean Coal Centre and Carbon Capture Project of `Oil Majors`; continuation phase into most likely cost-effective capture technologies.

The technology development strategy considered coal, gas and biomass in the short, medium and long terms. Within the scope of new plant and retrofits it is necessary to consider two targets. These are increased efficiency (E) and near to zero emissions with CCS (C). E should be applied to the UK market but will also act as a precursor to C and should carry on from existing programmes. C also needs to meet the timescale for enhanced oil recovery (EOR) and CCS. Plants considered were PF fitted with FGD, IGCC, gas turbines and fuel cells. The CO_2 capture options were pre- or post-combustion or oxyfuel firing. From this data a strategy trajectory graph may be produced. With time scale along the X- axis and carbon reduction on the Y-axis, two curves may be plotted. The lower curve is the 'enhanced efficiency trajectory' E and the upper one is the zero emissions trajectory C. Zero emissions will need the most efficient plant and a key issue will be the value of the CO_2.

If a BAT (best available technology) RD&D retrofit were undertaken it could comprise the testing of components, systems and the whole plant both nationally and abroad. In the case of supercritical PF, options would include CO_2 scrubbing or oxyfuel firing. A coal gasification retrofit could include pre-combustion capture of CO_2 and a CCGT system might involve post-combustion CO_2 capture.

In order for the CCS deadline of 2020 to be achieved it is possible to work backwards to determine when the critical activities to meet this target should begin. It is found that certain issues need to be addressed immediately which include design studies, performance standards, monitoring, verification, legal and regulatory requirements. These are necessary to enable the demonstration to begin in 2008, for it to become operational by 2012, for the building of the full-sized plant to start in 2015 and for the target date of CCS operation in 2020 to be met. The carbon abatement programme needs to start now to meet the target.

Implementation needs the existing industry-driven RD&D Programme to continue with engineering/economics studies for demonstration plant and participation in international programmes. Technology transfer and export promotion needs to be maintained by engaging future customers, seeking export opportunities and

examining `enablement` issues. UK universities research programmes should continue to feed into EPSRC, ESRC and Energy Research Centre. Measures for closer industry/academe co-operation should be sought to encourage development of new technologies and skills.

In terms of Government / DTI funding support the Year 0 needs were seen to be £10M comprising £5M for an industry-led programme involving engineering studies, £2M from EU programmes, £1M from international collaboration and £2M from technology transfer. The figure rises to £20M by Year 4 with an additional £10M for a UK site demonstration, all other costs remaining the same as for Year 0.Also needed is £20M per year from industry for the site demonstration.

Tony Oliver ended his presentation with a series of conclusions, viz. The RD&D strategy follows on from the White Paper and takes account of global issues and markets. Clean fossil power is crucial in meeting the needs of present and future generations - a critical transition issue is in moving to a sustainable future; in the long term a source of hydrogen. Carbon abatement strategy for fossil fuels is required as part of a portfolio approach to meet environmental aims. An uncertain future demands the need for a broad trajectory covering efficiency improvements (E) through to zero emission (C), so planning is necessary for options in the short, medium and long term; CCS is becoming high on many agendas world-wide. International collaboration will be essential, especially in establishing demonstration or lighthouse projects and hence the deployment of technology. The changing face of the power generation industry is resulting in a greater emphasis on added value components and technologies; these need a `shop window`. There is a continuing need to get the take-up of new technologies into the market place; RD&D and mechanisms that encourage deployment are essential, with a particular role from Government. Engagement of industry is essential and therefore there has to be benefits delivered in the short, medium and long term.

Robert Heathman of EPSRC gave a report on the role and current activities of his organisation. EPSRC are the main UK government agency for funding research and training in engineering and the physical sciences. They invest around £500 (US$800, €700) million a year in a broad range of subjects – from maths to materials science, and from information technology to structural engineering. They operate to meet the needs of industry and society by working in partnership with universities to invest in people and scientific discovery and innovation. The knowledge and expertise gained maintains a technological leading edge for the UK, builds a strong economy and improves people's quality of life. Their work is complementary to other research investors including other research councils, government agencies, industry and the European Union. They actively engage in and encourage partnerships and collaborations across disciplines, boundaries and the world.

The strategic objectives of the EPSRC were identified as:
Supporting world-class research: Research in science and engineering is vital for economic prosperity and quality of life. EPSRC aims to continue to improve the excellence, relevance and impact of the research it supports and in particular to increase the research capability and global standing of the UK in strategically important areas.
Developing talented scientists and engineers: Ultimately, the future technological capability of the UK depends on the supply of well-qualified physical scientists and engineers needed to populate industry and other areas of the economy as well as maintain a vibrant academic research base.
Supporting the knowledge economy: Research creates new knowledge; new knowledge drives innovation; and innovation produces the new technologies that

enhance national competitiveness, generate wealth, and contribute to quality of life.
Public engagement with research: New developments in engineering, the physical sciences and mathematics have far reaching impacts on society. By engaging the public's interest in research, healthy debate about its role in society can be stimulated and future generations of researchers can be inspired.

Effective and efficient operations: EPSRC's operations are about how we achieve our mission. They include planning, communications, programme management and evaluation and are supported by a range of infrastructure services and activities. As an agency of Government, EPSRC must also meet rigorous demands and expectations in the areas of corporate governance, accountability and reporting.

The EPSRC Engineering programme is split into three areas, though all three work in close collaboration. These are: Engineering (Responsive mode, meaning they respond to the ideas of academics), the Innovative Manufacturing Programme (IMP) and the Infrastructure and Environment Programme (IEP), which are both managed activities where funding is 'ring fenced' and the technical scopes are created with consultation with regulators and stakeholders in the areas identified through the business plan.

The General Engineering Programme is responsible for investing in UK engineering research and training of the highest calibre. While IMP and IEP focus on highly user-led applied research, Engineering has the responsibility to ensure that blue sky adventurous engineering research is encouraged across the entire spectrum, that basic science and technology are translated into applications and that emerging areas are captured and nurtured. Key Objectives include: Supporting excellence in engineering research, nurturing emerging areas and encouraging creativity and adventure. Promoting the exciting opportunities that arise from working across traditional engineering disciplines and between engineering and other areas of science, technology and social sciences. Supporting sufficient talented people through engineering research training and beyond to supply the UK's needs. Providing the equipment needed for top quality research.

The objective of the IMP is to promote and support high quality research and masters level postgraduate training in manufacturing engineering and related topics, so as to help improve the performance of the UK manufacturing sector and thereby increase its contribution to wealth creation and GDP.

The IEP is devoted to research and training that aims to improve quality of life. Focussing on user led research, engineering combines with social, environmental, medical, life sciences and other disciplines to meet many of the pressing problems facing the environment.

The EPSRC's Engineering panel meetings annually review over one thousand proposals. Each of the proposals was previously allocated to one of five panels based on subject area (Elec/Mech, Civ/Env, Med, Chem, Multidisciplinary). With this engineering panel structure, the panels have a tendency to centre themselves around core disciplines. EPSRC want to remove the discipline emphasis from the review system and encourage the consideration of difficulties associated with cross-disciplinary research and adventurous proposals. The introduction of a revised panel structure forms a set of panels where the sub-discipline boundaries are removed. As a result, multidisciplinary proposals will be on a level playing field with research sitting at the core of a discipline. The nature of engineering has changed enormously with the identity of traditional

engineering disciplines becoming far less well defined. Many universities have restructured their engineering departments and the EPSRC should also respond to the changing nature of engineering. The last 'old' panel structure took place in September '03, with all proposals received now being entered in to this revised scheme. The new Engineering Panel structure consists of four new panels;
Systems of Systems, Systems, Isolated Systems – Components and Flow around systems. The new structure also includes the level of a proposals complexity. At the engineering science level research closer to the underpinning science features, these research endeavours focus around single aspects of a problem and can often be simplified through the application of single hypothetical parameters. Increasing complexity moves research into the systems arena with multiple components, variables and interactions and a more holistic approach. Finally, the systems of systems panel sits at the highest level of complexity where challenges are more diffuse or intangible and solutions subjective.
EPSRC believe that this new panel structure not only meets the boundary crossing criteria but also meets key proposal processing considerations. Panel members should therefore understand and appreciate the core engineering principles of research presented at that panel regardless of its discipline.

A breakdown of all coal-related research grants submitted to EPSRC after January 2000 (including coal technology, combustion and mineral mining and extraction research topics) and closed grants (which started after 2000) was presented. Of 28 proposals, 18 were funded to a value of £2.05M. The 10 that were not funded would have cost £1.44M. It showed that there was a 64% success rate by number for coal-related projects and a 59% success rate by value. This was said to be much larger than for the general engineering responsive mode success rates of 33% success rate by number and 28% success rate by value for the period 2000-2003. Though the number of grants in the area is relatively small the statistics showed that the research proposals were of a very high quality.

A discussion of other current activities then followed beginning with SUPERGEN or (Sustainable Power Generation and Supply). This initiative is operated under the Infrastructure and Environment Programme of the EPSRC. The 5-year initiative will address the broader challenges of ensuring a sustainable and reliable power supply to the UK. It will invest over £25m through a number of calls for proposals. The status of calls was stated as:
Call 1 consortia started: Hydrogen (£3.4m), Marine (£2.6m), Biomass (£2.8m), Networks (£3.4m),
Call 2 consortia funded: PV (£3.1m), Plant lifetime (£2.1m)
Call 3 consortia in process: Fuel Cells, Energy Storage, Distributed Systems (up to £6m).
Call 4 consortia in process: Organic PV (up to £1m)
Call 5 open on website (Closing date of 7th June 2004, up to £5m available): Wind Energy, Network Infrastructure, Biological Fuel Cells.

SUPERGEN is funded in partnership with The Carbon Trust, NERC, BBSRC and ESRC and also receives funding through the MoD/DSTL Joint Grants Scheme. Industrial collaboration is a requirement of SUPERGEN consortia. Over £3m of industrial cash and in-kind support has been input to the first two rounds of SUPERGEN and over £17m of public funding.

The TSEC (Towards a Sustainable Economy) programme is a joint council initiative (EPSRC, NERC and ESRC with participation from BBSRC) totalling £28m to work on research on sustainable energy. For the first time research will be integrated, i.e. it will not just involve work on parallel programmes. The initiative will build on other research council work, such as that conducted by the Tyndall Centre and under the EPSRC's Sustainable Power Generation and Supply

programme (SUPERGEN). It will also link closely with others' work, such as the Carbon Trust and the Department of Trade and Industry. UKERC (UK Energy Research Centre) is the major feature of the TSEC initiative. UKERC will provide a stimulating environment to deliver rigorous, inter-disciplinary, whole systems research that will allow sustainable energy policy for the UK to be formed in a scientific manner, taking account of public engagement and acceptability. The Centre will provide leadership in energy research and assist in giving co-ordination and coherence to the UK energy research agenda. UKERC was established on 1 April 2004 with a budget of £12 million, which it is expected will be divided approximately equally between the Centre's two key activities, its research programme and its co-ordination and outreach activities. This will include establishing a National Energy Research Network (NERN) which will provide greater coherence, co-ordination and connectivity for current and proposed UK energy research.

The participating councils are seeking to appoint an Executive Director for UKERC to work with the recently appointed Research Director Designate (Prof Jim Skea Director of PSI), who is currently mapping out the Centre's research programme. It is expected that by the time the Executive Director has been identified the framework and scope of the proposed UKERC research programme will have been accepted by the participating Research Councils. The Executive Director will lead and implement an effective management strategy for UKERC, as well as providing significant intellectual contribution to developing the research agenda.

The remainder of the TSEC programme's funds (at least £16 million) will be used to support research that will operate independently of, but complementary to, the research performed by UKERC. Calls for proposals will be broadly under the following themes:

Call 1 is focussed on Nuclear Fission power and Managing new uncertainties.

For the KTNOO call (led by EPSRC) the consortium building process is in progress, those consortium partners identified will be invited to submit a full proposal in the Autumn with launch, subject to peer review, early 2005. Main areas include: Maintaining Current Fission generation, Fission within a sustainable economy and Future Fission Power, with particular emphasis on waste issues, plant lifetime extension and future reactor technologies. The managing new uncertainties call which is led by ESRC, focuses on The Socio-Economic Challenges and Implications of Moving Towards a Sustainable Energy Economy.

Call 2 is being led by NERC and the technical scopes are currently being constructed through a series of workshops, the call for full proposals will be open early July, though the themes focus on Carbon Management which will include technologies such as CO2 sequestration and fuel switching for example. Conventional energy research is often vertically divided, so that research looks at the use of individual fuels, or energy use in particular industrial, commercial or domestic sectors. There needs to be more "cross-boundary" and "whole systems" research, looking at how different technologies and social/environmental factors might be optimised to deliver the overall objectives.

And Renewables, including technologies such as carbon cycle audits and risks barriers and incentives in renewables innovation. The objectives for TSEC in this area will centre on work that supports the development of renewable and sustainable energy systems of relevance to the UK economy. Specifically, it will: encourage the introduction of renewable and sustainable energy systems into the UK economy; encourage consideration of renewable energy in the context of social/economic/environmental issues and carbon management; and provide data

for the development of policy. TSEC will fund research that is complementary to that supported through other Research Council activities, such as the ongoing SUPERGEN initiative.

The RCUK (Research Councils UK) Meeting the Energy Challenge Conference was held between the 2nd and 4th February 2004 with the intention of highlighting actions to tackle the global energy challenges. The event focussed on harnessing ideas and skills from relevant disciplines including the underpinning sciences, and developing creative solutions with particular emphasis on encouraging information exchange between academia and industrialists under the UK/US Memorandum of Understanding.

The objectives of the conference were to:
Discuss and identify long term R&D issues to meet the challenges of energy research across all basic disciplines considering the recommendations highlighted by the UK Chief Scientific Advisor's Energy Research Review Group and the DOE report from the Basic Energy Sciences Advisory Committee.
Contribute to the agenda for the proposed UK National Energy Research Network
Explore opportunities for UK/US collaboration
Expand the research community active in energy research.

A full conference report including the actions and outputs, together with the identified contact to take these forward will be available on the internet very soon.

A selection of actions from the conference included:
For Government – Work to establish recognised, single responsible high level co-ordinating group for energy in the UK. Government policy to keep the nuclear option open – research into what skills/R&D/ capabilities needed. Clear Steer from Government on future of coal – given current critical state of generating and other infrastructure including new emerging CO_2 disposal.
For Research Community - Create a compelling vision of UK scientific research needs for energy, Synthesise existing social research on human behaviour and communicate insights to non-social scientists.
For Research Councils - Diversify basic science research for H_2 storage. Commit the UKERC as a focal point for joint international research.
For Industry - Fuel cell cost reduction programme. Research into how to make marketing give priority to energy efficiency and climate impacts.
For Partnership working - Work with the US and Europe to develop the advanced materials required both for fusion and advanced fission, For fossil fuels:- Invent, develop better methods for neutralising or capturing SO_2, NOx, CO_2. Make CO_2 disposal work.

The Coal Characterisation Divisional meeting, which was chaired by Professor Denis Dugwell, formed Session 3 of the days event. It was opened by posing the question "Coal Characterisation: Where are we at present?" A coal producer, UK Coal Mining Ltd., and a coal user, Powergen, under the banner "Setting the scene in the UK, the industry view", provided responses.

The presentation from UK Coal Mining Ltd., which was entitled "Market requirements for coal characterisation; a producers view" was given by their Pricing and Quality Manager, Martyn Jones. The presentation described how UK Coal maintains the quality of the desired product to coal users. It showed how information was presented in the Standard Analysis Pro Forma, which contained details of the QC standard, date, quality, proximate analysis, hydrogen, calorific value, sulphur, chlorine, price (£/tonne and £/GJ) and slagging index. The next

form was the Product Specification which gave actual coal data which was compared with specified maxima and minima.

Coal analysis is carried out for UK Coal Mining Ltd. by TES Bretby. Sampling frequencies were explained in that each individual train-load is analysed for moisture, ash, sulphur and calorific value. On a weekly basis, coal sizing, volatile matter, chlorine and ash analysis is also undertaken. Annually, trace element analysis, carbon, hydrogen, nitrogen, Hardgrove Grindability Index and ash fusion data are obtained. Examples of weekly analysis sheets and a full annual analysis were presented.

The picture that emerged from the presentation seemed to be that UK Coal Mining Ltd. has a portfolio of coals which they are endeavouring to market to the users but which they have little or no control over in the way the product quality might change. The key issue, in all probability, is cost and this may be the area which is subject to most scrutiny in terms of increasing market share. Certainly, there seemed to be little to suggest 'new' or 'improved' products might be available in the future.
Will Quick of Powergen gave a paper entitled "Requirements for coal characterisation; a power generator's view". By way of setting the scene, information was provided of the coal quality for which current UK boilers were originally designed. Such coals in the as-fired state contained 10% to 14% moisture, 12% to 15% ash, up to 3% sulphur, although typically around 1.6% and up to about 0.4% chlorine. These coals had net CV's of around 24MJ/kg. The cost and generally high sulphur contents of UK coal lead to the well-documented decline of deep mine coal production. More desirable coal qualities and prices were to be found in surface-mined and imported coals. Now the electricity generators burn roughly equal amounts of UK and imported coal.

Of the coal quality impacts the most important is pollutant emissions.

Pre-combustion issues include handleability, erosion and abrasion, mill explosions and spontaneous combustion. The perception is that handleability is not a significant concern with the exception of occasional problems involving fine dust blowing off stockpiles and highly moist coals such as those from Indonesia. In terms of their impact on plant operation and maintenance, erosion and abrasion are likewise not a major factor. The cause may be attributed to the presence and size of quartz particles in the coal and relevant information has been gathered to assist in coal selection. Incidents of mill explosions and spontaneous combustion are rare but potentially likely to increase. This is because they are associated with high volatile, imported coals such as those from Colombia and Indonesia. The problem is also related to ultra-low sulphur coals which are usually imported varieties.

The impact on boiler involves corrosion, deposition, combustion stability, burnout and unburnt carbon (UBC) in ash. The effect of chlorine on corrosion is not regarded as serious. As before much work has already been done on relatively high chlorine UK coals. The mechanism of the problem is known and data from the Powergen 1MW CTF using 50 hour runs and full-scale trials is known. Most imported coals are very low in chlorine so the problem is much less severe when these coals are burned. Ash deposition and slagging is also not a problem for UK coals and most imported coals are regarded as benign from this aspect. A further gain is that low NOx combustion can beneficially affect the nature of deposited material. There is another advantage in that the now common 'two-shifting' boiler operating regime helps deposited slag material to be spalled away from heat transfer surfaces. Analytical techniques such as CCSEM (computer-controlled

scanning electron microscopy) have helped to identify potentially troublesome minerals in coals.

Combustion instability can arise from burning coals of insufficient volatile matter and the current limit is 30% on a dry, ash-free basis. However, the availability of lower volatile coals from Scotland, Australia and South Africa with desirable sulphur and ash contents and lower costs means that the volatile matter limit needs to be extended. One UK manufacturer, Mitsui Babcock is developing a burner system to handle extremely low volatile coals of around 10%.

Control of UBC in ash is reasonably well understood in terms of the effect of mill performance and grind quality, fuel/ air distribution and the effect of fitting low NOx burners on plant efficiency. The impact of UBC on ash sales is important and systems to reduce levels to acceptable values are in place at certain power stations such as Longannet (SRI process) and Fiddlers Ferry (Rocktron process).

Gaseous and particulate emissions form the major problem area for power generators. Sulphur dioxide is subject to the LCPD where all existing coal and oil fired plant has to comply with emission limits. Existing plant has to be compliant by January 2008 and new plant by November 2002. The limit for unrestricted plant is 400mg/m^3 which would require FGD, or 800mg/m^3 for so-called 'opt-out' plant which has a restricted life. Ultra low sulphur coals (<0.35%) would be needed to achieve compliance for the opt-out units. Such coals are low in rank and CV and high in moisture and volatile matter contents. NOx limits imposed by the LPCD are 500mg/m^3 from January 2008 and 200mg/m^3 from January 2016 for unrestricted units. Opt out plants are limited to 600mg/m^3 from January 2008. The limit by 2008 can be achieved by the use of current combustion control technology but the lower, 2016 limit will require SCR. It was also made clear that other regulatory requirements such as IPPC (Integrated Pollution & Prevention Control), NECD (National Emissions Ceilings Directive) and BAT must at all times be met. The effect of those coal properties which have most influence on NOx formation, i.e. coal nitrogen content and fuel ratio, are by now well understood.

CO_2 emission trading will begin in the EU in January 2005 and coal will be penalised as a result. There will be a CO_2 emission calculation which is based on three factors which are multiplied together. These are the Activity Data, Emission Factor and Oxidation Factor. The Activity Data is the amount of fuel consumed multiplied by its net CV, the Emission Factor is the carbon content of the fuel and the Oxidation Factor is the carbon content of the ash. It is not easy to combat CO_2 emissions from coal and the enforcement of such limits will probably lead to a reduced use of coal.

Dust emissions from stacks have been subject to a 50mg/m^3 upper limit since April 2001, with a limit of 25mg/m^3 for plant fitted with FGD. The coal quality factors which affect dust emission include its sulphur content and thereby the resistivity of the ash, the carbon content of the ash and its chemistry. The 50mg/m^3 limit is challenging and ESP rebuilds at Kingsnorth and Ferrybridge have had to be made to be compliant. This has involved improved transformer/rectifiers sets, changes to flow distribution within the ESP and additive injection using substances such as sulphur trioxide.

A great deal of attention is being paid to the emission of trace elements, particularly mercury, during combustion. The initiative is being lead by the USA but the EU has just published its mercury strategy and the LCPD is expected to issue a trace element review by the end of 2004. Options for the control of mercury include NOx combustion control and the role of ESP's in the process, FGD plant is known to remove oxidised mercury compounds. It is speculated that the

combined use of SCR, ESP's and an FGD plant could remove up to 90% of mercury emissions. Injection of adsorbent carbon materials into flue gas has also been shown to have promise. The prospect of using low mercury coals was also mentioned but typical values are low and other factors such as burnout and the presence of calcium and chlorine are important.

In conclusion, it appears that there exists a wealth of experience in terms of understanding the impact of coal quality on power plant performance. In the majority of areas, most aspects are well understood. Attempts to capture this knowledge have been made in software known as VISTA, (formerly known as CQIM, the Coal Quality Impact Model). This system compares data from a specific boiler and its performance using a known coal with that of unknown coals. Finally, and most significantly, the greatest threat to continued coal burn is not impact on the boiler plant itself, but from environmental legislation.

The remainder of the session was devoted to what is being done in UK universities. Tim Mays from the University of Bath gave his paper entitled, "Characterisation of the oxidation reactivity of coal chars". The aims of the work were twofold. Firstly, to develop a simple and effective thermogravimetric analysis method to characterise the gas-phase oxidation reactivity of chars derived from different coals and coal blends. Secondly, to use oxidation / reactivity data to compare different coals and blends that might be used or are being used in PF combustion and steel making, and to understand and predict coal performance in service. Two carbonaceous materials were studied which represent extremes in terms of their properties. One was an isotropic synthetic graphite which was crystalline and virtually non-porous and the other was a disordered, high surface area, steam-activated bituminous coal. Using a simple reactivity model, the effects of different oxidising agents, environmental effects and factors such as surface, porosity, presence of heteroatoms and crystallinity of carbon were investigated. It was found that although methods were available which gave data, several were time-consuming, inconsistent and sometimes rather crude in their approach.

Two better options were considered which were referred to as thermogrammes and step-ramp tests. The thermogrammes were produced by heating the samples at a steady rate (5 to 50°C/m) under oxidising conditions until burnout was complete. The oxidising gases were air or carbon dioxide and the sample size was 1 to 2mm. Manipulation of the mathematical terms in the rate equations enabled the values of E and A to be estimated. It was found that non-linear and linear models both gave good fit to the thermogramme data. Both E and ln(A) decreased with increasing heating rate but for reasons not yet clear. Maximum values for E at <130kJ/mol and ln(A) <10s^{-1} were similar for both models.

In the step-ramp tests, the sample is heated in nitrogen to a certain temperature and then exposed to oxidising conditions for a short period. It is then ramped to a slightly higher temperature and allowed to oxidise further. Straight line Arrhenius plots were obtained for both materials with the graphite showing the lower reactivity. Consistency was obtained when data was compared with that from thermogramme studies.

The new methods appear to offer better speed and consistency than other methods however, further work is needed and is in progress to full explain the observed effects.

Nigel Paterson of Imperial College then presented a paper entitled "The reactivity and operability of Chinese coals under conditions relevant to entrained flow gasifiers". This venture, which was part of a larger study, was a collaboration

between Imperial College and the Thermal Power Research Institute in China. The objective of the work was to characterise selected coals and assess their suitability for use in dry feed, entrained flow gasifiers. Fourteen coals representing a range of properties was selected for the study. The heated wire mesh reactor (HWMR), used in previous projects, was upgraded to operate at 30 bar pressure and 2,000^{O}C and was fitted with a molybdenum mesh.

Carbon dioxide was used for pyrolysis and gasification experiments and helium was used for pyrolysis experiments. Pyrolysis test temperatures were 1,000, 1,500 and 2,000^{O}C with pressures of 2.5,10,20 and 30bar and a hold time of 1s. Gasification, due to the rapidity of the reaction, was confined to 1,000 and 1,500^{O}C with similar pressures but hold times of 0.5 and 1s. Increasing pressure was found to reduce volatile yield by hindering its evolution. It was also noted that volatile matter continued to evolve during pyrolysis at 2,000^{O}C. This was thought to be decomposition and volatilisation of mineral matter in the coal. The extent of gasification fell as the dry, ash-free carbon content of the coal increased.

Ed Lester of the University of Nottingham gave his paper which was entitled, "Burnout predictions using coal particle characteristics". As background Ed explained that models take data on coal properties and attempt to predict burnout, usually with, at best, moderate success.

The overall aim of the Nottingham group is to be able to improve the prediction of carbon burnout using data obtained from individual coal particles. The approach, which has been supported by BCURA and Powergen UK plc, is made up of a number of separate activities. These include the incorporation of char data into an existing burnout model (CBK) and the automation of morphological analysis of char particles prepared using a drop-tube furnace (DTF). It is intended that the prediction of char size, shape and type from individual coal particles will be developed so that a complete package of information is available which can then be incorporated into an improved burnout model.

The manual process of char morphological analysis is time consuming and subjective. A new automated char image analysis technique has been developed and tested. It has been shown to be capable of characterising char to a similar level of accuracy as the manual method. The data produced by this technique has been incorporated into the CBK burnout model.

The next activity was to consider how the different char structures contribute to unburnt carbon in fly ash. This makes use of data gathered over the years on properties such as % Unreactives, grey scale histogram data, particle size, char type and porosity.

One of the problems associated with predicting behaviour is the heterogeneity of coal particles. This makes the prediction of char type resulting from these 'mixed' particles more difficult. A logic model was used to help with the prediction and early results were encouraging.

Data was shown for three coals, Collinsville, El Cerrejon and Welbeck in which the predictions for burnout using the improved method were encouraging. The work is still in progress and further developments are likely.

Jenny Jones of the University of Leeds presented her paper which was entitled " Characterisation and modelling approaches for the insight into the fundamental chemistry of coal combustion". The Leeds strategy was that characterisation and modelling complement one another. If one can characterise the structural

changes that occur it will allow models to be produced. These models can then be validated against experimental data and mechanistic pathways can be discovered.

The processes of concern during coal combustion are devolatilisation, char burn out, nitrogen chemistry and the effect of catalytic metals. It was felt that by using accurate, realistic models a better understanding of devolatilisation/combustion, the prediction of pore sizes and intrinsic char reactivities would arise. There are a number of characterisation methods which are applicable to coal structural studies. Some of the less common instrumental techniques include FTIR spectroscopy, x-ray diffraction, NMR, py-FMS and py-GC, XPS and XANES, each of which will provide different structural information. Combining certain techniques such as FTIR spectrometry with other instruments such as the thermogravimetric (TG) balance allows the detection of volatile organics and inorganic gases during pyrolysis. TG analysis coupled with mass spectrometry (MS) allows detection of reactive gaseous species during combustion. The extent of devolatilisation can be followed by examining the FTIR spectra of chars produced under various conditions. Spectroscopic measurements on the chars also allow the structural features of these fragments to be better understood. This has lead to the demonstration of a relationship between the reactivity of certain coals and the percentage of 'edge' carbons present in their chars. During char oxidation mechanisms can be suggested which involve further oxygen chemisorption or ring closure of aromatic structures. The latter would help explain the lower reactivity of residual carbon during the last stages of burnout.

Nitrogen chemistry is influenced by volatility of nitrogen, nitrogen content and functionality of the coal and the properties of the residual char. The use of nitrogen-containing model compounds allows a higher degree of control over the experiments. Porphyrins have been used to simulate nitrogen in coal. Metals can be chelated into the ring structure and their effects can be monitored in N-containing gaseous emissions. Pyrrolic and pyridinic nitrogen species have been detected and there is some evidence of metal-nitrogen interactions.

Iron, vanadium, cobalt and copper all showed catalytic effects on combustion. It is caused by the very strong metal-oxygen adsorption which facilitates the formation of carbon dioxide precursors.

Further proposed work will involve IR microscopy of coal and char surfaces and the effect that heating and atmosphere variation will have. In addition, the effect of metal carbon interactions and how they may change during heating or oxidation.

Nigel Russell of the University of Sheffield gave his paper entitled "Fate of trace elements in re-fired fly ash". The aim of the project was to investigate the stability of trace elements in fly ash and re-fired fly ash. The initial work involved the investigation of available standardised leaching tests in order to be able to select the most appropriate for the materials in question. There are a number of different types of leaching test, for example, column or batch tests. The batch test mentioned is known as the Toxicity Characteristic Leaching Procedure, (TCLP). The batch test involves mixing the ash with a particular solution with agitation for several hours or days. One column test is known as BS EN 12457. It involves leaching with deionised water on granular (<4mm) materials. The final pH of the eluate is controlled by the test sample itself. It is used to assess leachability under mild extraction conditions for waste disposal or material reuse options. Two-step test provides relative timeframe for contaminant release when compared with availability for leaching.

The conclusions from the work were that both tests had been used to assess the impact of leaching on certain ashes. It was found that the TCLP test was aggressive and provided a worst case scenario. pH was found to be a major parameter in controlling the leachability of trace elements. Element leachability could be grouped into four categories. The highest solute levels were found with a leaching solution of pH<3. The tests allowed the development of a predictive capability for long term leaching assessment.

Future work was intending to look at re-fired ash and modelling of the process.

Mark Thomas of the University of Newcastle gave his paper entitled "Active carbons for environmental applications: Adsorption of species in flue gases". The objectives of the work were to study the adsorptive capability of a number of different active carbons for the purposes of removing mercury, dioxins and furans from power plant flue gas. This work was a continuation of some work described in detail at the Coal Conversion Division meeting held at Monckton Coke works, (see Newsletter No. 38). It is recommended that this issue should be consulted for further details.

The newer work involved the adsorption of mercury. There were a number of particular problems with this element, for example the complex speciation. It was likely to be found in the flue gas as either elemental mercury or mercury (II) sulphate or mercury (II) chloride. The other problem seems to be co-adsorption of mercury compounds with other substances. Elemental mercury seems to present the greatest challenge in securing its capture and activated carbon seems to be a poor adsorber of mercury. It was found that activated carbon need impregnating with other materials such as sulphur, iodine, chlorine or chelating agents to make it more effective. Mercury chemisorption onto suitable substrates occurs at 200°C to 300°C and the process may be measured using Raman spectroscopy. The kinetics are slow and the careful control of temperature is essential to maximise mercury removal.

24th June 2004. Coal Combustion Division to Longannet Power Station, courtesy of Scottish Power and Scotash.

The annual outing of the Coal Combustion Division took us North of the border this year. The well-tried format of a mini-seminar in the morning followed by a site visit after lunch was again found to be a successful as the full quota of 30 people was fully taken soon after the event was advertised.

The weather in Edinburgh was appalling with torrential rain beating down as the Newsletter editor arrived in Scotland on the morning of June 24th. The opening of the Highland Show adjacent to the airport did not augur well for the trip as the roads were gridlocked in the locality. However, once free of traffic Longannet power station soon loomed into view over Kincardine Bridge through the mists and rain.

After a somewhat delayed start caused by the inclement weather the proceedings got under way with a welcome from Alan Thompson, the Combustion Division Chairman and Karl Bindemann of Scottish Power who had been instrumental in organising the event.

The first presentation, entitled "Introduction to Scottish Power and Longannet Power Station", was given by Martin Sedgwick, who is the Station Manager at Longannet. He began by explaining who Scottish Power (SP) are and what they

are about. We were told that the Company had a turnover of £5.8 billion in 2003-04 and has a market capitalisation of £76.1 billion. It employs 14,000 personnel and the split is 60% US and 40% UK. Within the UK SP has 10% of the domestic electricity market which is generated from a mix of coal, gas, hydropower and wind. SP is the third largest distribution company and the leading developer of wind power in the UK.

The plant portfolio for Scotland comprises coal-fired units at Longannet and Cockenzie (3,456MW in total), pumped storage at Cruachan (400MW) and conventional hydro power (120MW). In England 1,760MW of CCGT power is available at Damhead Creek, Rye House and Shoreham.

A few brief statistics on Longannet power station were impressive. At 2,400MW it is the second largest coal-fired plant in the UK. It has four boilers, which are 60 metres high occupying a volume of 9,000 cubic metres and containing 250 miles of piping. Each of the eight turbines uses high pressure steam at $568^{O}C$ and 167 bar, the four generators are each of 576MWe and the chimney stack is 183 metres in height.

The focus for Longannet into next year was explained as aiming to meet a changing market where it will prove two-shifting, improve combustion performance and undertake large-scale, efficiency-improving maintenance on unit #2 (cost = £15 million). Plant performance will be a key issue in that SP will be seeking to improve commercial availability – maximising it when prices are high, identifying controllable losses – systematically identifying and cutting and prioritising key component maintenance and investment. Improvements to load following accuracy will be sought by operational discipline and reliability-centred maintenance.

The next presentation was given by Jane Telfer and Brian McNaught and was entitled "Emission regulation and FGD Implementation".

Jane Telfer, who is the Business Environment Manager, had the difficult task of trying to explain to non-experts the very complex situation regarding current and future regulatory limits on emissions. Directives to be complied with included the Large Combustion Plant Directive (LCPD), the National Emissions Ceiling Directive (NECD), the Integrated Pollution Prevention and Control Directive (IPPC) and the Emissions Trading Directive.

The LCPD is mainly concerned with reducing emissions of SOx, NOx and dust. New combustion plant must meet the emission limit values (ELVs) given in the LCPD. For 'existing' plants (i.e. those in operation pre-1987), generators can choose to meet the obligations by either, complying with ELVs for NOx, SO_2, and particles or operating within a 'National Plan'. That would set an annual national level of emissions calculated by applying the ELV approach to existing plants, on the basis of those plants' average actual operating hours, fuel used and thermal input, over the 5 years to 2000.

On this basis the generators would decide whether to 'opt in' or 'opt out' of whichever alternative they had chosen to follow. By opting out of either plan the generator would have to limit operation to a total of 20,000 hours from January 1st 2008 and to close completely by January 1st 2016.

If opting 'in' the generator then has a choice as to whether to restrict boiler operating hours or not. If the limited hour option was chosen then $600mg/Nm^3$ NOx, $800mg/Nm^3$ SOx and 2,000 hours per year would be enforced. The same restrictions apply whether the National or ELV options had been chosen.

In the case of the National plan, the duration of unrestricted operation would be limited by an emission cap. This is 13kT for sulphur dioxide at Longannet. For the ELV option from 1st January 2008, 500mg/Nm^3 NOx, 400mg/Nm^3 SOx and 50mg/Nm^3 dust would be required. This SOx limit would require the fitting of flue gas desulphurisation (FGD) plant. From January 1st 2016 the NOx limit would be reduced to 300mg/Nm^3 which would require the fitting of selective catalytic reduction technology (SCR).

The NECD covers SOx, NOx, VOC's and ammonia. It sets bubble limits for all EU member states. The UK caps are 585kT of SO_2 and 1,167kT on NOx. It is estimated that the electricity supply industry share of the SO_2 limit is a maximum of 200kT. It is up for review this year and needs to be complied with by 2010. The view is that the SO_2 bubble limit is likely to be more constraining on the LCPD opting-out plants than the 20,000 hour limit and stations without FGD can expect their SO_2 bubble limits to ramp downwards. The SO_2 bubble is felt to broadly equate to a 25% load factor firing a low sulphur coal, (~0.6%), which effectively limits the plant to 2,000 hours operation per year. NOx limit bubbles are also expected to be introduced.

The IPPC Directive is about minimising pollution from various point sources throughout the European Union. It is intended to cover the combined control of emissions to air, land and water. It is based on the original Integrated Pollution Control (IPC) legislation but is more detailed and demanding. Existing plant will be phased in sector by sector and Best Available Techniques (BAT) documents will provide guidance for each sector. BAT is expected to change with time as developments evolve and cost reductions are implemented. Draft reference documents for large combustion plant cite best practice but it is difficult to predict site specific requirements. Permits, which incorporate the requirements of all three directives, will have to be applied during the first three months of 2006. Each plant must have a site specific BAT implementation plan agreed by October 2007. Plant NOx and SOx bubble and instantaneous limits will be allocated via these permits.

The EU Emissions Trading Directive is initially only concerned with CO_2. There will be two trading periods, 2005-2007 in which the UK has secured opt-out status if certain criteria can be shown to have been met regarding emissions of CO_2 and 2008-2012 when it will be compulsory. The directive will cover companies emitting over the minimum threshold in specified high emitting industries such as fossil fuel power generation. There will be a free allocation of permits during phase 1 but the penalties for non-compliance are severe. Initially each tonne of excess CO_2 emitted will cost €40 rising to €100 and the shortfall still has to be purchased in the market place. The implications are that this directive will establish a cost for CO_2 emissions capped by the level of penalties. It will add a significant cost to coal-fired power generation and additional cost to gas-fired generation. It was felt that the free allocation in Phase 1 was considerably less than what was required and that the power sector was taking the brunt of UK required reductions.

The second half of the presentation was by Brian McNaught, who is a Projects Manager with Scottish Power, and posed the question "To FGD or not to FGD". Brian began by summarising the factors that needed consideration and listed them as the technology, cost, programme, contracting strategy, benefits and alternatives. There were four different technologies which could achieve the necessary targets, namely wet limestone / gypsum, spray dryer absorber, dry circulating bed and seawater scrubbing. The latter is, obviously, only an option because of the location of Longannet. Capital and operating costs need

consideration and when to start the programme would also have a major impact depending on the state of the market place. What should be the contracting strategy? Should SP contract with the designer or installer or a consortium? How should the contract be formulated? All of these factors and no doubt many others were being considered at the time of the presentation with a decision being expected within a few weeks of the meeting. It is now September and I am not aware of the outcome of these deliberations. If FGD was rejected other options mentioned were repowering of Longannet or the development of a 'brown field' CCGT plant.

The next presentation was by Alan Wilson, who is the Technical Services Manager at Longannet PS. He gave a talk which described work to improve the combustion performance at Longannet. The problems he described were poor combustion efficiency i.e. higher carbon in ash levels which had also resulted in higher NOx emissions and ultimately lower value ash sales. The SP approach was to create a Combustion Working Group whose remit was to investigate prime causes for deterioration in combustion performance and review those parameters that have greatest impact on combustion performance.

Briefly, the crucial parameters which were identified were a change in fuel supply and plant condition and operation. Key plant issues were a greater diversity in coal supply, now that the locally mined coal was no longer available, excessive tramp air, poor wind box air distribution, inconsistent PF size distributions, poor primary (PA) air flow control and PA/PF ratios and poor PF distribution. Plant operation issues were now seen as a need to 'load follow' and 'two-shift' rather than operate at base load, to improve operator training and to maximise plant auto controls.

To address the problems of coal variability SP arranged for trials to be undertaken using Russian, South African, Ayrshire and Colombian coals. This produced better knowledge of the behaviour of different coals. Important plant condition outcomes were improved coal feeder and PA control, elimination as far as possible of tramp air, improved secondary air control and better mill set up and geometry. Plant operation improvements involved better plant information being made available to operators to allow for flexible operation, more training and better support from all areas of the plant.

Jon Osbourne gave the next presentation on Gas Reburn – Current and Future Prospects. The technique of reburn is well-documented and, for this reason, will only described briefly. It is a technique for NOx reduction that involves using a main fuel, often coal, and a reburn fuel, usually gas although other s are possible and have been investigated. In the lower part of the furnace around 80% of the fuel needed is burned. This is known as the primary combustion zone and excess air and therefore NOx is relatively low. Above the coal burners the reburn fuel is injected and it is here where the remaining fuel (20%) is combusted. his zone is slightly fuel-rich and NOx formed below is reduced to elemental nitrogen. Above the reburn fuel injection ports the overfire air is introduced where the final burnout takes place.

Longannet was used as a demonstration project to confirm reburn technology and the equipment was installed in 1996 and commissioned in 1998. Extensive testing showed that the technique was very effective and the expected targets were exceeded. NOx levels below 350mg/Nm^3 were achievable without unacceptable increases in unburnt carbon or carbon monoxide. Currently, gas prices make the operation of reburn at Longannet uneconomic. However, it may have a possible future use if SCR plant are needed and where it can reduce the NOx loading on such units.

Karl Bindemann, Generation Engineering Manager at SP, then introduced the audience to the delights of WDF. WDF or waste-derived-fuel is made from sewage sludge which is pelletised and heat-treated. It is burned as a blend with coal and in time-honoured Blue Peter fashion, Karl then produced and circulated "one he had produced or should that be prepared earlier!!" Longannet can burn up to 100,000 tonnes per year of WDF which has a similar energy content to brown coal. WDT is made at the Daldowie sludge drying plant which processes the entire sewage output from the Greater Glasgow area, a population of 1 million people. WDF is milled with the coal and although up to 15% can be burned with coal, it is usually restricted to 10%. The low calorific value limits the amount that can be blended with coal and the presence of WDF in the fuel blend can also affect the fuel particle size. Although WDF is relatively high in ash content, (~20%), it does not appear to have any adverse effect on the quality of the ash produced by Longannet and ash sales have not been affected as a result. The burning of WDF by SP has resulted in the receipt by SP of ROC's (Renewables Obligation Certificates) which makes it a financially worthwhile activity for the generator.

The last presentation was about ScotAsh, what it is and what it is doing. The presenter was Peter Quinn, who is its Managing Director. ScotAsh is a joint venture company owned 50/50 by Lafarge, (originally Blue Circle in 1999 when formed) and Scottish Power. It was formed for a number of reasons which included environmental drivers such as landfill tax, mineral and aggregate taxes and CO_2 taxes. It also wished to be seen by HM Government to be proactive in recycling and sustainability and primarily to create value from coal ash.

There has been large investment in the ScotAsh plant, around £8M, which includes fly ash beneficiation, 100t/h blending plant, two large classifiers, (40 and 20t/h), packing plant for 25kg bags and 1.5 tonne IBC's (intermediate bulk containers), 10,000 tonnes covered storage space and a rail link.

The output from the ScotAsh plant needs to conform to certain specifications. The PFA delivered to the plant can vary considerably in its LOI content and so it needs to be processed to a consistent product. This is done using STI tribo-electric separation. ScotAsh evaluated a number of other beneficiation options before selecting the STI process. They found it to be commercially proven, to be relatively simple and easy to learn the process and it was 'bolt-on' technology.

In simple terms, the STI process involves ash being fed into a thin gap between parallel planar electrodes. Unburned carbon particles in the ash take on positive charge and minerals take on negative charge through particle-to-particle contact. The charged particles are attracted to the electrode plate of opposite charge. The separation is improved by the use of two open mesh belts made of polymeric material which contra-rotate at high speed.

The performance of the STI unit can be affected by a number of factors such as the LOI of the ash feed, the feedrate, the electrode separation gap and voltage across them, the feed port location, the ash temperature, ($35^{O}C$ to $50^{O}C$ are optimum conditions), the ash humidity and the ash fineness.

Although ScotAsh produce a variety of ash-based commodities, two of their main products are ash to BS 3892 Part 1 and EN450 both grades of which are used in the concrete industry. The ash is used as a partial replacement for ordinary Portland cement but also imparts additional beneficial properties to the concrete. The STI plant can process around 35t/h of PFA and this is equivalent to approximately 24t/h of EN450 grade product or 17t/h of BS3892 Part 1 product.

In addition to carbon reduction the ash has also to be classified to remove coarser particle in order for it to be compliant with the two mentioned specifications.

Other uses for PFA were also mentioned. These included the use of PFA-based grouts for filling in tunnel linings, pipe cavities, old mine workings etc. Landscaping, road base or load-bearing fill can also be made from PFA. Applications such as the use of PFA in lightweight aerated concrete were mentioned as was a new development known as Envirocems.

An interesting situation was mentioned regarding the fate of the separated carbon which arises from the STI process. Although originally from the coal burned at the power station, we were told that SP are currently prevented from re-introducing it into their boilers by the Scottish Environmental Protection Agency!! Consequently, they are seeking markets for the high carbon fraction produced by the beneficiation process.

Several pictures showing examples of the use of coal ash in concrete structure were shown. These included the Small Isles Ferry Project, the Orkney wind farm and the Royal Scottish Academy building. Peter, mindful of the imminence of lunchtime, then closed what had been a particularly interesting presentation .

With the formal presentations now over, the meeting broke up for lunch and after thanking all of the presenters for their time and efforts the bunfight began!

As the lunch drew to a close, (and I must give especial thanks to Scottish Power for the excellent food provided and the service that went with it, many thanks indeed), we were shown a video. It continued the earlier theme of WDF and provided us with a very detailed insight of the process throughout all of its stages. The only thing missing was the smell but I think many were prepared to forgo that 'pleasure'. In attendance to provide able back up to the video was Dylan Hughes who is Scottish Powers Commercial Operations Manager, Generation Business.

After lunch we were kitted out for our plant tour and divided into two groups. A short bus journey dropped us outside the main boiler house and we were led into the control room where we could see that three of the units were operating at almost full load and one was off line for major overhaul.

A further short journey then took us to the ScotAsh plant where we were able to see the STI unit operating and we shown samples taken from the unit to 'prove' that it really worked!! A visit to the laboratory then followed where the computerised records and data from sample analysis was shown to us. (It would be a distinct advantage, in my opinion, if on-line analysis of carbon could be initiated. This would speed up the process and eliminate the need for time-consuming LOI testing - just a thought - ed!!)

The bag-filling and storage area was most impressive as was the range of different products that were capable of being produced. Finally, we were taken back the ScotAsh offices where we divested ourselves of our protective clothing and were plied with very welcome coffee and biscuits.

Back at the main offices we just had time to thank Karl and his colleagues for a really superb day then it was time for the trek South – for many of us anyway. Also the small matter for some of getting to a TV set to see England quarter final match with Portugal in Euro 2004. In hindsight, they needn't have rushed!!

Scottish and Southern buys AEP's UK power plants

LONDON, July 30 - Scottish & Southern Energy has bought two of Britain's biggest power plants from American Electric Power for £250 million, making it the country's third-biggest generator.

SSE said on Friday the deal for the coal-fired Ferrybridge and Fiddler's Ferry power stations in Yorkshire - which account for about 6 percent of capacity in England and Wales - was expected to boost its earnings in the current financial year.
The purchase is the latest in a string of deals in the UK power sector, which has sparked back to life after a 25 percent jump in wholesale electricity prices since January. "This is a sensible acquisition which will bring both financial and strategic benefits to the company," said Fraser McLaren, analyst at ING Financial Markets.

SSE is one of the biggest suppliers to Britain's liberalised energy market, with more than three million electricity customers and 1.5 million gas customers.
The company said the two 2,000-megawatt power plants would help diversify its mix of generation, which up to now has been dominated by gas-fired stations, and help it manage exposure to fuel prices. Friday's deal included a stockpile of coal and contracts to supply fuel to the stations.

SLIDING ASSET VALUES
AEP bought the plants, which were commissioned in the late 1960s and early 1970s, for 650 million pounds in 2001 from U.S. utility Edison Mission Energy. Analysts said the dip in value reflected the stations' age and restricted lifespan in the face of tough new rules on emissions. The plants will not be able to comply with European Union limits on sulphur emissions from 2008 and SSE said it would stop operating the stations in 2015. The disposal by AEP, which is selling international assets to focus on its core U.S. business, nearly completes the retreat of American utilities which flocked to Britain in the late 1990s with a view to expanding into mainland Europe. Sliding UK prices and difficulties breaking into the liberalising European energy markets thwarted their ambitions. A credit squeeze following Enron's collapse in 2001 compounded the pressure on U.S. firms to give up their European aspirations.

REUTERS NEWS SERVICE

Sasol to study feasibility of plant in China

August 25, 2004, by Lynda Loxton, Cape Town.

Oil-from-coal producer Sasol confirmed yesterday that it had signed a letter of intent with Chinese officials to investigate the feasibility of a major new plant in China. "It's early days yet, and we cannot confirm what it would cost or what the output would be," said a spokesperson. He was responding to reports from China that a Sino-South Africa team would next month begin studying the feasibility of building two coal liquefaction production bases in northern Shaanxi province and Ningxia autonomous region at a cost of about $6 billion (R40.2 billion).

Coal liquefaction is the conversion of coal into synthetic fuels. Liquid and solid products from coal can be used for fuelling vehicles and power generators, and yielding materials for chemicals. "This marks China's strengthened efforts in finding substitute energy and its attempts to counteract price fluctuations in the global crude oil market," Xinhua news agency quoted Zheng Xinli, the deputy director of the policy research office of the Communist Party's central committee, as saying.

China was interested in coal liquefaction on a large scale as the country's coal reserves of about 1 trillion tons accounted for 70 percent of its total energy reserves, Xinhua said. The agency said China's increasing dependency on Middle East oil and rising crude prices had "spurred a new sense of urgency in the country to guarantee its energy supplies ... China is reliant on overseas producers for one-third of its demand."

The Sasol spokesperson said the feasibility study would take about a year to complete, but would get under way once a memorandum of understanding between the two parties was finalised.

Underground chapel remembered

Wednesday August 25th 2004, BBC Radio

The story of a miners' chapel - hundreds of feet underground in Swansea was told in a radio programme by the BBC. The show marked the 75th anniversary of the final service held in the chapel at Mynydd Newydd colliery. The pitmen established the chapel following an explosion at the colliery in which three miners died. Over the years, the miners cut three chapels in the rock as geological conditions changed. The timber-framed chamber, made from the solid coal, measured around 16 yards long by six yards wide. With a white-washed roof and sides, its seats were made from rough plank seats between rows of timbers. Every Monday morning, the chapel held a service before the men went to work - a weekly tradition that lasted more than 80 years. Services were conducted by the men themselves - only occasionally were visiting clergy invited to address the meetings.

John Hamen has fond memories of the services. "It was a simple, Welsh prayer service - just hymns and readings," said Mr Hamen. "There was a great religious fervour at the time. "One of the readers was the oldest man in the pit - he was 69-years-old and still working underground. "The service normally lasted about half an hour, at 6.30 in the morning." Dudley Evans' family were also involved in the services. "My grandfather William took services there but, according to my sister, he was more into prayers than sermons, so would have led prayer meetings as he always did in chapel anyway," said Mr Evans. "They were miners, yes, but Fforestfach is a community that had a strong singing tradition."

The colliery itself closed in the mid 1950s. Programme producer Steve Groves said: "The people who were there recorded their thoughts, as a tradition that went back for generations came to an end. "That's helped bring the story to life." "We know the hymns and at least one of the passages from the Bible read at that last service."

Nuclear power 'UK's only option'

www.icsouthlondon.icnetwork.co.uk September 14 2004

Nuclear power will have to provide half of Britain's electricity needs if the Government is to meet its key international commitment on reducing greenhouse gas emissions, a leading Department of Trade and Industry official has warned. The forecast, by Adrian Gault, director of strategic development at the DTI's Energy Strategy Unit, emerged as Prime Minister Tony Blair prepared to make a major speech on the need for global action to combat climate change and its effects. Nuclear power currently provides a fifth of Britain's electricity, but the nation's nuclear power plants are ageing and will be closed down progressively

from 2008. At present there are no plans to replace the generators which are shut down. The Energy White Paper, published in February 2003, put in place a policy of "not now, but not never" towards new nuclear generators. But according to The Times, Mr Gault's advice to ministers is that nuclear power will have to play a major role in electricity generation if it is to meet its commitments under the Kyoto Protocol, the international concordat under which the developed nations agreed to limit their greenhouse gas emissions relative to 1990 levels. However, a DTI spokesman said: "The report looks at differing scenarios for reaching the 60% carbon dioxide reduction target by 2050 - it includes both nuclear and non-nuclear possibilities. "It is a research document to help inform government policy but in no way does it constitute government policy or indeed change it. "We are not abandoning renewable energy."

Tailings

Rutland Fund has acquired Uskmouth Power Company, the operator of the Fifoots coal-fired power station at Newport in South Wales, and will restart the site with a workforce of about 100. 06-Jul-2004

AES Kilroot is to invest £35m in the installation of flue gas desulphurisation equipment at its power station in Northern Ireland. 02-Jul-2004

Student Bursaries for 2004

Up to 6 travel bursaries for up to £300 are on offer to bona-fide full-time students wishing to attend appropriate coal-related conferences. To apply, please send the abstract submitted to the conference with a brief supporting letter from your supervisor to:
Prof. J.W. Patrick
SChEME
The University of Nottingham
Nottingham
NG7 2RD
The bursaries come with no obligations to the recipient other than to supply a short essay about his or her impressions of the conference to the Newsletter for inclusion in the next edition.

Update on current BCURA Projects

B54 "Arching Propensity in Coal Bunkers with Non-Symmetric Geometries",
UNIVERSITY OF EDINBURGH,
Dr J Y Ooi and Prof J M Rotter, (01/09/01 to 31/08/05).

B55 "Investigation of the Reactivity of Gasification Chars and the Optimisation of Process Design",
IMPERIAL COLLEGE, LONDON,
Prof R Kandiyoti, Prof D R Dugwell and Dr N P M Paterson, (01/04/01 to 30/04/05).

B56 "Advanced Characterisation of Industrially-Important Coal-Based Carbons",
UNIVERSITY OF BATH,
Dr T J Mays, (01/10/01 to 30/09/05).

B58 "Advanced Image Analysis for Coals, Chars and Blends",
UNIVERSITY OF NOTTINGHAM,
Dr M Cloke, Dr E Lester and Mr P Langston, (01/10/01 to 31/05/04).

B59 "The High Pressure Interactions of Coal with CO_2 : Implications for CO_2 Disposal and CH_4 Displacement from Coal Seams",
UNIVERSITY OF STRATHCLYDE,
Prof P J Hall, (01/10/01 to 30/09/04).

B60 "Three-Dimensional Visualisation and Quantitative Characterisation of Fossil Fuel Flames using Digital Imaging Techniques",
UNIVERSITY OF KENT AT CANTERBURY,
Prof Y Yan, (01/09/02 to 31/08/05).

B62 "Large Scale Semi-Automated Tester for Rapid Assessment of Coal Handling Performance",
UNIVERSITY OF EDINBURGH,
Dr J Y Ooi and Prof J M Rotter, (01/09/02 to 31/08/05).

B65 "The Partial Removal of CO_2 from Flue Gases using Carbon recovered from PFA",
UNIVERSITY OF NOTTINGHAM,
Dr.M.Cloke, Prof.C.E.Snape, Prof.J.W Patrick and Dr.E.Lester, (01/10/02 to 30/09/05).

B66 "Direct On-Line Measurement of Wall Friction of Coal as an Indicator of Handleability"
UNIVERSITY OF GREENWICH,
Dr.M.Bradley and Dr.R.J.Farnish, (01/10/02 to 30/09/05).

B67 "A Study of the Behaviour of Coal Injected into the Blast Furnace",
IMPERIAL COLLEGE, LONDON,
Prof. R. Kandiyoti and Prof. D. R. Dugwell, (01/07/03 to 30/06/06).

B68 "On-line Measurement of Size Distribution and Concentration of Pulverised Fuel Using Digital Imaging Techniques",
UNIVERSITY OF KENT AT CANTERBURY,
Prof. Y. Yan, (01/08/03 to 31/07/06).

B69 "Handling Characteristics of Biomass/Coal Mixes for Co-Firing : Measurement Techniques and Establishing Benchmarks",
UNIVERSITY OF GREENWICH,
Dr. M.S.A. Bradley, (01/10/03 to 30/09/06).

B70 "Optimisation of Coal Fired Power Plant Performance when using Flue Gas Scrubbers for CO_2 Capture",
IMPERIAL COLLEGE, LONDON,
Dr. J.R. Gibbins and Dr. R. Crane, (01/08/03 to 31/10/04).

B71 "Improved Design of Sparge Pipe Air Distributors for Fluidised Bed Combustion Systems",
UNIVERSITY OF GLAMORGAN,
Prof. J. Ward, D.R.Garwood, T.Maksoud and Mr.M.Fisher, (01/06/03 to 31/05/05).

B72 "The Maintenance of the BCURA Coal Bank",
TES BRETBY,

Mrs.P.D.Alexander, (01/04/04 to 31/03/07).

B73 "The Selection of Low Cost Sorbents and Process Conditions for Mercury Capture from Flue Gases",
IMPERIAL COLLEGE, LONDON,
Prof. R. Kandiyoti and Prof. D. R. Dugwell, (01/10/04 to 30/09/07).

B74 "The Properties and Combustion Characteristics of Coal-Derived Fuels for Industrial Gas Turbine Applications",
CRANFIELD UNIVERSITY,
Prof. J.B. Moss, (01/10/04 to 30/09/07).

B75 "Effect of Coal Type and Oxyfuel Combustion Parameters on Pulverised Coal Ignition",
IMPERIAL COLLEGE, LONDON,
Dr.C.Man and Dr.J.R.Gibbins, (01/10/04 to 30/09/05).

B76 "Microwave Pre-treatment of Coal and Coal Blends to Improve Milling Performance",
UNIVERSITY OF NOTTINGHAM,
Dr.S.Kingman and Dr.E.Lester, (01/09/04 to 31/08/05).

B77 "The Effect of Additions of Biomass on PF Combustion Efficiency and Ash Properties during Coal/Biomass Co-Combustion",
UNIVERSITY OF NOTTINGHAM,
Dr. E. Lester, Dr. A.W. Thompson and Dr. M. Cloke, (01/07/04 to 30/06/06).

CALENDAR OF COAL RESEARCH MEETINGS AND EVENTS

Date	Title	Location	Contact
Monday 18th October 2004	53rd BCURA Robens Coal Science Lecture to be given by Dr Kelly Thambimuthu, CANMET Energy Technology Centre, Ottawa, Canada	The Royal Institution, Albermarle Street, London	Mr J D Gardner, BCURA Company Secretary, Gardner Brown Ltd., Calderwood House, 7 Montpellier Parade, Cheltenham, GLOS, GL50 1UA Tel : 01242-224886 Fax : 01242-577116 E-mail : john@gardnerbrown
Wednesday 3rd November 2004	Joint Meeting of the Advanced Power Generation and Combustion Divisions, "Low Carbon Future - Opportunities for Coal"	Scottish and Southern Energy Plc., Ferry Bridge Power Station, Knottingley, Yorkshire	Mr P W Sage Tel: 01235-432098 Fax: 01235-452753 E-mail: peter.sage@aeat.co.uk Dr A W Thompson, Tel: 0115-951-4198 Fax: 0115-951-4115 E-mail: alan.thompson@nottingham.ac.uk
6-9 December 2004	Fifth International Coal Conference, Coal Tech 2004: Coal for Regional Development	Kuala Lumpur, Malaysia	More details can be found by visiting the conference web-site www.ics.or.id/ct2004.htm
Late January/ Early February 2005	Re-launch Meeting of the Environment Division, Title to be Announced	Venue to be Announced	Dr M Whitehouse Casella CRE Energy Building 7/3 Vantage Point Business Village Mitcheldean GLOS. GL17 0DD Tel: 01594-546334 Fax: 01594-546342 Email: michaelwhitehouse@casellagroup.com
13 April 2005	Meeting of the Coal Preparation Division, "Coal Preparation and Handling, Where We are at Present, What is Being Developed and What Needs to be Done"	The Coal Authority, Mansfield, Nottinghamshire NG18 4RG	Mr AW Howells Tel: 01226 730440 Fax: 01226 730688 E-mail:andrew.howells@norec.ltd.uk

April 17 - 21, 2005	The 30th International Technical Conference on Coal Utilization & Fuel Systems Coal Technology: Yesterday – Today – Tomorrow	Sheraton Sand Key Hotel Clearwater, Florida, USA	Presented by U.S. Department of Energy http://www.fe.doe.gov Coal Technology Association & American Society of Mechanical Engineers - Fuels & Combustion Technologies Division http://www.asme.org/divisions/fact/ in co-operation with the National Energy Technology Laboratory, U.S. Dept. of Energy http://www.netl.doe.gov