ACARP ANNUAL REPORT 2011

MINISTER'S LETTER

The Hon Martin Ferguson AM, MP
Minister for Resources and Energy
PO Box 6022
House of Representatives
Parliament House
Canberra ACT 2600

Dear Minister

Once again I have pleasure in submitting to you the Annual Report of the Australian Coal Association Research Program (ACARP).

Despite uncertainty in the operating environment the export market has improved somewhat from the worst of the Global Financial Crisis. ACARP's role is to provide the research that will enhance the industry's performance under both challenging and strong market conditions. I believe it is fulfilling that role and that it is adding significant value.

The program is running smoothly and enjoys strong support at board, committee and mine site levels. It is pleasing to see the level of its interaction with producers and the supportive feedback received.

ACARP is unique, and as the coal industry's research program, produces high quality research and development for the benefit of its stakeholders in the primary areas of safety, productivity and environmental sustainability in a way that individual companies could not hope to achieve. It is not surprising therefore to see that its success has even been recognised by other industries and by coal industries in other countries.

Increasing interaction with companies, and high numbers of report downloads have again been features of this last year, and it is clear that ACARP research is making a difference. We believe the good progress that has been made toward better estimation and measurement of fugitive mine site greenhouse gases will be of value to all. ACARP is playing a pivotal role in providing this world class research to inform the industry and government.

Once again, the Annual Report highlights a range of case studies, which I am confident will be of interest to you. On behalf of the Australian Coal Association Research Program I look forward to your continuing support for this important industry.

Yours faithfully

Rob Neale
Chairman
Australian Coal Research Board

ACARP AT A GLANCE

VISION

To assist the Australian coal industry develop and adopt world-leading sustainable mining practices and, through collaboration, to ensure a sustainable position for the global use of coal.

MISSION

Utilise the collective technical competence and resources of the Australian coal industry to develop and manage a comprehensive research program which, through technological and process innovation, assists coal producers achieve their financial, environmental and social objectives for sustainable development.

The Australian Coal Association Research Program (ACARP) is the nation's pre-eminent coal research funding mechanism.

To maintain their position as world leaders, Australian coal producers must be profitable, technologically innovative and, at the same time, mindful of their social and environmental obligations. Through ACARP, they combine their expertise and resources to direct, support and fund world class research that benefits the industry as a whole.

Over the past decade, an evolution has occurred within the industry as coal mining companies have increasingly embraced sustainability as a core business value. A commitment to meeting the needs of the present without compromising the ability of future generations to meet their own needs has produced a realignment of company goals. Today's coal mining companies measure their success in terms of sustainable financial, social and environmental performance, such as those highlighted in this annual report.

As a key driver of research and development in the coal industry, ACARP has responded to this evolution by broadening its research focus. Today our projects cover a wide range of subjects, from developing and enhancing technology to reduce production costs, to improving safety for mine workers, and to measuring our impact on the communities in which we operate. Our research is multi-disciplinary with a growing number of social scientists joining our research teams.

Key facts about ACARP include the following:

- Every year we invest approximately $14 million in research projects of relevance to all areas of coal production.
- We are funded by all Australian black coal producers via a levy of five cents per tonne of product coal, currently committed to June 2015.
- We operate at the direction of the Australian Coal Association Executive, under a Memorandum of Understanding with the Commonwealth Government.
- The strength of the program is derived from the 150 senior technical people who are members of five technical committees and task groups, which provide technical direction and control.
- More than 40 mine sites currently host ACARP research projects.
- We have provided $209.8 million in funding to 1,195 projects since 1992.

THE AUSTRALIAN COAL INDUSTRY'S RESEARCH PROGRAM

ACR BOARD

- Strategic planning
- Allocation of funds

RESEARCH COMMITTEE

- Program overview
- Definition of strategic projects
- Sustainability issues

TECHNICAL COMMITTEES

- Underground
- Open cut
- Coal preparation
- Technical market support
- Mine site greenhouse mitigation
  - > Nomination of Industry Monitors
  - > Definition of priorities
  - > Project selection
  - > Task groups

AUSTRALIAN COAL RESEARCH (ACR)

- Program management
- Levy collection

AUSTRALIAN RESEARCH ADMINISTRATION (ARA)

- Project administration
- Distribution of outcomes

AUSTRALIAN COAL RESEARCH LIMITED

Rob Neale
Chief Executive Officer
New Hope Corporation
Chairman ACR Board

Australian Coal Research Limited is responsible for strategic planning, funding and overall management of ACARP. ACARP is a research program that sits within the broader responsibilities of the Australian Coal Association.

The following persons were directors of Australian Coal Research during the financial year.

ACR BOARD OF DIRECTORS AND ALTERNATES

Directors

Rob Neale (Chairman)
CEO of New Hope Coal Corporation Ltd

Mark Bennetts (Executive Director and Company Secretary)

Noel Ashcroft
Chief Executive Government Relations for The Griffin Group

Nick Barlow
Head of Resource Development and Operational Excellence for Anglo American Metallurgical Coal Pty Ltd

Julie Beeby
General Manager Strategic Planning and Projects for Peabody Energy Australia Pty Ltd

Steve Bracken
Chief Operating Officer for Centennial Coal Company Limited

Rob Brenchley
Director Marketing and Development for Wesfarmers Resources

Dan Cawte
General Manager Development at the SSE Lake Vermont Mine for the Jellinbah Group

Jeff Cochrane
Regional Head of Planning, Strategy, and Operations for Anglo American Metallurgical Coal Pty Ltd

Russell Conley
Chief Executive Officer for the Griffin Coal Mining Company

Peter Cronin
Manager Technology for BHP Billiton Mitsubishi Alliance (BMA) Coal

Sean Egan
General Manager - Operational Support for Vale Australia Pty Ltd

Allan Fidock
Executive General Manager – Mine Services for Macarthur Coal Limited

Rob Gallagher
General Manager – Technical Services & Operational Excellence for Vale Global Coal Pty Ltd

Steve Hadwen
Vice President - Strategy and Resource Development for BHP Billiton Mitsubishi Alliance (BMA) Coal

Alex Hathorn
VP, Technical Services and Continuous Improvement for Peabody Energy Australia Pty Ltd

Arun Jagatramka
Chairman of Gujarat NRE Minerals Limited

Chris Millard
General Manager Operations for Sonoma Mine Management Pty Ltd

Colin Moffatt
General Manager Technical for Ensham Resources Pty Ltd

David Moult
Chief Operating Officer for Centennial Coal Company Limited

Hennie du Plooy
General Manager – Resource Development for Rio Tinto Coal Australia Pty Ltd

Glen Robinson
General Manager Projects for Xstrata Coal Pty Ltd

Alternate Directors

Grant Adams
General Manager Technical Services for Macarthur Coal Limited

Kent Beasley
Manager Public Affairs for Wesfarmers Resources Limited

Peter Brisbane
Chief Engineer for Peabody Energy Australia Pty Ltd

Chris Harvey
Head of Technical Services for Gujarat NRE Minerals Limited

Lloyd Jensen
Manager Technical for Ensham Resources Pty Ltd

Mark Levey
General Manager – Business Support for Centennial Coal Company Limited

Andy Myors
General Manager - Western Region for Centennial Coal Company Limited

Bruce Robertson
Regional Manager – Underground Technical Services for Anglo American Metallurgical Coal Pty Ltd

Trevor Stay
General Manager Gas & Carbon for Anglo American Metallurgical Coal Pty Ltd

Ross Rinella
General Manager Business Development and Technical Services for Xstrata Coal Queensland Pty Ltd

Graham Willetts
General Manager - Business Improvement for Rio Tinto Coal Australia Pty Ltd

EXECUTIVE DIRECTOR'S REPORT

Once again, it has been a challenging year for the Australian black coal industry. However, ACARP has continued its strong performance and delivery of valuable research for industry. In fact, a significant portion of the research program has been directed at reducing some of these uncertainties, especially in the licence to operate areas of the industry.

ACARP – the coal industry's research program – supported 193 research projects around Australia during the year, representing a funding commitment of $51.9 million in total, including new funding of $ 14.9 million for 60 projects approved in December 2010. As you will see from the report, research is being undertaken in a wide range of very interesting, exciting and important areas covering safety, productivity and environment.

For example, valuable research has been undertaken in respect to more accurately assessing and estimating fugitive emissions from open cut and underground coal mines in an effort to understand their impacts on the environment and the operational adjustments needed at the mine site to minimise emissions. The industry driven Fugitive Emissions Steering Group is providing valuable expertise and oversight that is being used by both government and producers alike and their efforts will ensure the success of this research theme. Important research continues too on underground roadway development, active explosion barriers, improved beneficiation technologies, and mine site greenhouse gas abatement technologies.

As another example, the new major program entitled RISKGATE has enormous potential to reduce injury in the workplace and has broad application well beyond coal mining. The benefits and learnings of the highly proactive four year safety research program will be progressively made available to all as it is rolled out.

The strong support ACARP enjoys is evidenced by high levels of participation at board and committee level as well as via the just shy of 3,000 reports that were downloaded for the year.

I would like to express my appreciation for the contribution of the ACR Board in 2010-11, which underwent significant change during the year and I look forward to working with those continuing and new Directors again in the coming year.

ACARP is truly unique - its success relies on the support of coal producers and the substantial time and effort put in by each of each of our committee and task group members and I would like to express my personal thanks to all of them. I would also like to recognise the efforts of the many world-class researchers involved in ACARP as they strive to deliver world class research in a real world environment.

Please enjoy your review of our 2011 Annual Report.

Mark Bennetts
Executive Director
Australian Coal Research

STRATEGY AND SUSTAINABILITY

Together with the Executive Director, the Research Committee is responsible for the overall operation and strategic direction of ACARP research. It takes a whole of industry view, maintaining a balance between the priorities of the technical committees, short term operational issues and longer term strategic issues. The individual technical committees develop detailed research priorities and select projects in their respective areas, addressing critical issues such as safety, licence to operate, cost effective resource utilisation and market support.

Communicating project outcomes is critical. The Research Committee encourages constructive engagement with government and community groups. ACARP also provides high quality technical information to key industry organisations. The technical committees publicise their individual project results through on site demonstrations, focused seminars, conference papers, journal articles, via the ACARP Matters bulletins, CDs and on the internet.

RESPONSIBILITIES

The Research Committee is responsible for a range of long term strategic initiatives, assisted by the five technical committees and associated specialist task groups. A proportion of funding is retained for major strategic projects directed by the Research Committee. The committee is directly responsible for strategic environmental projects that impact beyond the mine site.

ACARP Scholarship Scheme

Two candidates have been supported to undertake their PhDs on topics of significant interest and import to the industry through the year.

One candidate will be working alongside an ACARP project focussed on geotechnical design for open cut operations. As mines get deeper and spoil pile dumps higher, the need for better design is accentuated. The project will investigate the geotechnical stability of very high spoil dumps with an emphasis on appropriate shear strength models and potential destabilising effects of dumped mixes of coarse and partly dewatered fine CHPP waste. This work will address a substantial knowledge gap. With increasing environmental and legislative pressures, it is expected that dumped disposal of all CHPP waste will become a more frequent practice in the future.

The immanent legislature on fugitive emissions from both underground and open cut coal mines has driven a need for greater scientific accuracy around the measurement of same. ACARP has played a significant part in coordinating the scientific and industry response, so it is fitting that the second scholarship should be targeted to understand the consequences and challenges of using ventilation abatement methods (VAM) to treat underground ventilation air containing levels of methane and carbon dioxide. This project has significant safety aspects as do most underground projects.

RESEARCH COMMITTEE

Peter Brisbane	Chief Engineer	Peabody
Steve Burgess	General Manager, Engineering and Procurement	Centennial Coal
Chris Dempsey	General Manager, Coal Technology – Operations	Macarthur Coal
Tony Egan	Manager Engineering System and Support	Xstrata Coal
Phillip Enderby	CHPP Manager	Bulga Coal
John Grieves	Project Manager – Minyango	Caledon
Hans Hayes	General Manager Open Cut Mining Excellence	Anglo American
John Hempenstall	Chief Risk Officer	Centennial Coal
Barry Isherwood	Group Manager, Coal Technology	Xstrata Coal
Bernie Kirsch	Principal Planning (Environment and Sustainability)	BMA
Guy Mitchell	Manager Underground Planning	BMA
Bruce Robertson	Chief Mining Engineer Underground	Anglo American
Peter Roe	Manager Environment – Regulation	BMA
Jim Sandford	Manager Gas Projects	Xstrata Coal NSW
Ken Sullivan	Technical Advisor	Cornwall Coal

John Hempenstall
Chief Risk Officer
Centennial Coal
Joint Chairman
Research Committee

Bruce Robertson
Chief Mining Engineer Underground
Anglo American
Joint Chairman
Research Committee (part)

Tony Egan
Manager Engineering System and Support
Xstrata Coal
Joint Chairman
Research Committee (part)

PROJECTS UNDER MANAGEMENT DURING 2011

ACARP funded 193 research projects during 2010-11 with a total financial commitment of $51.9 million. This included additional funding of $14.9 million for 60 new projects.

Over the past few years we have broadened the scope of our research to reflect the industry's commitment to financial, environmental and sustainability. The ACARP funding is expressed in the following table, with the three pillars of sustainability; people (social), productivity (economic) and environment. These categories demonstrate the diversity of projects supported by the program.

		No of Projects	ACARP Funding
People	Community	3	512,000
	Occupational health	19	4,959,318
	Safety	38	10,421,385
Productivity	Coal quality	19	3,700,802
	Maintenance	11	3,099,249
	Productivity	51	18,317,102
	Resource definition	8	1,591,264
Environment	CO_2 Management	8	1,597,400
	Rehabilitation	10	2,104,616
	Subsidence	3	676,461
	Waste management	13	2,563,525
	Water	10	2,350,485
	Total	193	51,893,607

This diversity of research is further demonstrated in the following case studies which showcase the high quality, multi disciplinary research supported through the program.

The Australian coal mining industry recognises that it must address sustainability issues over the longer term if mining companies are to retain their licence to operate. ACARP has acknowledged this industry driver by funding the development of new and innovative technologies and practices that will help operators achieve their financial, environmental and social goals.

There are an equal number of ACARP projects targeted to reduce the cost of production and those that address the broader licence to operate issues. In addition, many projects, particularly those focusing on underground problems, also address cost of production and safety.

PRODUCTIVITY

ACARP addresses the three elements of sustainability with a strong focus on increasing yield and reducing unit cost. The Coal Preparation Committee continues to invest in research designed to improve plant efficiency and the underground operators are pushing hard to improve the rate of roadway development which has been lagging behind the increasingly productive Australian longwalls. In open cut operations the focus is on improving equipment performance.

Accurately measuring in-bucket payload volume and optimising dragline bucket size to the rated suspended load have been identified as effective methods of increasing dragline performance. A range and bearing laser is being used to locate and scan full buckets between the lift and dump stages of the dragline cycle, with algorithms developed to map the surface of material in the bucket. This process has increased dragline performance by up to 10 per cent.

OCCUPATIONAL HEALTH AND SAFETY

ACARP's number one program priority is occupational health and safety, which reflects the industry's aspiration for a zero harm workplace. One key project addressing catastrophic events in underground mines is the development of a water-based active explosion barrier. Sophisticated modelling techniques were developed and used to simulate coal dust and methane explosions in underground roadways. This data was then used to establish engineering parameters for a prototype active explosion barrier. Preliminary testing has proven the technology with larger-scale testing and further modelling work still to be undertaken.

The intense manual strata support activities on a continuous miner challenge the occupational health and safety of underground employees and constrain production. An integrated, automated strata support materials handling system prototype has been constructed to address these issues. The prototype is expected to be fitted to a continuous miner for a full underground trial. Automating this process will eliminate repetitive strain and other injuries.

COMMUNITY AND THE ENVIRONMENT

The cumulative effects of coal mining are assuming a greater importance in Australia and a more collaborative approach is needed to assess and understand the complex range of economic, social and environmental impacts of new mine development and the expansion of existing ones.

ACARP continues to support research that investigates this issue, including the production of *Cumulative Impacts: A Good Practice Guide for the Australian Coal Mining Industry*. The guide provides tools, protocols, frameworks, case studies and practical examples of how to manage multi-mine impacts.

PEOPLE – COMMUNITY

MANAGING THE CUMULATIVE IMPACTS OF MINING

The Australian coal industry and its stakeholders are now better able to identify, assess, manage and monitor the cumulative social, economic and environmental impacts of mining using a good practice guide produced by the Centre for Social Responsibility in Mining (CSRM).

The guide – *Cumulative Impacts: A Good Practice Guide for the Australian Coal Mining Industry* – focuses on the opportunities and challenges to proactively identify and respond to cumulative impacts and includes tools, protocols and frameworks rather than the measurement of impacts at the regional or local level. It includes case studies as well as practical examples and methodologies on how best to deal with multi-mine impacts.

Industry Monitor and BMA Manager Communities Fiona Martin said prior to the development of the good practice guide there was no definitive or recognised work in place that offered an Australian context or guidance to industry, government and practitioners on the identification, assessment and management of cumulative economic, social and environmental impacts.

"Through ACARP, participating resources companies sanctioned a collaborative approach to the guide's development with the instruction to the CSRM that it had to be very practical and user friendly, designed for use by practitioners and underpinned by solid research and leading practice. CSRM definitely got this balance right," she said.

Cumulative impacts are assuming greater importance in Australia and elsewhere, and there is more focused attention from regulators and planners within government agencies.

Fiona said a more collaborative approach between industry and government was required to assess and understand the complex array of economic, social and environmental impacts deriving from the entry of new mines and the expansion of existing ones.

"Government policy needs to be based on sound theoretical principles and research, as does company decision making. This guide will provide a foundation to encourage the situation where all parties are talking the same language and fundamentally considering the same assessment approach," she said.

Project Leader Daniel Franks said while communities and environments experienced the impacts from multiple activities cumulatively, mining policy, regulations and onsite management of mining operations had traditionally been undertaken on a project-by-project basis and largely in isolation from other contributors to these impacts.

"It was the right time for this kind of work and it's found a willing and enthusiastic audience," he said.

"The feedback we've been getting from communities who have requested the guide and have asked us to deliver training workshops is that it's all good stuff – but they are quite pragmatic about whether it is currently standard practice across the industry. In any case, they are using it to advocate for better practice in the places they work."

Daniel said he was surprised by the level of interest in this work.

"We knew there was a growing interest in this issue in industry, community and government circles, but we were surprised at the extent of the interest," he said.

"We had 180 people attend the launch of the guide by the previous Queensland Minister for Infrastructure and Planning, The Hon Stirling Hinchcliffe MP, and 80 people at the professional development workshop.

"Our work with ACARP has been the foundation of our cumulative impact research. Since then we've been working with the Queensland Government to produce a guide on how to address this issue and with local governments in applying the guide. We are now working on multi-stakeholder governance of cumulative impacts and have started a second ACARP project looking at around 30 case studies of multi-stakeholder groups in the Bowen Basin and elsewhere."

2010-11 ACTIVITIES

- Completed the final research report.
- Produced *Cumulative Impacts – A Good Practice Guide for the Australian Coal Mining Industry.*
- Launched the guide at the Cumulative Impacts: Coordination and Collaboration forum on 19 November 2010.
- Ran a professional development workshop on the guide.

BMA's community development approach to cumulative impacts

One practical way BMA is addressing cumulative impacts is by partnering with its host communities and government to deliver more childcare places. Manager Communities Fiona Martin said 80 new places had been delivered, or were about to be delivered, through the upgrade of childcare centres across the Bowen Basin supported by BMA's Community Development Program and government funding through the Sustainable Resource Communities Fund.

"BMA has also supported the establishment of 60 new before and after school care places as well as an additional 10 family day care places in Moranbah. We are working to a long-term strategy that is underpinned by forecast growth of our operations and that of communities across the region," she said.

"To address the potential negative impact on childcare, we have put in place support packages to enhance the capacity of the childcare sector across our host communities. This includes affordable accommodation subsidies, a trainee support program, childcare curriculum, and centre and staff capacity building support. BMA's financial commitment in this area amounts to almost $4 million over the past two years.

"This is a very real and practical example of the ways that industry can collaborate with government and the community."

PEOPLE – OCCUPATIONAL HEALTH AND SAFETY

AUTOMATING ROADWAY DEVELOPMENT

Automation of the roadway development process in underground coal mines is a step closer to reality with the construction of an integrated, automated strata support materials handling system prototype.

Developed by University of Wollongong researchers as part of ACARP's Roadway Development Improvement Project, the prototype has undergone extensive surface trials and will be fitted to a continuous miner for a full underground trial in mid 2012.

Senior Mechanical Designer Peter Donnelly said in order to limit project risk, researchers had opted to take a retrofit approach rather than to fundamentally redesign the continuous miner.

"We are very pleased with the results. We have successfully demonstrated a method of transferring roof and rib mesh, bolts and washer bolts from the rear of the miner and automatically placing and fixing the components to the roof and ribs of the roadway using a laboratory simulation of a continuous miner," he said.

The automation of roadway development is being driven by the failure of Australian development rates to keep pace with modern longwall systems. A Roadway Development Task Group (RDTG) – which comprises nine member companies and represents about 90 per cent of the country's longwall production – was established in 2005. The RDTG developed the CM2010 Roadway Development R&D Strategy which is focused on supporting research into key enabling technologies of a high-capacity development system. In particular, the RDTG's vision is to achieve roadway development rates of at least 10 metres per operating hour and utilisation rates of 20 hours per day. Automation is critical to achieving this vision.

Manual strata support activities on a continuous miner were identified through a series of industry surveys as a major bottleneck that restrains improved production and affects the safety of operators. There has been limited experience in the automation of underground coal mining equipment, particularly roadway development processes.

Peter said while compliance issues with the underground safety requirements were difficult, the greatest challenge to researchers had been the lack of space.

"We were constrained by a minimum roof height specification of 2.8 metres over a Joy 12CM30. Further, after consideration is given to conserving operator access for servicing and maintenance, the amount of space left to automate the handling of 23 items per metre of travel is very small," he said.

"System complexity usually results when mechanisms are compressed into a space that is too small. Coming up with systems suitable for the small amount of available space without introducing great complexity was by far the greatest challenge in this project."

Following the successful surface trials, the prototype will be fitted to a continuous miner for a full underground trial. In preparation for this trial, researchers will:

- Carry out a general upgrade and improvements to make existing equipment more rugged for the underground trial.
- Make changes to increase the speed of operation to be consistent with 10 metres per hour.
- Add proximity sensors and write a more robust control program for the underground trials.
- Source intrinsically safe solenoid valve banks.
- Design and manufacture a temporary roof mesh magazine so that continuous runs of four metres can be tested with all components in the underground trials.

Peter said the next steps included developing concept designs for an integrated materials handling system to supply material to the on-board system at a sustained rate of 10 metres per operating hour.

"Again, space has been identified as a major issue with shuttle cars taking up almost 70 per cent of the available roadway behind the continuous miner, severely constraining access to the miner," he said.

"Researchers are continuing to investigate materials handling systems as utilised in other industry sectors, together with low profile continuous haulage systems, which could significantly reduce current space constraints."

ACARP Coordinator for the Roadway Development Improvement project Gary Gibson said the system as demonstrated was a significant advancement in the development of safer roadway development processes.

"This is because the technology essentially engineers-out the majority of personnel from the immediate face area," he said.

"Three years ago we could not have appreciated the potential benefits offered by development of such a system. Now it has been demonstrated – brilliant work!"

2010-11 ACTIVITIES

- Developed a working bolt magazine for roof and rib bolts.
- Developed a working washer delivery system for both roof and rib washers.
- Completely integrated all the systems – roof mesh, rib mesh, roof bolts, rib bolts, roof washers and rib washers into a fully functioning model.

PEOPLE – SAFETY

2010-11 ACTIVITIES

- Finalised the CFD modelling to develop the operational parameters of the prototype active barrier.
- Established the basic design requirements of the prototype, that is the maximum volume of water and driving pressure required to meet the range of conditions to be tested at Kloppersbos.

USING WATER TO SUPPRESS UNDERGROUND COAL MINE EXPLOSIONS

Cutting edge Australian research has proven that it's possible to suppress the flame front of a simulated underground coal mine explosion using a water-based active explosion barrier.

Researchers from SkillPro and BMT WBM have been able to simulate coal dust and methane explosions in underground roadways using computational fluid dynamics (CFD)[1] – a world first – to establish a set of operational requirements for a prototype active explosion barrier that will be tested in the 2.5-metre diameter and 200-metre long Kloppersbos explosion testing gallery in South Africa.

The primary goal of an active explosion barrier is to limit the extent of underground mine explosions as close as possible to the working face with minimal loss of life.

The prototype barrier has a flame detector inbye of the explosion barrier, a pressurised vessel to store water, and two metal spray bars with around 180 nozzles. When the flame is detected, an electric signal activates a release mechanism that opens a valve at the bottom of the pressurised vessel. A fine water spray is injected at great speed into the roadway to stop combustion and suppress the flame front.

ACARP Monitor and BMA Manager Underground Planning Guy Mitchell said although the concept of this active explosion barrier was simple, getting the modelling parameters right had been a complicated process.

"The water needs to be ejected from a bulk container into the air at great speed at the right micron size so that it will absorb the heat – up to 2,200 degrees Celsius – and withstand explosion speeds of up to 200 metres per second," he said.

"Within 250 milliseconds up to 240 litres of water is pushed out of the container pressurised to 20 MPa."

Project Leader David Humphreys said the research had been about more than building and testing a prototype active explosion barrier.

"We could have built a prototype based on our best guess work for its operational requirements and tested it in an explosion gallery. Depending on whether it worked or not, we could have made changes to determine the required operational characteristics for a production unit," he said.

"Since we don't have a suitable explosion testing gallery in Australia and we wanted to base the design of our prototype onto some scientific/engineering prediction, we decided to develop a capability in CFD to allow us to simulate the behaviour of underground coal dust explosions and then use this capability to address the design requirements for an active explosion barrier. This was undertaken in partnership with local consultants at BMT WBM."

David said the next phase of the project was to ship the prototype to South Africa where it would be installed in the Kloppersbos tunnel to undertake a series of suppression tests.

"The prototype design was developed using a model of the explosions in the Kloppersbos tunnel. In a previous ACARP project an extensive database of explosion behaviour at Kloppersbos was kept and used in this project to 'fine tune' the CFD model," he said.

"We hope we will be able to confirm that the design characteristics developed by CFD modelling are correct which will give confidence that the modelling can be used for other situations such as the characteristics of an active barrier in a larger roadway. Successful testing at Kloppersbos will 'close the loop' by further validating the CFD modelling of the barrier performance."

ACARP has invested around $1.5 million in active explosion barriers over eight years.

"If it saves just one life, it will have been worth it," said ACARP Research Coordinator Bevan Kathage.

"In developed countries ignitions happen rarely but they are usually catastrophic. This active explosion barrier puts another line of defence in the system in addition to stone dusting. It means we can contain an ignition to a face area and stop it from going through the mine. This allows other workers to escape and could also permit mine re-entry.

"This world-first, cutting edge research has produced an explosion barrier that is so simple; it's not reliant on a complicated set of elements working together at the same time."

[1] CFD uses high-speed 'supercomputers' to perform calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary condition

- Located and procured a flow control valve with the requisite opening time (very short), flow rate (very high) and pressure rating (very high) required for building an acceptable prototype barrier. This was probably the most significant step in the whole process of building the prototype as everything else depends upon its performance capabilities.
- Completion of the physical design details of the prototype barrier to allow construction of the pressure vessel and spray bars to commence.
- Development, design and construction of a custom release mechanism for the flow control valve.
- Assembly of the prototype explosion barrier on site at Simtars (the use of facilities and the support provided by Simtars is gratefully acknowledged).
- Shakedown trials and industry demonstration day.

Following on from Kloppersbos, the industry expects some further modelling work to be undertaken including that of a standard rectangular roadway (the Kloppersbos facility is a circular tunnel). The potential market for a commercial version of this active explosion barrier could be immense given the number of underground coal mines around the world. There has already been interest in applying this CFD modelling work to the explosion at Pike River, New Zealand, to assess whether it is possible to forensically determine what happened there.

Explosion barriers are just one form of protection in addition to numerous preventive measures used in underground coal mines, including:

- Flameproof equipment.
- Intrinsically safe equipment.
- Methane monitors to trip power if methane levels rise to 1.25 per cent.
- Regular workplace safety inspections by statutory officials.
- Principal hazard management plans.
- Competently trained operators and tradespeople.
- Stone dust placed throughout the face areas and outbye to also control explosions.

PRODUCTIVITY – COAL QUALITY

MAKING COMPUTERS EASIER TO USE UNDERGROUND

Industrial grade, intrinsically safe (IS) touch screen technology suitable for use in the harsh underground coal mine environment has been designed and is under development in Australia.

CSIRO Earth Science and Resource Engineering researchers are developing a transparent overlay that can be mounted onto the external surface of a flameproof enclosure window, providing mine operators with an easy-to-use computer interface in hazardous areas. Once the touch screen is aligned with the enclosed LCD, operators would be able to interact with the computer by touch screen control which is faster, easier and more accurate than using a keyboard, particularly if the operator has dirty hands or is wearing gloves. This technology could also be included into dedicated, machine-mounted, keypad style input devices that are currently fitted onto many mobile mining machines.

Project Leader Ron McPhee said negotiations were under way with a touch screen manufacturer to complete a small quantity production run of the prototype so that samples could be submitted to Simtars to evaluate the critical IS parameters necessary for IEC certification.

“Commercial touch screen manufacturers usually operate with large minimum order quantities for custom-designed products. For example, a minimum order quantity of 200 units is not unusual for an international manufacturer. In this instance, we have requested a special arrangement so that our order can be much smaller. I am currently awaiting a response from the manufacturer,” he said.

2010-11 ACTIVITIES

- Investigated the many touch screen technologies available – significant technical knowledge gathered during this process.
- Identified a suitable touch screen candidate for project IS design.
- Investigated high sensitivity projective capacitive touch (PCT) screens as an alternative technology.
- Developed an alternative (and perhaps simpler) approach to the IS touch screen design. The true outcome of this will not be known until Simtars has tested several touch screen samples.

"Once we have the critical parameters from Simtars, we will be able to complete the IS design. This final design will then form the basis for the IEC certification."

Ron said the researchers had faced five key challenges during the project:

- Obtaining specific information from international manufacturers.
- Retaining support from a local IS manufacturer – this is essential for IEC certification.
- Securing small quantity orders for custom design product in a huge international marketplace.
- Identifying a suitable technology.
- Alternative technological advances during the project lifetime.

"We had difficulty in obtaining specific information from international manufacturers regarding product electrical specifications which are critical to the IS design and certification process. Without a manufacturer's electrical specification, the testing station must rely on 'sampling' techniques," he said.

"The support of an Australian based IS equipment manufacturer is necessary from the early stages of any IS project. This is primarily because the certification process requires the manufacturer to be the applicant for the certificate of conformity. Local manufacturers often express initial interest in a new concept but it is understandable that a commercial organisation will respond best to a completed design."

"In projects such as the IS touch screen, the final design is usually only available near the completion of the project. This requires the project leader to maintain a potential manufacturer's interest over an extended period of time while not being able to offer a demonstration of a completed product."

"Another challenge was the emergence of new technology. During the development of the original prototype an alternative approach to the IS design was explored. I believe that in the long run it will prove to be a better method which is more likely to achieve the desired outcomes of the project."

Although the project was originally scheduled for completion by August 2011, it is expected to be completed in February 2012. This is due to the need for touch screen samples for Simtars' testing and certification, and the uncertain timetable surrounding arrangements currently being negotiated with the manufacturer for a small production run.

ACARP Research Coordinator Bevan Kathage said the introduction of computer systems into Australian coal mines had shown that there were irritating problems with their use, particularly in face areas.

"In particular, mine operators wearing gloves or even with dirty fingers find that the available IS keyboards are awkward, time consuming and difficult to operate. Therefore accuracy is sometimes compromised when trying to type," he said.

"Industry recognised that all the potential gains from use of computers were not being achieved in practice due to the operational problems already mentioned. Therefore, the industry endorsed the development of an IS, see-through, touch screen overlay that could be used as generic technology in a variety of hand-held and machine-mounted underground equipment – primarily for use with FLP enclosure equipment and other interface devices such as small keypad input modules."

"This research has delivered the design for an IS touch screen which will be available to industry once the necessary IS certification is obtained."

PRODUCTIVITY – PRODUCTIVITY

IMPROVING DRAGLINE PERFORMANCE BY MEASURING BUCKET BULK DENSITY

Open cut coal mines are able to increase dragline performance by up to 10 per cent by accurately measuring in-bucket payload volume and optimising bucket size to the rated suspended load.

Researchers from CRCMining have used a range and bearing laser to locate and scan full buckets between the lift and dump stages of the dragline cycle. The bucket is segmented from the scene by cluster analysis and the pose of the bucket is calculated using the iterative closest point (ICP) algorithm. Payload points are identified with a known model and subsequently converted into a height grid for volume estimation. The system was trialled at Anglo American's Drayton mine in June 2010. Results from scaled and full-scale implementation show that this method can achieve an accuracy of more than 95 per cent.

Project Leader Paul Lever said the research team developed its own algorithms to accurately and robustly map the surface of material in the dragline bucket. A significant benefit was that the laser hardware was off-the-shelf technology, so there was no need to develop purpose-built technology and software.

"The laser system sits on the dragline boom. It has its own processor that maps the in-bucket material surface, calculates the bucket volume and transfers this data to the dragline's onboard monitoring system. Bulk density is then calculated by combining bucket volume with the measured bucket payload," he said.

Knowledge of the bulk density of the dragline bucket payload can provide feedback to mine planning and scheduling to improve blasting and, thereby, provide more consistent dragline productivity across the mine. This allows the optimal bucket size to be selected for different material conditions. Achieving maximum overburden removal per dig will, in turn, reduce costs and emissions in dragline operation and maintenance.

Anglo American General Manager Open Cut Mining Excellence Hans Hayes said this new system took the guess work out of determining the material swell factor in the bucket.

"It can enable an increase of between five and 10 per cent in dragline performance by optimising the bucket size based on the average in-bucket density experienced across the whole operation, or by designing specific buckets suited to the material in each dragline pass or area of the mine," he said.

"This could lead to an extra 100,000 tonnes of coal per annum per dragline, or $20 million in revenue."

"Anglo American undertook the testing at its Drayton operation in 2010 as we saw the value in the project which will shortly be commercialised through MineWare. This is another example of an ACARP project being progressed through to commercialisation to reduce the cost of production."

ACARP Research Coordinator John Brett said the project went well from an organisational and operational perspective.

"The researchers had established a rapport and successful relationship with the mines and were, therefore, able to get the necessary assistance from site and access to machines and data," he said.

"A second project has been approved for funding because we were pleased with the effort put into the original study and the objectives achieved."

CRCMining has just started the second ACARP project which aims to measure the in-place bulk density of overburden following a blast.

Automation Engineer Alex Bewley said the project scope had been expanded to include evaluation of an existing hardware platform as a possible alternative to a custom built system.

"This decision was made to simplify the process of installing the hardware required to collect the terrain data. The process took longer than expected as the only working prototype of this system is located on a dragline where access for collecting the required data is limited by mine scheduling," he said.

"This project is approaching the completion of the first milestone where we have evaluated a suitable hardware platform for data collection. In addition, progress has begun on developing algorithms to interpret digital terrain maps for measuring in-place bulk density."

2010-11 ACTIVITIES

- Carried out successful field trial of the in-bucket bulk density in late June 2010.
- Completed the in-bucket bulk density project and final report.
- Completed work was presented at the International Conference for Robotics and Automation at Shanghai in May 2011.

PRODUCTIVITY – PRODUCTIVITY (CONTINUED)

IMPROVING THE DEPTH ACCURACY OF BLAST HOLE DRILLING

Bowen Basin drillers will soon be able to stop their drill bits accurately above the top-of-coal by combining existing rotary air blast (RAB) drilling equipment and mobile phone technology.

This breakthrough innovation will help open cut coal operations overcome coal losses from over-blasting and will also allow coal seams to be more accurately modelled.

Researchers from the University of Sydney and CRCMining have proven many of the key concepts needed to produce the measurement-while-drilling (MWD) top-of-coal sensing system and are now working to prove up the technology.

Project Leader Iain Mason said they had identified that the miniature, rugged, intelligent terminal transceivers embedded in mobile phones could be used to send data from the drill bit to the operator's console in the cabin of the machine.

"With assistance from BMA Peak Downs Mine and RAB suppliers, we have established that cylindrical air-filled channels inside RAB drill strings could be used without modification to allow retrofit of operationally invisible, wideband communication links from the drill bit to the driller," he said.

"The installation of a wireless system inside any RAB drill string requires no modification and the mobile phone transceivers can be lodged in existing counter-bore relief spaces, without significantly disrupting compressed air flows."

"Development of the small and efficient, minimal impact, wireless top data swivel should speed up construction,

installation and testing of prototype look-ahead ‘radars’ to see if they can first imperceptibly blend with, and then extend, the existing practice of touching top-of-coal one in five blast holes.”

“Our initial project successfully broadened the scientific baseline from which to view RAB logging-while-drilling. The extension project currently under way aims to unambiguously demonstrate that sensors, transceivers and data swivels can be integrated into a system that will guide drillers routinely into a clean touchdown as the drill bit finally approaches top-of-coal.”

Accurately detecting the top of a coal seam before blasting is key to efficient coal recovery. Industry results have shown that adopting a program of correctly mapping and then blasting can reduce coal losses from 13 per cent to 4 per cent. Currently coal levels are located from an exploration drill rig ahead of blasting. This method is costly and involves many additional processes and resources. The infrequency of point sampling limits its ability to adequately identify faults and other geological features.

Industry Monitor Ken Preston said most losses that occurred in coal mining were due to over-blasting or over-digging coal.

“This is largely a result of overburden drills drilling into the coal. If it is possible to predict seam top then this would be prevented or at least reduced,” he said.

“I believe that the project has proven the concept of detecting top-of-coal while drilling and identified some of the practical issues, but it is still in an early stage of development.”

BMA Manager Technology Peter Cronin said BMA supported the continuation of this project to reduce the number of processes and complexity associated with detecting the top of coal during RAB drilling.

“This could make coal detection for drillers quick and simple without relying on information from other processes that also require interpolation,” he said.

PRODUCTIVITY – PRODUCTIVITY (CONTINUED)

MICRO-SCREENS IMPROVE PLANT YIELD

Micro-screening technology adapted from the water treatment industry has improved coal preparation plant yield by up to four per cent.

The Baleen Filter, trialled at four preparation plants in New South Wales as part of an ACARP research project, proved that the coarser fraction of tailings solids could be effectively separated from the slimes. This is good news for industry, which currently loses millions of tonnes of good quality, ultrafine coal each year, discarded as waste due to inefficiencies associated with classifying cyclones.

Researchers from Tekpro Metallurgical investigated the effectiveness of the Baleen Filter in separating coarse, low density particles (coal) from fine, high density particles (slimes) on a size basis, in order to try to recover saleable, coarser product fractions.

Project Leader Neill Turner-Dauncey said the Baleen Filter was a genuine self-cleaning micro-screen which was capable of size separation of solids in dilute slurries down to 20 microns, without the assistance of vacuum, pressure, or vibration.

“The implications of this in the coal processing industry could be massive, simply because of the nature of the classification equipment used in most plants – hydrocyclones,” he said.

“No matter how efficient the desliming hydrocyclones might be performing, the cut point will vary in accordance with variation in density and particle size. As a result, there will always be a significant amount of coarse, low density particles reporting to the overflow (tailings stream), along with the fine, high density particles.”

“We were surprised at just how much good quality coal is being thrown away due to the inherent cyclone inefficiency. This coal is recoverable by a straight size separation. We also found there was a lot of recoverable coal in flotation tailings.”

The Baleen Filter is a high, open area, fine mesh, stainless steel, pre-tensioned, static screen onto which the slurry is fed. The oversized particles come to rest on the screen surface, and are then cleared off the screen by a reverse spray arrangement. This arrangement comprises two high pressure / low volume spray bars, one below the screen spraying upwards and one above the screen spraying forwards. The undersized solids and most of the water pass through the screen into the underpan.

Industry Monitor and Newstan Plant Manager Neil Drakeford said that the Baleen Filter had potential to recover ultrafine coal.

“The process works well and has very good potential to be utilised throughout the industry to recovery many tonnes of ultrafine coal, a lot of which currently ends up in tailings dams,” he said.

“The filter needs to be scaled up to a full-scale, working model. This would establish if the process/machine is capable of achieving similar good results and whether it is reliable in an industrial environment.”

ACARP Research Coordinator Peter Newling said researchers demonstrated that the Baleen Filter was capable of capturing coal misplaced into reject fines streams very effectively.

“In coal preparation plants it has always been more difficult and expensive to treat fine coal. This screen works at a finer size than other screens available,” he said.

2010-11 ACTIVITIES

- Carried out Baleen Filter test work on three sites under the ACARP program.
- Developed a fully mobile demonstration / test rig for the Baleen Filter which can now be operated on its trailer.
- Carried out further Baleen Filter test work on three other coal preparation plants outside of ACARP.
- Received first purchase order for a commercial scale unit in a coal handling preparation plant application to deslime current fine coal centrifuge feed.

"The downsize of this unit is that the finer the size it operates at, the more area required per tonne processed and for the area in which it has the most rewarding results, the amount of screening capacity required would be prohibitive."

Industry Monitor and Bulga CHPP Manager Phillip Enderby concurred. He was impressed with the simplicity and energy efficiency of the Baleen Filter but said its throughput was too low at the finer cut points.

"For a plant such as Bulga, we would need about 138 of these screens to recover the coal – and that's a lot of real estate," he said.

"The suggestion to the manufacturer was to make the unit bigger to improve the throughput, and even to consider triple-deck units."

Phillip said another issue in recovering ultrafine coal in the thermal coal market was the challenge of drying it.

The Baleen Filter will now be installed at a commercial scale on an Xstrata coal preparation plant to assess its robustness and identify any scaling up issues.

PRODUCTIVITY – RESOURCE DEFINITION

USING IS GEOPHONES TO IMPROVE SEISMIC MONITORING UNDERGROUND

The Australian coal industry is better able to forecast ground conditions ahead of the working longwall face using intrinsically safe (IS) geophones as part of the seismic monitoring system.

IS geophones are a critical link in using seismic energy generated by a longwall shearer to tomographically[2] image roof conditions ahead of the advancing face. Researchers had been able to demonstrate that strata conditions could be reliably imaged, paving the way for the development of a roof mapping technique to predict rock conditions, maximise coal recovery and prevent mining hazards. This work has been hampered until now by the absence of IS geophones.

To overcome this hurdle, researchers from CSIRO microseismic and longwall automation groups have designed an electrical circuit that can be installed onto a conventional geophone element. This special circuit allows the voltage/current to remain within the IS range without changing the essential characteristics of the geophone. The technology has been certified by the International Electrotechnical Commission (IEC), an international standard governing the design, manufacture and quality control of IS equipment for use in potentially explosive atmospheres.

Theme Leader of Coal Production Technologies Hua Guo said seismic monitoring techniques had been found to be useful in underground risk management and production control in Australian coal mines.

"Geophones form part of the seismic monitoring system, sensing rock/coal fractures near the longwall face that have been induced by mining. The IS geophones enable seismic monitoring to be readily applied near underground coal mine workings. In addition, the cost will be reduced to the point where seismic monitoring can be used widely to provide accurate ground condition information to mine operators on an ongoing basis," he said.

"Unknown poor ground conditions ahead of the working longwall face can cause considerable interruption to mine production and expose mine personnel to increased safety risks. Small geological anomalies are seldom detected by routine exploration techniques and a clear need exists to detect these conditions during mining."

"Underground seismic monitoring can provide more detailed information than conventional ground seismic surveys about geological structures and ground conditions near the working face and their movement characteristics associated with mining operations. This information can be used by mine operators to assess ground responses to mining and ground control requirements. IS geophones make underground seismic monitoring possible."

Project Leader Xun Luo said one of the difficulties researchers faced during the project was sourcing quality specifications from international manufacturers.

"We found that it was better to source products from established manufacturers – it costs more but the documentation and quality control is better," he said.

"We also found that under the latest IEC and AUS agreements, the IS manufacturer's involvement is essential for certification. No manufacturer involvement means no certification."

Industry Monitor and Anglo American Principal Geotechnical Engineer Ismet Canbulat said development of the IS geophones was a precursor to a larger ACARP project application.

"Through ACARP funding, a seismic tomography system using the geophones is being developed to monitor the structures and stresses ahead of longwall faces. This system will enable us to develop advance longwall face management plans to mine through 'high risk' or high stress geotechnical domains," he said.

"A seismic system can be used to confirm some of the assumptions and parameters used in the design during mining, detect changes in seismic parameters, provide warnings, and improve efficiency of design and monitoring."

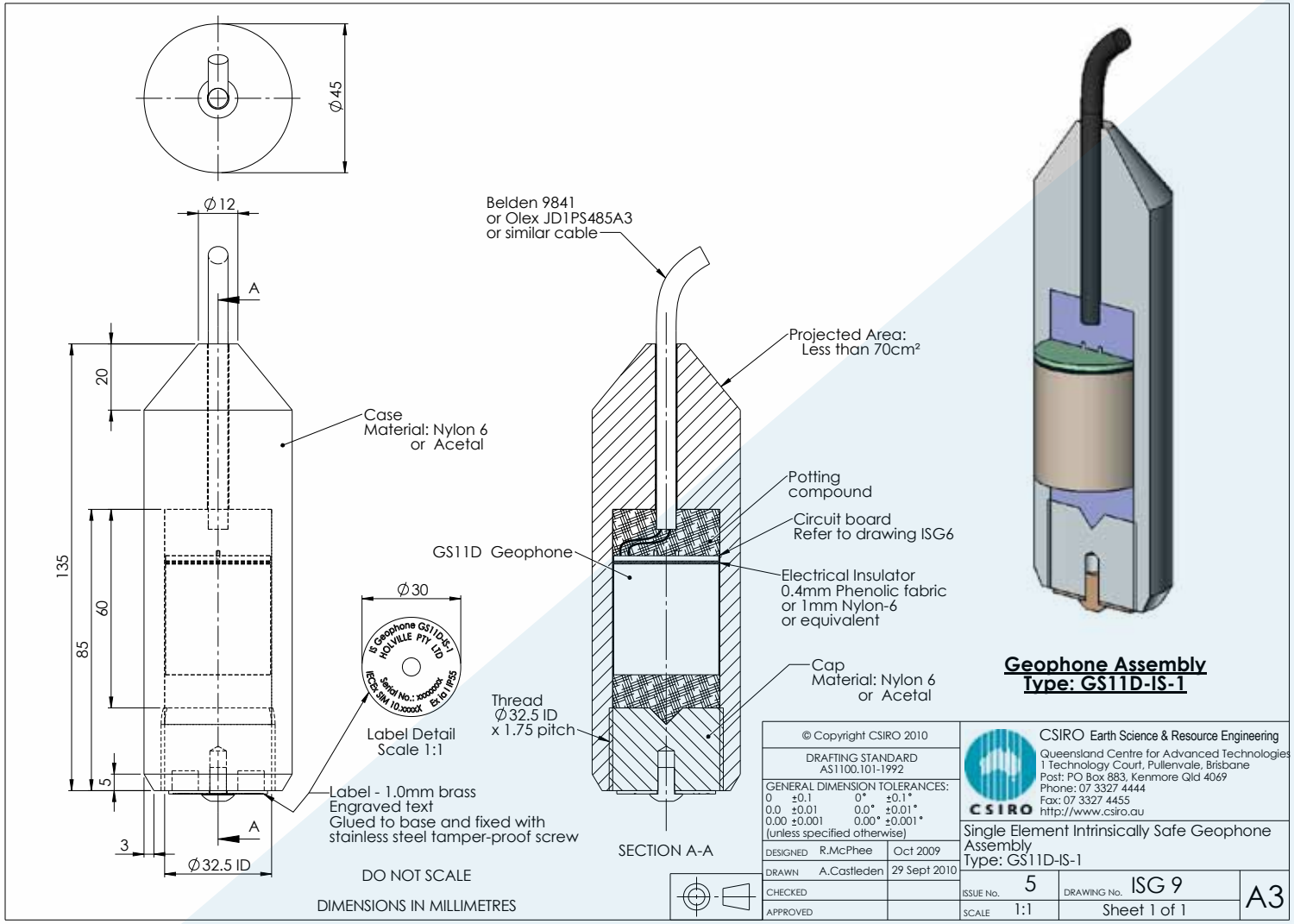
Xun said one underground mine had already expressed an interest in using the IS geophones in its longwall panel monitoring.

"We think that this will happen once mine site personnel realise the benefits of the micro-seismic modelling," he said.

[2] Tomography is a method of producing a three-dimensional image of the internal structures of a solid object.

2010-11 ACTIVITIES

- Secured a competent and interested manufacturer.
- Obtained IEC certification.



ENVIRONMENT – WASTE MANAGEMENT

2010-11 ACTIVITIES

- Attended UNEP's second Inter-governmental Negotiating Committee (INC2) on the development of the mercury instrument, Japan, January 2011.
- Attended IEA Workshop on Mercury from Coal Combustion, South Africa, May 2011.
- Met with National Generators Forum Environment Committee to discuss implications of UNEP process, July 2011.
- Attended at presented at the 10th International Conference on Mercury as a Global Pollutant, Canada, July 2011.

ADDRESSING GLOBAL MERCURY EMISSIONS AND DISCHARGES

ACARP is playing a key role in Australia's input into the Global Mercury Partnership, the United Nations Environment Programme's (UNEP) voluntary, accelerated action to address mercury exposure issues.

In 2009 UNEP's Governing Council agreed on a plan for a global approach to reduce population and ecosystem exposure to mercury. This landmark decision, taken by more than 140 countries, facilitates the development of an international mercury convention to deal with world-wide emissions and discharges of this pollutant. The Global Mercury Partnership is a means of taking immediate action while the convention, scheduled for completion in early 2013, is being finalised.

Signing a mercury agreement could have major implications for the Australian coal and mineral processing industries. Existing inventories suggest that these sectors are the major sources of human-induced emissions to the atmosphere – the most important pathway for environmental transport and, ultimately, mercury exposure. The draft document includes a requirement for each party to reduce and, where feasible, eliminate atmospheric emissions of mercury from the sources such as coal-fired power stations, metal smelters and alumina refineries.

To keep the industry up-to-date and to facilitate involvement in the Global Mercury Partnership from Australian coal combustion experts, ACARP has approved a project led by Prof Peter Nelson from Macquarie University's Graduate School of the Environment.

This project, The Mercury Treaty – Implications and Responses for the Coal Industry, has four key benefits:

- Early indications of consequences and impacts to the coal industry.
- Ability to formulate informed contributions to policy and regulatory developments.
- Confidence in assessing the market impact.
- Support for expert Australian input into the development of actions.

Peter has been charged with:

- Reviewing UN documents relating to the treaty development.
- Reviewing Australian government documents and input to the treaty development process – industry's role in Department of Environment, Water, Heritage and Arts (DEWHA) projects, contact with DEWHA staff, other activities that result in significant access to the developing Australian position and to UN developments.
- Reviewing possible key responses to the likely treaty provisions.
- Participating in the UN Partnership activities.
- Participating in the IEA Mercury Emissions from Coal workshops.
- Delivering regular briefing notes to ACARP.
- Producing a final report.

Peter said momentum was building towards the development of a global approach to the management of mercury in the environment.

"As a major source it's important that the coal industry engages with this issue and has an input into cost effective and successful management strategies. The ACARP project is an efficient way to achieve this engagement," he said.

Industry Monitor Barry Isherwood said although Australian coals were generally considered low in mercury content, addressing mercury exposure was a global issue.

"As a major exporter of coal, Australia needs to be at the forefront of any technical and legal discussions, and that is why we have Peter Nelson involved. Peter is considered one of the world's experts in the area of trace elements emissions, such as mercury," he said.

INCOME/EXPENDITURE

Income	10/11	09/10	08/09
Levy	**15,863,512**	16,213,912	15,074,290
Interest	**1,322,154**	921,123	862,214
Other	**323,037**	4,613	5,481
Total	**17,508,703**	17,139,648	15,941,985

Expenditure			
Research Projects *	**12,761,851**	12,399,690	12,146,462
ACR Management	**483,425**	426,027	460,401
ARA Project Administration	**1,320,320**	1,293,129	1,282,797
CCSD Research Projects	**370,727**		
Total	**14,936,323**	14,118,846	13,889,660

Outstanding commitment for research at 30 June 2011			
Projects Started	**18,919,892**	15,027,353	14,731,302
Projects Yet to Start	**3,119,437**	5,605,783	2,930,557
Total	**22,039,329**	20,633,136	17,661,859

Cash Reserves	**25,290,989**	22,193,248	19,172,445

* Reconciliation with Financial Report Australian Coal Research Ltd for 2010/11

ACARP Research Project Expenditure	12,406,915
Reversal of Invoicing Lag July 10	-497,670
Invoicing Lag June 11	852,606
Research Project Expenditure Financial Report ACR	**12,761,851**

Funding Committed by Technical Area

	10/11	09/10	08/09
Major Project	**910,000**		
Underground	**5,843,292**	5,986,679	5,123,017
Open Cut	**4,486,198**	3,589,532	4,338,435
Coal Preparation	**2,062,778**	2,046,189	1,935,552
Technical Market Support	**978,959**	826,680	766,187
Mine Site Greenhouse Mitigation	**677,140**	1,512,000	615,331
Low Emission Coal Use	**0**	0	58,000
ACARP Total	**14,958,367**	13,961,080	12,836,522
Other Funding	**11,986,182**	7,958,230	13,206,088
Total Funding	**26,944,549**	21,919,310	26,042,610
Leverage	**1.8 times**	1.57 times	2.03 times

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