AUGUST 2011

CURRENT PROJECTS

This report is a summary of current projects for the quarter May, June & July 2011
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MAJOR PROJECT

C20003
RISKGATE

University of Queensland
Jim Joy

Value: $1,068,453
Report Expected: 25/01/2012
Industry Monitor/s: Amanda Smith, Dave Mellows, Garry Saunders, John Hempenstall, Jose Pinel, Paul Wood, Tony Egan

ACARP Contact: Keith Smith

The main objective of this project is the design, development and operation of an on-line information system, RISKGATE, providing causal and control information for priority unwanted events (‘topics’) for the Australian coal mining industry. This system is being built to requirements identified through research and a series of coal industry workshops (RISKGATE Phase I) held in 2010.

RISKGATE Program Summary

RISKGATE will cover a list of topics that are of highest importance to the industry, starting with fire, strata, collisions, tyres and isolation in 2011. Each topic is an unwanted event, not a hazard. Development of each topic is planned in several phases, starting with a topic-specific industry workshop to define that topic’s database terms and structure, identify initiating events, and then build on this step through collection and analysis of a comprehensive set of existing public and corporate resources (accident/incident reports, technical literature). Subsequent workshops undertake detailed bow tie analysis for each of the identified initiating events, and conclude with analysis and feedback for quality control of the RISKGATE system to ensure that technical accuracy is upheld and industry user requirements are fulfilled.

ACARP companies are being asked to provide subject-matter experts for the topic workshops, in addition to a comprehensive set of corporate resources (e.g. fatal risk protocols, standard operating procedures, HPI reports, guidance documents, bow ties, etc.) for subsequent analysis by the RISKGATE project team.

RISKGATE Progress Summary

Project Management
The RISKGATE Project Management Group (RMG) held regular meetings to review progress and inform technical direction.

The first RISKGATE ACARP Monitors Meeting was held in July 2011 in Brisbane with a detailed program summary and milestone/progress stoplight report. Workshops were discussed in detail, with a conclusion that obtaining broad participation from the mining industry is the key factor underlying RISKGATE success.

System design and architecture
Development of system architecture is ongoing with ‘product testing’ undertaken at each of the topic workshops and industry feedback immediately incorporated in further iterations of the system. This dynamic approach has enabled considerable fine tuning of the final integrated design, prior to committing resources to the software build. The data entry tool has been constructed, and the RISKGATE team are starting to upload information captured in workshops. Prototypes of checklists (the main system output) can be built from the uploaded information to enable workshop participants to visualise project outcomes in real time.

Content
RISKGATE 2011 topic teams have been assembled with the following topic leaders: FIRE – David Cliff, STRATA – Bruce Hebblewhite, and COLLISIONS, ISOLATION and TYRES – Gul Kizil and Tilman Rasche. Panels of industry experts have been assembled for each topic area, and a series of workshops developed to capture best practise knowledge. Workshop I is focused on topic definition and identification of initiating events, the knot in the bow tie. The Workshop II series captures causes, consequences and controls for each initiating event. Workshop III is a master bow tie review.

Industry Engagement: Experts by Content
Company experts have participated in topic workshops for the following total number of person days.

Industry Engagement: Topic Workshops
Nineteen days of industry workshops have been completed between May 1 – August 10, and additional workshops are scheduled for the following dates.

STRATA: April 19, May 10
Open Cut: June 29, July 19 &20, next dates to be set
Underground: June 30, July 27 &28, Aug 31-Sept 1
TYRES: May 17, June 28, August 2 &3, September 8-9
FIRE: May 18, July 12, August 4 &5, September 7
COLLISIONS: June 3, July 21, September 13-14
ISOLATION: June 9, next dates to be set

RISKGATE welcomes full participation from all ACARP members, requesting nomination of additional subject matter experts in 2011.
UNDERGROUND

Detection and Prevention of Fires and Explosions

C14027
Active Explosion Barriers

SkillPro Services
David Humphreys

Value: $1,452,000
Report Expected: 25/08/2011
Industry Monitor/s: Guy Mitchell
ACARP Contact: Bevan Kathage

The objective of this project is to utilise the design parameters previously developed in the project to build and demonstrate the performance of a water based active explosion barrier. Previous CFD modelling has indicated for an explosion in which the coal dust density is about 250g/m³, a water mist density of about 250g/m³ is required to prevent propagation of the explosion.

Construction of the prototype explosion barrier was completed during this last period and the finished unit was delivered to Simtars for shakedown testing and an industry demonstration day. As part of the design and construction process, verification of the design calculations and construction methods was undertaken to satisfy the requirements South African pressure vessel regulations. This delayed construction but all components were delivered with just sufficient time for some initial testing before the industry demonstration day on 19th July which proceeded with no problems at all.

Since then testing has been based upon increasing the operating pressure to the maximum required for Kloppersbos explosion testing. Operation of the prototype barrier has now been successfully tested 5, 10, 15 and 20 MPa driving pressure with a water volume of 240 litres. The maximum operation requirement is for delivery of 240 litres of water with a driving pressure of 20 MPa so as to deliver the water volume in 250 ms. The pressure data and high speed video are being analysed against the results of the numerical model of the barrier to validate the model performance. The next phase of testing is to confirm the delivery time for the proposed test points for the Kloppersbos explosion tests of 60, 120 180 and 240 litres.

Water Dispersal from Prototype Barrier with Driving Pressure of 20MPa

C16006
Investigation of the Aging Effect of Electronic Components in Power Supplies

Simtars
Andre De Kock

Value: $175,000
Industry Monitor/s: Greg Briggs
ACARP Contact: Bevan Kathage

The need for this project was identified in a previous project C11034 where discrepancies were observed while testing intrinsically safe active power supplies. Tests were conducted on intrinsically safe active power supplies using the Spark Test Apparatus. Tests on the same type of power supplies delivered different results when the same tests were performed. The objectives of this project are therefore to:
- Identify the effect of aging electronic components on the Intrinsic Safety of Power Supplies used in the coal mining industry; and
- Investigate the repeatability of Spark Test Apparatus tests when testing Intrinsically Safe Power Supplies.

Testing of the power supplies was interrupted by the disintegration of the test chamber of one of the Spark test Apparatuses. A new chamber has been received from the manufacturer. The accident investigation is nearing completion and it is anticipated that testing will recommence within the next two weeks.

C20002
Airo Dust - Additional Testing to Satisfy Inspectorate Requirements

Mining Attachments (Qld)
Matt Ryan

Value: $300,000
Report Expected: 25/06/2011
Industry Monitor/s: Bruce Robertson, Peter Bergin, Peter Brisbane
ACARP Contact: Bevan Kathage

A draft final report is being reviewed by Industry Monitor(s).
Environment - Subsidence and Mine Water

C18015
Effects of Geology on Upsidence and Closure Movements and Impacts in Valleys

Mine Subsidence Engineering Consultants
Don Kay

Value: $300,000
Industry Monitor/s: Gary Brassington, Peter Brisbane
ACARP Contact: Russell Howarth

The objectives of this research project are to:

- Provide more appropriate upsidence and closure predictions and impact assessments near valleys;
- Provide probabilistic predictions and improve the accuracy and level of confidence in predictions, and to;
- Reduce, where appropriate, the costs to protect surface infrastructure affected by valley movements.

Additional work is being undertaken, with the assistance of Mathematics and Statistics Professors from the Australian Centre Commercial Mathematics to analyse the complicated, multi-variant data.

All field inspection trips have been undertaken and the gathered field data is being reviewed and analysed. Reports of these field trips are still being finalised. All of the new geological and topographical data has been entered into the new database. All available valley upsidence, closure and strain data from the extra collieries in the Southern Coalfields has now been entered into the expanded survey database. Field reports indicate that site geological conditions influence the observed valley upsidence, closure and strain and the timing of pool impacts.

The Mathematics and Statistics Professors from UNSW and Uni of Melbourne had just submitted an update report on the first stage of their multi-variant analysis of the 2002 set of valley closure incremental longwall data, which now includes the valley depth factor. The professors expect to finish this first stage in the next few weeks and then they will commence a larger multi-variant analysis with the new 2011 valley closure incremental longwall data, which now includes the new geological and topographical factors. On completion of this stage this new “total series” set of data will be sent to the Mathematics and Statistics Professors from UNSW and Uni of Melbourne for a further multi-variant analysis with the “total series” data set.

The task of gathering distances between monitored sites and the nearest edges of the total series of longwalls is nearing completion. Historical upsidence, closure and strain data was initially gathered on an incremental longwall basis and this data is being reviewed again on a “longwall series” and “total” upsidence, closure and strain basis.

Work on writing of the research report is continuing.

C18016
Reducing the Impact of Longwall Extraction on Groundwater Systems

CSIRO
Deepak Adhikary

Value: $289,310
Report Expected: 25/12/2011
Industry Monitor/s: Neil Alston, Peter Brisbane
ACARP Contact: Russell Howarth

The objectives of this project are to:

- Expand the current knowledge base and understanding of the strata deformation, fracturing and caving mechanics;
- Establish the relationships between longwall geometry and intensity of overburden fracturing in different geological environments;
- Quantify the impact of longwall mining on groundwater systems in different geological environments;
- Develop hydrogeological response models for different hydrogeological environments; and
- Develop a generic methodology for assessing the hydrogeological impact at other mine sites.

The data obtained from both Springvale and Dendrobium collieries are being analysed. Numerical models simulating Springvale geological conditions are mostly completed and results are being analysed. Numerical model of Dendrobium colliery has been developed and a number of computer simulations are running. Calibration of numerical parameters is taking longer than anticipated.

C20038
Standardised Subsidence Information Management System

NSW Department of Trade and Investment, Regional Infrastructure and Services
Gang Li

Value: $480,000
Report Expected: 25/04/2014
Industry Monitor/s: Dan Payne, Neil Alston
ACARP Contact: Russell Howarth

Very recently commenced.
C20046
Monitoring Surface Condition of Landscape Features Subject to Mining Subsidence with Very High Resolution Imagery

University of Queensland
Andrew Fletcher
Peter Erskine

Value: $278,191
Report Expected: 25/04/2013
Industry Monitor/s: Edwina Wright
Gary Brassington
Mary-Anne Crawford
ACARP Contact: Bevan Kathage

The aim of this project is to develop spatial metrics that are sensitive to changes in condition and species composition of swamp communities following underground mining subsidence. This work aims to converge ground observation and remotely sensed imagery to develop robust metrics that are sensitive to change through an iterative process. The application of sub-decimetre imagery collected at the time of ground observation may provide spatial confidence to ground observations with limited coverage.

Initial planning and preparation for the project has progressed well with site selection completed for both Centennial Coal Newnes Plateau and BHPB Illawarra Coal Woronora Plateau. A collaborative agreement with Biosis Research is being developed and will add substantial field knowledge to the Woronora Plateau sites with the offer of botanical identification and site access assistance as in-kind support to the project. Imagery collected in the last week of May 2011 at Newnes Plateau has been used to interrogate image mosaicing software and has demonstrated the capability to identify ground control points and markers directly. Weather conditions prevented low level flights and resulted in imagery with 5cm ground sample distance. Improvements to ground control marking has been made resulting in highly visible, lightweight and compact markers to identify plots, transects and measured 3D model control points. Image mosaics have been introduced to E-cognition and have undergone initial segmentation. Resampling for image orthophoto-mosaics results in some loss of ground sampling resolution. This requires collected raw imagery to be at a higher resolution than the final planned resolution. Therefore, a target resolution of 2cm ground sample distance will require modification of camera optics to narrow the field of view to reduce ground sample distance. Several lenses are being examined for this purpose which must still meet weight and size requirements for the UAV.

C16018
Advanced Logging System for In-Seam Drilling

CRCMining
Dave Cusack
Scott Thomson

Value: $250,000
Industry Monitor/s: Andy Willson
ACARP Contact: Russell Howarth

The objective of this project is to produce a commercial prototype logging system for inseam boreholes. The tool will be demonstrated in a field trial.

On 18 July the advanced logging tool was deployed in a 1,300m medium radius drill in-seam borehole at Ward’s Well (BMC site). Data was recorded and downloaded successfully. This was the final requirement to be satisfied for this ACARP project. The final report will be submitted in due course.

C18018
Design, Certification and Manufacture of Geophone for Underground Coal Mining

CSIRO
Xun Luo

Value: $117,200
Industry Monitor/s: Peter Henderson
ACARP Contact: Russell Howarth

This project aims to develop, obtain certification and source a commercial partner for an intrinsically safe geophone for use in the underground coal mining industry in Australia. The approved IS geophone will find extensive application for geological structure mapping, mining risk management and production control in longwall and possibly development situations.

Two geophone assemblies, a single element and tri-element geophone have been granted certification IECEx SIM 10.0011X. The two geophone are identified as: Uni-axial IS geophone assembly type GS11D-IS-1 and Tri-axial IS geophone assembly type GS20DX-IS-3 the geophones are manufactured in Australia by Holville.

The final report has been prepared and is currently being independently reviewed. The report will be submitted to the Industry Monitors as soon as this process is completed.

C19013
Improving Reflection Seismic Success Through Ground Truthing

CSIRO
Binzhong Zhou

Value: $147,005
Industry Monitor/s: Andrea Rutley
Mike Armstrong
ACARP Contact: Russell Howarth

Seismic surveying, especially 3D reflection studies, has been widely accepted throughout the Sydney and Bowen Basins because of its unprecedented capability to delineate geological structures for underground coal mining. While the technique enjoys continuous growth across the coal industry, its true performance has not been systematically assessed for Australian coal fields. Structural interpretation of seismic data is generally performed before mining, and later compared to (and validated against) underground mapping for individual projects.
Many discrepancies between prediction and validation results have been observed, including systematic overestimation of fault throws, missed significant faults, and less commonly, non-validated faults. For these discrepancies, the underlying causes are not well understood. This project will provide methods for seismic back analysis and guidelines for future seismic studies; assist in providing an empirical basis for the classification of seismic features into ‘confidence’ classes; and help improve the geological definition of coal deposits.

The project is in the concluding phase. We are currently documenting the findings of this project and a draft report will be ready at the end of August. In this project, we investigated the detectability of small faults by the seismic method using seismic numerical modelling in an ideal environment (i.e. data in perfect quality). From this exercise, we have made the following observations:

- For horizontal reflectors, faults can be identified even if the fault throws up to 1/8 of the wavelength;
- Up-dip faults become difficult to detect if the fault throws < 1/8 of the wavelength;
- Down-dip faults are amplified and can be detected even if the fault throws up to 1/8 of the wavelength; and
- Faults are more difficult to detect when they exist amongst other structures.

In typical coal-related seismic exploration in Australia, the dominant seismic frequency is about 100 Hz and the seismic velocity of the overburden ranges from 3000m/s to 4000m/s. The corresponding wavelength is 30m to 40m. The 1/8 of wavelength is about 4 – 5m. Therefore, the typical lower limit of fault detection by seismic methods is about 4 - 5m. Although this can be redefined for faults as small as 1/16 of wavelength (2 - 2.5m) through use of computer-aided horizon identification and by the improved spatial coherence offered by 3D seismic surveying, the actual fault detectability will depend on the seismic data quality associated with the geology of the area of interest.

In addition, we analysed two 3D seismic data sets: one from Broadmeadow Mine of BMA and the other from Lake Macquarie of Centennial’s Mannerin Mine. The Broadmeadow 3D seismic data are in good quality with many boreholes to control. From the reconciliation at Broadmeadow Mine, we have the following observations:

- All faults > 2.5m throw have been identified (detection limit);
- No faults < 1m throw were identified in the 3D seismic data;
- Between 1-2.5m throw faults may or may not be identified; and
- False positive fault identification is uncommon, but can be controlled by tracking the confidence of the seismic interpretation.

These observations are consistent with the theoretical fault detection limits.

In the case of the Lake Macquarie, we have analyzed the newly (CSIRO) and originally (VelSeis) processed Lake Macquarie 3D seismic data sets against the coal seam mapping and in-seam long-hole drilling data. Seismic forward modeling has been conducted to provide an explanation of the observed complexity of seismic data interpretation. We found that small scale faults (< 5m) may not be observed when they occur against the background structures such as synclines, anticlines and dipping strata. This may possibly explain the lack of evidence of the expected 5m upthrown fault on the seismic data as the fault is located in a syncline. The inconsistency of the long-hole drilling seam depth with the reflection time trend can be explained by the velocity variation, which is a common seismic interpretation pitfall when dealing with seismic sections in time.

The outcomes of this project were communicated to the coal industry in the BBGG-ACARP joint meeting 9-10 June 2011 in Rockhampton.

### Maintenance

**C17011**

**AFC Chain Reliability Study**

**CRCMining**

Joe Cronin  
Paul Lever

**Value:** $195,000  
**Report Expected:** 25/09/2011  
**Industry Monitor/s:** Peter Crossland  
**ACARP Contact:** Bevan Kathage

The aim of the project is to measure real-time AFC chain tension under different operating conditions. As chain design improves it is expected that failure modes will move from wear limit to fatigue failure. By analysing real-time chain tension data, chain failure mechanisms can be understood. Initial testing has shown that chain tensions differ dramatically from expected or planned values. Without accurate, real-time tension measurement and logging, optimisation of operation and maintenance strategies cannot be achieved. The final report will be completed early in the next quarter.

**C17020**

**Reducing the Risk of Hydraulic Hose Assembly Failures on Longwall Systems**

**Monash University**

Henry Bartosiewicz

**Value:** $593,420  
**Report Expected:** 25/11/2011  
**Industry Monitor/s:** Steve Burgess  
Trevor Hartley  
**ACARP Contact:** Bevan Kathage

The objective of this project is to identify possible improvements in longwall hydraulic system/hose assembly selection, management, operation and maintenance to reduce the risk of injuries and to maximise effective hose assembly service life. Due to a large number of pressing issues identified in the initial stage, MTI has applied for an extension to this project. The new/extended project commenced in March 2010 and aims to achieve the following:

- Establish the hose cyclic pressure loading spectrum/profiles for two longwall systems designs by measuring in-service hydraulic pressure profiles – Joy system at Mandalong Mine and Bucyrus system at Newlands mine;
- Verify compliance of selected new and used/aged hoses with the relevant safety and fatigue (design life) requirements based on in-service pressure spectrum data;
• Identify possible design improvements to LW hydraulic circuits/components to reduce extreme loading conditions;
• Review the adequacy/applicability of current Australian/International standards recommended test requirements for evaluating the performance of hose assemblies (hoses and staples) used in longwall hydraulic systems particularly with regard to endurance/service life prequalification testing criteria.

The Bucyrus longwall hydraulic pressure system monitoring program at Newlands mine commenced on the 28th of July mine. Hydraulic pressures are being monitored at 19 different locations including:
• Pump station (pumps 1-3 and positive set);
• Dump valve (incoming pressure, ring main and positive set); and
• Number 60 roof support (interchock hose, return line, positive set, side shield, power lower, DA ram advance and push, maingate and tailgate leg set, flipper, spray and base lift).

The pressure monitoring program is expected to be completed by last week of August. The Newlands mine has also supplied about 100 hydraulic hoses that were removed from roof supports being currently re-furbished at Inbey workshop facilities, Mackay. These hoses are being sorted by MTI according to their size, age, conditions and location within longwall hydraulic system in preparation for burst and impulse pressure testing by Alfagomma. The burst and impulse pressure hose testing program for aged hoses received from Joy system at Mandalong mine is scheduled to be completed by 19th of August. These tests are being done at Parker Hannifin production facilities, Albury NSW.

C18020
Big Tyre: Non Pneumatic Non Solid Wheel

Big Tyre
Bruce Louden

Value: $420,000
Industry Monitor/s : Barry Moore
John Corben
Keith Cardew
ACARP Contact: Bevan Kathage

In the last three months we have been testing the prototype, investigating its performance and determining means to improve it. Testing the prototype quickly proved that the concept works well, though not totally as expected. The tread, and the segmented structure supporting it, has proven to be more flexible than we expected from the computer modeling (which we attribute to the significant difficulty in accurately modeling rubber using finite element analysis), consequently with this configuration, the springs carry more force than they would in a wheel with a stiffer tread structure.

This means that the initial wheel configuration is not as strong as we expected, although we believe that our desired strength is quite achievable through simply installing a new set of stronger springs with appropriate flexibility. On this initial configuration, we have loaded the wheel with 7 tonnes while stationary and 3 tonnes while travelling at 20kph.

We are currently modifying the existing set of springs and retesting the wheel to define more accurately the spring characteristics we need to achieve the wheel strength, suspension and footprint characteristics we believe are most suitable for the mining applications we have in mind for this wheel size.

We have also been manufacturing the components necessary to insulate the wheel from the test machine in order to test the wheel for any accumulation of static electricity. This testing will be carried out shortly to check whether changes are required in the spring materials, after which we will be ready to manufacture a new set of springs.

Once we have achieved the strength and suspension characteristics that we are designing for the wheel, we will conduct productivity tests on the heat build up in the tyre by simulating travel with the actual loaded/unladen weights, speeds and durations over a 24/7 period on our test equipment prior to live testing on above ground mining equipment.

C19012
Intrinsically Safe Touch Screen for Computer Interfaces in Hazardous Areas

CSIRO
Ron McPhee

Value: $168,760
Industry Monitor/s : Brad Lucke
Dave Boyling
ACARP Contact: Bevan Kathage

The objective of this project is to develop a suitable robust intrinsically safe transparent touch screen overlay which can be mounted onto the external surface of a flameproof enclosure window and which will provide underground operators with an easy-to-operate computer interface in hazardous areas.
In an alternative application, the technology could be included into dedicated, machine mounted, keypad style input devices which are currently fitted onto many mobile underground coal mining machines.

The design of the touch screen system and Ex ia application documents have been prepared and forwarded to SIMTARS which has requested samples of the touch screen. The touch screen manufacturer has agreed to supply the product in quantities less than the normal minimum order quantity (MOQ). This concession is subject to the project paying the cost of the touch screen design and associated tooling jigs. In addition the manufacturer has agreed to construct the sample touch screens using a 1.5mm clear polycarbonate substrate and with an adhesive backing. This is the preferred option. Thin glass was considered as too fragile and thick glass introduced additional unwanted parallax error into the application.

Organising this arrangement and obtaining agreement on the preferred size of the touch screen and the installation details have taken much more time and effort than anticipated. Ten samples have been ordered and should be available by the end of August 2011 at which time SIMTARS testing procedures will commence.

**Mining Technology and Production**

**C19008**

**Roof Support Design Methodology for Wide Roadways**

Colwell Geotechnical Services
Mark Colwell

| Value: | $375,000 |
| Report Expected: | 25/08/2012 |
| Industry Monitor/s: | Dan Payne, John Grieves |
| ACARP Contact: | Roger Wischusen |

The first year of the project was primarily dedicated to collecting information necessary to formulate the industry database. The data collection phase of the project is now complete with information having been collected from 26 longwall operations resulting in approximately 150 longwall installation roadway case studies. This significantly exceeds the original project goal of 100 case studies. In addition, with the inclusion of shearer, maingate and tailgate stables, these 150 case studies will translate into over 400 data points ranging in roadway width from 6.5m up to 12m.

The project received additional funding so as to include the Geophysical Strata Rating (GSR) as one of the rock mass classification systems to test in terms of empirical analyses. In addition to the GSR being included in the database, an investigation will be conducted to ascertain if there is a correlation between the GSR values determined for individual rock units and the rock units’ individual Unit Ratings (UR) which are the basic building blocks of the Coal Mine Roof Rating (CMRR).

The main focus during the second half of 2011 will be to finalise the database and undertake the analysis to identify/quantify influential factors affecting longwall installation roadway stability.

The eventual design methodology will be developed using a combined empirical/analytical approach. The two components (empirical and analytical) essentially feed off one-another during the research period so that the empirical model faithfully represents the mechanics of the problem, while the analytical model can be tested, improved and calibrated.

**C19016**

**AFC Pan Stability Investigation**

BMT WBM
Fidel Gonzalez
John Vazey

| Value: | $100,000 |
| Report Expected: | 25/12/2011 |
| Industry Monitor/s: | Bill Short, Brian Owens, Tony Logan |
| ACARP Contact: | Russell Howarth |

The project aims to understand the extent of Armoured Face Conveyor stability problems in the industry, and propose methods for evaluating pan stability in proposed designs.

The consultation phase of this project is complete. Analysis is continuing to develop a simple method for assessing proposed AFC Pan designs based on the mass distribution and forward profile of the pan. The current aim is to assess existing pan geometries and theoretical geometries in a simple spreadsheet format.

A draft report of this project is scheduled to go to the Industry Monitors at end of August.

**C20033**

**Development of a Safer Underground Explosive**

University of New South Wales
Andres Castro
Duncan Chalmers

| Value: | $323,500 |
| Report Expected: | 25/07/2013 |
| Industry Monitor/s: | John Hempenstall, Scott Langley |
| ACARP Contact: | Russell Howarth |

The project is progressing with explosives arriving on site for preliminary testing. This preliminary testing will ascertain if the new product is close to the desired product or whether further development is required. Literature review is well underway and documents related to Indian testing regimes are being sought.

Both NSW and Qld Chief Inspectors have expressed support for this project and in particular the roadmap outlined in the project. Further clarification of the field trials is being sought from both CI’s to ensure that the field trial will yield the desired result if the explosive is suitable.

Existing cannon is then to be dismantled and new cannon is being tendered. Project was delayed as the cannon was in use for compliance testing by an explosive manufacturer of an existing explosive.
C20037
Polymeric FRAS Rated Conveyor Idlers for Underground Mines

Ellton Longwall
Mark Newton
Phillip Erickson

Value: $321,110
Report Expected: 25/04/2013
Industry Monitor/s: Bob Gordon
Peter Bergin
Peter Brisbane

ACARP Contact: Russell Howarth

We are completing the Design Risk Assessment before starting the project as required by ACARP.

C20041
Polymer Based Alternative to Steel Mesh for Coal Mines: ToughSkin

University of Wollongong
Ernest Baafi

Value: $1,160,066
Report Expected: 25/12/2012
Industry Monitor/s: Bob Gallagher
Bob Gordon
Frank Fullham
Greg Pawley
Guy Mitchell
Jim Sandford
John Coughlan
Peter Bergin
Peter Brisbane
Richard Porteous
Roger Wischusen

ACARP Contact: Roger Wischusen

Very recently commenced.

Occupational Health

C18017
Triple Frequency Ultrasonic Diesel Exhaust Soot Scrubber

CSIRO
Darren Bates
Patrick Glynn

Value: $182,975
Report Expected: 25/08/2011
Industry Monitor/s: John Hempenstall
Keith Cardew

ACARP Contact: Bevan Kathage

We are in stage 3 of the project and there is a delay in meeting the timelines of the project program due to BHPB requiring independent dynamometer testing before fitting the acoustic agglomerator to the test vehicles.

Diesel particulates are by their nature are very hard to remove from diesel exhaust because of their size and the difficulty of detection on a particle size basis. The smaller the Diesel particle the higher the risk of inhalation by humans this is through the mechanism of Diesel particles lodging deep in the lungs and becoming the precursor of lung cancer (IARC 1989). The proposed ultrasonic agglomeration Diesel Soot Scrubber would increase the Diesel particle size by ultrasonic agglomeration of particles down to .1 micron and increase the size to greater than 10 micron for cyclone and electrostatic filter removal.

This project is the second project in the acoustic agglomeration of diesel particulates to reduce human exposure in underground mines. The outcome of the project is to further reduce diesel particulates to 99% reduction.

Progress against milestones:
• Testing of production prototype is continuing both in Western Australia and at QUT Qld;
• As soon as BHPB are happy with the dynamometer testing the Prototype Acoustic agglomerator will be fitted to two underground vehicles for extended test which has been put back to June due to the diesel particulate dynamometer testing and characterisation of turbo charged diesel engines;
• The draft final report has been submitted to the project monitors for comment, but will not be completed until the vehicle testing is complete; and
• We have located a LHD locally and will fit the prototype within the next month to carry out some mine vehicle testing.

The project is 6 months behind schedule due to the extended testing regime for BHPB.

C18019
Improved Dust Control on Longwalls Using a New Water Mist Venturi System

CSIRO
Graeme Cooper
Shiva Karekal
Ting Ren

Value: $240,045
Report Expected: 25/07/2012
Industry Monitor/s: Dave Mellows

ACARP Contact: Russell Howarth

The project main objective is to develop a new venturi system based on ultra fine water mist spray to significantly reduce the airborne respirable dust generated on medium and thick seam longwalls, particularly those dust particles from the advancement of the Main gate side chocks and the intake ventilation passing the beam stage loader (BSL) on to the longwall face.

The important feature of the system is to develop the effective controlling means for minimising the dust which will improve the health of the personnel working underground together with safety performance and productivity of Australian longwall mines.

Because of the safety regulatory requirements in NSW coal mines, the venturi units have to be manufactured from cast FRAS (Fire Resistant Anti Static) material and to withstand the abuse that so often occurs in underground coal mining, Tecpro and UOW have therefore been working on a new material for the venturi units to
satisfy the safety requirements in NSW underground coal mines to allow underground trials at these mines. The new design and fabrication is scheduled to complete in late September for field trials. The project team is also working on a new design of the venturi unit using a new material. As a result, a delay of field trials in NSW coal mines has occurred, however the project team has been in close contact with the participation mines (Mandalong and Metropolitan) to continue the planned field trials once the new venturi units become available in September 2011.

New CFD models have been completed for both Metropolitan and Mandalong Mines for understanding the behaviour of dust from MG chocks and outbye, and the optimum positioning of water-mist venturi units. Results from the CFD models will be validated against field ventilation data and will be used to assist coming field trials.

Modified field trials have been planned following the initial trials in Anglo Coal Moranbah North Mine (MN). Although initial trials of the water mist venturi system have reduced the dust levels by 20-30% at Chock#8 and 8-31% for the dust exposure levels of Shearer workers. A field visit has been planned to investigate this effect. There are indications that the 'wetting' due to the water mist produced by the venturi system has reduced the dust levels by 20-30% at Chock#8 and 8-31% for the dust exposure levels of Shearer operators. A field visit has been planned to investigate this problem and possible modifications of the location of the venturi units to mitigate this issue.

C18021
Analysis of Industry Data to Enable Quantitative Control Effectiveness Assessment

University of Queensland
Gul Kizil

Value: $145,000
Industry Monitor/s: David Carey, Gary Brassington, Peter Brisbane
ACARP Contact: Roger Wischusen

There is a growing demand within the mining industry for genuine quantitative risk analysis. The data to support these studies is often sparse or hidden, and industry skills have generally developed around semi-quantitative methodologies. The QRA project builds on project C17014 Developing a Risk – Cost – Benefit (RCB) Decision Support Tool for the Mining Industry by Using the Bow Tie Analysis (BTA) Technique (Kizil, Bye & Joy 2010), and focuses on quantitative data gathering requirements and data quality and databank design.

The project has developed a unique and detailed Quantitative Control Effectiveness Method (QCEM). To date, an in-depth review of the method has been undertaken by industry experts and risk professionals, Prof A Bye (CEO CRC Ore) and D Griffiths (Risk Management Principal Research Fellow, MISHC, SMI - UQ). They both commented on the comprehensiveness and robustness of the method, and recommended a few revisions. The suggested changes have been implemented on the model.

There has been a delay in accessing the site involved in the 2nd case study (Electric Shock) due to unexpected operational issues experienced at the site. The required 2nd visit has now been conducted successfully. During the site visit, meetings with the site’s Electrical and Mechanical team members were held and their feedback on the constructed Fault Tree Analysis, focusing on 'Electric Shock at LW Face', was sought. This process helped the team with finalising the FTA content. The initial analytical work has been re-visited and updated to reflect the revisions made on the FTA. More incident statistics specifically relating to ‘Electric Shock at LW Face’ incidents have been searched. Further site feedback and confirmation on FTA results/analytical work will be sought. The FTA process assists with determining electrical controls and then their adequacy assessment.

The 3rd case study (U/G collisions) related project site visit had to be postponed due to changed site conditions. But the site visit has now been –re-arranged and a ‘two day’ site visit is planned to be held in Sep. This case study will investigate and assess collision detection related controls.

As a part of the Control Adequacy Assessment, application of Layer of Protection Analysis (LOPA) has been explored. Dr Kizil has undertaken a self-learning exercise and implemented the method on subsidence / electrical related controls. During the last project progress review meeting, the LOPA application has instigated discussions relating to undertaking formal training in this technique’s use. Formal LOPA training provider by a credible organisation has been investigated and identified. As per the monitors’ recommendation, a potential extension to the project will be sought. LOPA is a widely used technique by the high-risk industries, i.e. Oil, Gas, and Chemical industries, to demonstrate achievement of ALARA.

C19010
Emergency Response: Mine Entry Data Management

Queensland Mines Rescue Service
Geoff Nugent
Seamus Devlin

Value: $195,000
Industry Monitor/s: John Grieves, Peter Brisbane
ACARP Contact: Bevan Kathage

The Mine Entry Data Management project aims to research and develop a functional specification for data collection and management systems suitable for the efficient, risk-assessed management of mine hazards in the event of an emergency response.

The objectives of this project are to:
- Develop a functional specification for an information collection and management system appropriate for efficient, effective implementation of the Mine Entry/Re-Entry Guidelines; and
- Raise awareness of Mine Entry/Re-Entry Guidelines and information collection and management systems appropriate for Emergency Responses.

As a part of this project’s objective and research priorities, industry forums and workshops were recently conducted in Queensland (Mackay 22 July) and NSW (Hunter Valley 27 July) to inform industry of the current status of the project and provide industry with the opportunity to discuss and propose future priorities and direction for the researchers to consider.
As part of the forum content all participants were offered a copy of the current prototype software including the developed explosibility assessment tool as well as the paper based guideline the software was modelled on. Access to this material can be obtained by contacting any of the researchers. The researchers are now compiling the draft report for presentation by the end of October.

C19011
Longwall Hydraulics, Staple Loc Staple, Fatigue Assessment

BMT WBM
Russell Smith

Value: $179,000
Report Expected: 25/01/2012
Industry Monitor/s: Greg Bartley
Trevor Hartley
ACARP Contact: Russell Howarth

This project aims to establish the fatigue performance of longwall hydraulic fitting staples in a scientifically valid manner. This requires testing of many more staples than is conventionally undertaken by suppliers. Additionally, testing must be undertaken at a number of pressures to produce an S-N curve, and allow fatigue life prediction in applications with varying pressures (i.e., longwalls).

Following shortcomings identified with the original test rig design, an alternate test rig design was developed and approved. Final engineering drawings and calculations were generated and approved for manufacture. Following negotiations with potential manufacturers, a purchase order for manufacture was placed. Manufacturing of the test rig components is now virtually complete. Assembly of the completed components has commenced, and is scheduled for completion along with final control system design and implementation before 19th August 2011.

Selection of an appropriate test rig power unit was completed and orders placed. Delivery of the completed power unit was accepted 8th August 2011. Additionally, PLC and control hardware has been procured and is being assembled.

Recruiting of test program supervisors is underway, with an aim for high pressure test commencement from 29th August 2011. The initial tests are anticipated to span 4 weeks, after which assessment of the test validity and duration to complete will be made.

C19015
Safety Case For Electrical Isolation

University of Queensland
Gul Kizil
Derek Griffith

Value: $175,000
Report Expected: 25/05/2012
Industry Monitor/s: Dave Mellows
John Hempenstall
ACARP Contact: Keith Smith

The main objective of this project is to develop a leading practice ‘Safety Case for High-Voltage Electrical Isolation Using ACARP Coal Mine Safety Regime (CMSR) Approach’ for application in Underground, Open-cut mining and CHPP operations.

The project program has been expanded at project monitors’ request to allow application of the Safety Case model at a different coal producer’s site. This process will then enable to identify potential variations among different coal producers’ sites in relation to high-voltage electrical isolation management, and assist with the development of a generic industry model.

As soon as the site became accessible, the 2nd site visit was conducted (Jun 7th, 2011). As per the 1st site visit, the 2nd site visit was quite productive. A day’s workshop was held with the site Electrical Team. The workshop was also attended by the relevant Mechanical Team members. Dr Kizil provided a status update on the project that followed by discussions relating to changed site conditions and their impact on site operation. The site personnel were actively engaged in the discussions. During the second part of the workshop, the team sought site personnel’s feedback on the constructed Fault Trees. Time only allowed in-depth review of the FTA 1. The team is planning to hold a team workshop in late August and further site feedback/confirmation will be sought on the risk analysis that has been conducted.

The 1st site visit highlighted the need to focus on ‘Safety Case for High-Voltage Electrical Isolation’, and as a result, the research team has formulated a more focused scope for the project. Following approval of the more focused scope, the project work plan has been re-visited and revised, and the plan has been supported and approved by the project monitors.

C20036
DPM Risk Factors

SkillPro Services
Terry O’Beirne
Zoran Ristovski

Value: $114,107
Industry Monitor/s: Peter Brisbane
ACARP Contact: Bevan Kathage

A draft final report is being reviewed by Industry Monitor(s).
Roadway Development

C17004
Tough Skin for Strata Control

University of Wollongong
Chris Lukey
Ernest Baafi

Value: $1,520,200
Report Expected: 25/08/2011
Industry Monitor/s: Roadway Development
ACARP Contact: Roger Wischusen

A draft final report is being reviewed by Industry Monitor(s).

C17018
Continuous Miner Mounted, Fully Automated System for Installing Self Drilling Bolts and Steel Mesh for Primary Roof and Rib Support during Roadway Development

University of Wollongong
Ian Porter
Stephen Van Duin

Value: $2,166,650
Report Expected: 25/04/2012
Industry Monitor/s: Roadway Development
ACARP Contact: Roger Wischusen

This project aims to automate the installation of roof and rib support materials from a continuous miner such as roof/rib bolts and mesh. This is expected to improve roadway development advance rates in line with ACARP's CM2010 initiative. At the completion of this project, operators can be removed from the continuous miner and the immediate face area to minimise roof support installation injuries.

Work progressed during the last quarter on the redesign of some components of the automation system for underground trial readiness. The roof mesh conveyor is currently being modified to a continuous conveyor design which includes a new temporary mesh delivery magazine at the rear of the miner. Work has been undertaken to improve the robustness of the plate handling equipment, and modifications are being designed to increase the performance of the roof and rib bolt manipulators. The project is still awaiting details of which miner the equipment will be retrofitted to. Work will continue on machine modifications and towards planning for successful underground trials.

In parallel to the activities above work has continued on the development of the proposed material handling options. Investigations were undertaken to identify existing alternate coal haulage systems that would enable full shared access for both coal haulage and face consumables. Three potential systems exist in early prototype form and visits to view two of these systems have provided a level of confidence. The RDTG presentation meeting in June resulted in the decision being made pursuit continuous haulage options over shuttle cars. The next quarter involves the preparation of a conceptual system designs, using a smaller fit for purpose conveying system and other existing technology that maintain projects parameters.

C18023
CM2010 Project - Continuous Miner Automation Component

CSIRO
David Reid

Value: $2,629,162
Report Expected: 25/02/2012
Industry Monitor/s: Roadway Development
ACARP Contact: Roger Wischusen

The aim of this project is to develop the mining navigation and control system necessary to deliver a remotely supervised, self-steering capability as part of the larger CM2010 roadway development project. The automation component will also provide real-time machine position and operational information essential for the successful integration of bolting, mesh and haulage systems which are being independently developed within the CM2010 initiative.

The project is being undertaken in two parts each of eighteen month duration. The first part project was completed in September 2010 and the second part project officially commenced in December 2010.

The following tasks and milestones have been completed since the last current projects report (in May 2011):
- Newly designed Doppler radar units have been built which incorporate more advanced signal process and are more tightly integrated with the inertial navigation system. These radars are a compact design and are being tested with low profile antennas making them more practical for deployment.
- Preparations are being made to conduct a larger scale Phoenix-based trial of the navigation/radar system. This trial will evaluate the navigation system performance with the Phoenix replicating the CM path in a two-heading roadway development configuration. This trial will utilise a large specially prepared coal-surfaced area at Ebenezer mine.
- The core components of the Mine To Plan software package have been developed and work is continuing towards a demonstration of this software package as part of a full system demonstration using the Phoenix platform.

C20034
Rapid Advance Conveyor

Oregate
John Bremhorst

Value: $384,959
Report Expected: 25/02/2012
Industry Monitor/s: Roadway Development
ACARP Contact: Roger Wischusen

RAC testing performed to date strongly suggests that the RAC will operate without requiring manual labour for lifting or assembly tasks. Manual handling functions except for certain non-weight bearing tasks (ie: fixing pins etc) associated with standard conveyor structure has been mechanised.
A small scale extendable structure jig was assembled and operated successfully.

At the date of the July report a 15m extendable full size prototype conveyor jig was fabricated. The prototype conveyor jig was workshop tested for proof of concept for extensions, retractions, angular specification and extension time. The prototype was tested on a short skid with fixed length legs, which approximated the worst case operable ground conditions specified. The 15m prototype conveyor test jig was successfully extended in less than 90 seconds. The test was considered a success because:

- It provided proof of concept;
- It confirmed that the mechanics of the structure behave in practice as was theoretically predicted; and
- The speed with which the structure may be capable of operating in practice conforms to predictions.

The second generation of structure-to-idler connectors and idler-to-idler connectors have undergone static testing and were successful.

Numerous component suppliers have now provided their input into the manufacture and supply of sub-components.

The carry and return conveyor idlers have been delivered.

The hydraulically powered lifting and leveling functions of the RAC have not been tested to date, although they are relatively straight forward and complications are not expected to arise from their operation. The lift/level functions will be installed onto the second generation prototype.

The retraction mode is to be tested on the second generation test jig.

The self setting extendable conveyor legs have been proven to operate successfully. The self setting legs do not require manual labour to set to height. Leg setting times were reliably reproduced to durations of less than 1 second per leg. This is considered to be a substantial success because:

- Automatic leg leveling benefits the efficient operation of the extendable/retractable structure; and
- Existing conveyor structure used in coal mines is incapable of being leveled either automatically or in a similar duration. A second generation of leg components will be fabricated for testing on the second generation prototype.

The hinged idlers that facilitate installation of the pod into the conveyor were found to operate well on the prototype jig. The opening and closing times are expected to support short pod installation durations. A second generation of hinged idler components is being prepared for fabrication.

The DMU towing attachment which will interface between the RAC and the DMU will be unknown for a few months because the mine is considering a series of sled attachments of its own to which the RAC may have to attach. The interface will have to be designed within the next 6 weeks so that fabrication can be achieved by November.

The mine has advised that an opportunity to perform underground mine site testing is likely to arise in or about December 2011.

In summary, the first generation prototype jig has delivered proof of concept and preparations are underway to commence manufacture of a second generation pod for testing and the final stage of risk assessment processes.

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C20035
Automated Monorail Extension System for Roadway Development

University of Wollongong
Scott Jensen
Stephen Van Duin

Value: $176,806
Report Expected: 25/04/2013
Industry Monitor/s: Roadway Development Task Group
ACARP Contact: Roger Wischusen

This project aims to create a concept design for the automated installation of monorail beams during roadway development. The successful implementation of this concept would remove the need for manual handling of monorail beams and vent ducting during drivage. This technology will ultimately minimise workplace injuries and increase advance rates in line with the ACARP CM2010 initiative.

Work this quarter has involved further analysis of the Macquarie University Manufacturing development monorail. The current rail attachment mechanism has been studied in order to identify which design features and constraints can be maintained and which required modification for an automated system.

Two initial concept designs have been created for the rail manipulator: a rail mounted system and a miner mounted system. Concepts have also been created for the mechanism which attaches to roof support and corrects for variation in roof height.

The next quarter will involve refinement of the concepts above and the analysis of requirements for the rail storage and delivery methods, in line with concept developments in project C17018.

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C14014
Practitioners Handbook on Managing Geotechnical Risk in Underground Coal Mining

University of New South Wales
Jim Galvin

Value: $370,000
Report Expected: 25/12/2011
Industry Monitor/s: Paul O'Grady Richard Van Laeren
ACARP Contact: Roger Wischusen

This project is concerned with producing a Practitioners Guide to Managing Geotechnical Risk in Underground Coal Mining. The first draft of Volume 2, which is concerned with excavation behaviour, ground support and monitoring, is well advanced. When completed, it will be merged with Volume 1 into a single text. The next round of workshops commence on 24 October and will be conducted over a couple of months.
C18022
Use of Pro-active Resin or Grout Injection for Roadway Stabilisation Promoting Improved Rock Mass Competence

Frith Consulting Services
Russell Frith

Value: $150,000
Report Expected: 25/10/2011
Industry Monitor/s: Ismet Canbulat
ACARP Contact: Russell Howarth

The objective of this project is to evaluate the extent by which the early or pro-active injection of either resin or grout into otherwise deteriorating strata conditions, can bring about vastly improved levels of stability through reinforcement (rather than consolidation) by reducing if not eliminating the weakening effect of open discontinuities in the strata.

As indicated in the previous quarterly report, a full technical report for the laboratory test work undertaken as part of Stages I to III would be compiled. This report was completed in the previous quarter and is now being reviewed by the industry monitors as part of determining whether full-scale field trials should be undertaken and if so, what those trials should consist of.

A project meeting with the Industry Monitors is being planned for around the end of August 2011 to review progress to-date and agree upon the work program required to bring the project to completion.

C20031
Update of Stress Concentration Effects about Longwall Panels for Improved Mine Planning

SCT Operations
Winton Gale

Value: $165,000
Report Expected: 25/11/2012
Industry Monitor/s: John Grieves, Roger Byrnes
ACARP Contact: Russell Howarth

Very recently commenced.

C20032
Dynamic Response of Longwall Systems and their Relationship to Caving Behaviour

PDR Engineers
David Hoyer
Peter Hatherly
Terry Medhurst

Value: $250,000
Report Expected: 25/04/2013
Industry Monitor/s: Ismet Canbulat, Roger Byrnes
ACARP Contact: Bevan Kathage

The interaction between longwall supports and the surrounding strata is a complex phenomenon. At present neither empirical nor numerical models can adequately capture the critical factors required to predict strata response. However, recent advances in the ability to analyse longwall monitoring data provide a potentially large and valuable data source to quantify time related factors. It also provides a means in which to assess how operational practice can influence shield behaviour. In this project we will analyse various data from existing longwall operations using the Geophysical Strata Rating (GSR) to characterize the strata, and then correlate this with the various outputs that can be provided by Longwall Visual Analysis (LVA) software. Outcomes are anticipated to include a measure of the likelihood of weighting events, potential for development of face cavities and criteria to assist in future longwall support design, strata characterisation and face management.

A review factors thought to influence periodic weighting has been undertaken and in particular factors affecting the behaviour of conglomerates. Analysis of data from AAMC’s Moranbah North Mine has been obtained and a GSR model developed. The next phase will include comparing the GSR and LVA data across two panels with similar strata but different longwall equipment. Two further sites will also be analysed in the project.

Ventilation, Gas Drainage and Monitoring

C10012
Coordination of In-Seam Drilling, Gas & Outburst Research

J & SD Hanes
John Hanes

Value: $199,000
Report Expected: 25/08/2011
Industry Monitor/s: none
ACARP Contact: Roger Wischusen

The objectives were to facilitate communication and technology transfer of research and development in in-seam drilling, gas management and outbursts, when needed. The project was extended for 2007-2008 and has remained open-ended.

An Outburst Seminar, organised by the Outburst Seminar Committee, was be held in Wollongong in June 2011.

Participation in the Outburst Seminar Committee, including a submission to ACARP for funding in 2012 to 2014, and response to queries from some industry participants were the only activities for this project during the quarter.
The objectives of the project are:

- To validate a numerical outburst model by comparing model predictions with the observed response of the working seam and adjacent rock strata to mining and roadway development, taking into account heterogeneity and variability in rock properties;
- To assess the factor of safety with respect to outburst of the participating mines, taking into account reservoir, geomechanical and operating factors;
- To use the model as a guide to mine through some difficult areas; and
- To review the current outburst management protocol and to develop rational guidelines for outburst management based on field experience acquired during the project and using the validated model.

The project is an extension of work conducted in Projects C6024, C9023, C11030 and C13012. One of the major aims of the project is to apply the understanding on outburst mechanisms gained and the numerical outburst model developed in previous ACARP projects to field problems, especially in mining through difficult areas. The model will be tested and validated through field applications. The current outburst management protocol will be reviewed based on careful analysis of the data collected by Dr Ripu Lama, data and experience on past outbursts reported in the literature, and the new data and field experience from this project, with the aid of the validated outburst model.

Summary of Progress:

- A paper on the effects of CO2 on the strength of coal has been submitted to a journal and is currently under review.
- A trip is being organized to visit a couple of mines in the Southern coalfield within the next couple of weeks to collect new data and to discuss some possible issues in mining through some outburst prone areas for one of the mines, and the possibility of using the outburst model to conduct some modeling studies.
- Some new data collected from various sources on outburst mechanisms, control and management have been studied and analysed. An abstract is being prepared for the Coal Operators’ Conference (Coal2012) to be held in February 2012 at the University of Wollongong.
- Work has commenced to identify the practical issues associated with outburst control and management based on the existing gas content threshold values or other guidelines and any issues that need to be considered for any new approaches or revision to existing guidelines.
IMU based Borehole Survey System - The objectives of this project are to develop a concept design for an IMU based system that will generate a more accurate survey of borehole than current systems.

Several theoretical models have been developed to evaluate the potential for several concept designs. Fabrication of a simulated borehole test facility is almost complete. Our concept prototypes will be evaluated using this facility.

Compilation of the final report for this project is underway and we expect to complete a draft in the next quarter.

C18013
Information Dissemination for the Management of Spontaneous Combustion

University of Queensland
Darren Brady
David Cliff

Value: $109,000
Report Expected: 25/01/2012
Industry Monitor/s : John Grieves
Peter Bergin
ACARP Contact: Bevan Kathage

The main aim of this project is to review the documents that were developed following the Moura No. 2 mine disaster in 1994 to provide educational resources to improve the understanding of the management of spontaneous combustion. In addition the project aims to provide other mechanisms such as web based information packages to encourage best practice spontaneous combustion management.

The objectives of this project are:

- Update and revise information within the “green book”;
- Using this information and research project reports (including ACARP) to develop a web based information system similar to the ACARP funded Outburst Management site – linked to the MIRMGATE metadata system;
- Include case studies on this website;
- Update the “red” and “blue” books;
- Provide updated information to providers of education and training in spontaneous combustion;
- Identify the major changes and improvements in spontaneous combustion management in the past 10 years; and
- Identify areas for future spontaneous combustion research.

Due to the involvement of the project team in the Pike River investigation and Royal Commission this project has been placed on hold until their involvement has been completed.

Discussions were held with the NSW DII working group who are overhauling MDG1006 to ensure that this project embodies the outcomes from that group and do not duplicate their work. Meetings were held in September and October where the project team were allowed to participated in the development/review of the draft technical reference guide (TRG) associated with the draft MDG. Now that the MDG and TRG have been released for comment the project leader has started to create a web version of the TRG. This will be used as the basis for the new green book with additional material collected as part of the ACARP project. The prototype website should be ready for beta testing by the end of September.

C20006
Development of an Alternative Electronic Spark Test Apparatus

CRMCrining
Deryck Lauf
Paul Lever

Value: $383,000
Report Expected: 25/12/2011
Industry Monitor/s : Greg Briggs
Peter Henderson
ACARP Contact: Bevan Kathage

The Electronic Spark Testing concept deploys an electronic device that emulates the function of the current Spark Testing Apparatus (STA) for intrinsic safety testing.

This project has four major objectives:

- Develop a set of well defined functional specifications for an Electronic Spark Tester (EST);
- Develop, design, fabricate and demonstrate an operational prototype EST;
- Validate the operational performance of the EST relative to an existing STA and to meeting regulatory requirements; and
- Develop a commercialization and deployment strategy for the EST.

A project variation proposal was written to collaborate with PTB (Physikalisch-Technische Bundesanstalt) in Germany to develop a state-of-the-art spark model (which includes dynamic effects) for the EST. A collaboration plan has been drafted and sent to PTB, and initial collaboration activities with PTB has commenced. PTB are manufacturing a Mechanical Spark Generator (MSG) that can mimic the STA. The MSG will be sent to CRMCrining for testing to be conducted. Specifications for the design and scope for the first round of tests for the MSG and EST are being developed in conjunction with PTB.

A project development status meeting was held in March 2011 with Jim Munro (Chairman – IEC Committee, explosive atmospheres); Phillip Brown (Austdac & Convenor IEC TC31 October 2011); Peter Henderson (Xstrata, Industry Monitor); and Bevan Kathage. In July 2011, a further presentation was made to the members of the EL-014-04 Intrinsic Safety Standards committee (AUS & NZ). These meetings are directed towards gathering the support of the standards bodies for implementation of the EST as an alternate test device to the STA. All are very supportive of the progress and development of the EST.
C20012
Geophysical Estimation of Concentration and Composition of Gas In-Place in Unmined Coal Seams

Curtin University of Technology
Mark Lwin

Value: $244,753
Report Expected: 25/04/2013
Industry Monitor/s: Agi Burra
Andy Willson
Cecile Naess
James Knowles
Mike Armstrong
ACARP Contact: Bevan Kathage

The objectives of this project are firstly to demonstrate an ability to predict concentration and composition of Gas In Place (GIP) from geophysical logs and laboratory measurements on core samples. Secondly, an assessment of the readiness of seismic methodologies for areal prediction of GIP will be made. The primary rational for this is the realisation that coal swelling, which is highly dependent on gas content, is driven by large equivalent pressures and may therefore produce a noticeable effect on sonic/seismic response because of the latter’s pressure dependency.

The early stages of this two year project concern measurement of those properties which are required to model sonic/seismic response to the presence of fluids, collection of VSP data and some equipment development. We have begun measuring the aforementioned properties, with realistic results obtained, though on a limited number of samples. We will soon be in a position to use this data in laboratory tests of a self-consistent scheme for fluid substitution. We have scheduled our first Vertical Seismic Profile acquisition for 1 September and our apparatus for measuring low frequency response is operational.

As a result of consultation with industry participants during visits to all potential sites (May 2011), it became clear that retrieval of core and access to VSP holes would be dependent on mine site drilling programs. Thus receipt of the first core samples were delayed till mid-July. A positive outcome of the aforementioned visit is that a very good working relationship has been developed with industry participants. Further it has been found that core plugs have taken significantly longer than expected to reach equilibrium during simultaneous measurements of adsorption and strain. This is a vital part of the project and thus we will be proposing a course of action to address this and other problems to industry monitors shortly.

C20014
Fibre Optic Based Methane Sensor

CRCMining
Saiied Aminossadati

Value: $148,500
Report Expected: 25/01/2013
Industry Monitor/s: Colin Gilligan
Jim Sandford
Peter Brisbane
Troy McDonald
ACARP Contact: Russell Howarth

The ultimate goal of the project is to produce a fast and reliable technology for the real-time measurement of methane concentration in underground coal mines. The objectives of the project can be classified as follows:
- Examine and evaluate current and potential fibre optic gas sensing technologies;
- Establish the required technical specifications and criteria from theoretical and test studies, and practical application at the mine site;
- Design and build prototype sensor;
- Test the prototype and demonstrate the technology on a laboratory scale;
- Examine the effect of air flow characteristics on the accuracy of the measurements; and
- Develop a commercialisation plan.

In the first quarter of the project, the past research studies on methane sensors have been extensively reviewed and future opportunities have been identified. The methane absorption line and the laser output frequency have been determined. The effects of pressure and temperature on the methane concentration measurements have been examined based on the information obtained from the High Resolution Transmission database (HITRAN). HITRAN is a compilation of spectroscopic parameters that a variety of computer codes use to predict and simulate the transmission and emission of light in the atmosphere. The development of the experimental apparatus has been completed. A series of tests (different methane concentrations ranging from 0.2%-10%) have been carried out to determine the relationship between methane concentration and intensity/harmonic signal based on the Direct Absorption Spectroscopy and the Wavelength Modulation Spectroscopy. Most of the equipment has been purchased for the all-fibre methane sensor, and the research technician (postdoc) and the postgraduate students have been hired.

During next quarter the multi-cell methane sensors will be tested to determine the technical and laser power requirements and the accuracy of the measurements. The construction and testing of the gas flow box will also be started and the abilities to control the gas flow, concentration, temperature and pressure will be examined.

C20039
Controlling Heatings and Gas Leakage Using Innovative Polymer Gel - Pilot Plant Scale Testing

CSIRO
Sheng Xue

Value: $226,100
Report Expected: 25/06/2013
Industry Monitor/s: Ken Lewthwaite
Peter Brisbane
ACARP Contact: Russell Howarth

The project aims to carry out pilot-plant scale testing of gel systems developed in project C14021 for controlling heatings and gas leakage. Specifically, the project objectives are to:
- Review of China’s practices in gel technologies and their delivery systems;
- Develop suitable batch and continuous approaches for preparing gel systems on pilot-plant scale;
• Develop delivery (pumping, injection or spraying of gels) approaches that would maximise air-blocking area;

• Assess the effectiveness of gel systems in controlling heatings and gas leakage on a simulated goaf at the CSIRO laboratories; and

• Develop guidelines for selecting gel systems suitable for particular types of heatings (e.g. heating in a seam, pillar or goaf) or gas leakage and operational procedures for the gel technique.

The literature review of China’s practices in gel technologies and their delivery systems is in progress.
OPEN CUT

Major Projects

C16031
Automated Swing Loading System for Electric Mining Shovels (SLAP)

CRCMining
Eleonora Widzyk-Capehart
Ross McAree

Value: $2,704,100

ACARP Contact: John Brett

This project aims to provide operator assists that improve truck-shovel operations. The benefits of SLAP span safety, availability, productivity, and maintenance. Phase 1 of the project has been completed; Phase 2 of the project has commenced this quarter. From the operator’s perspective, SLAP technology provides two functionalities, TruckShield and AutoLoad. TruckShield is conceived as a layer-of-protection that prevents metal-on-metal collision that might injure truck drivers and damage trucks/dippers. AutoLoad is an operator assist that reduces the cycle time, lowers machine duty through smoother operation, and reduces the workload on operators. Both technologies can bring benefits and are expected to become increasingly important with the emergence of significantly faster AC mining shovels.

The work completed in this quarter includes the development of the detailed work breakdown structure for the project and preliminary work on robust and accurate truck position determination.

Drilling & Blasting

C18028
Field Instrumentation to Measure the Performance of Low Density (Low Shock) Explosives

CSIRO
Gary Cavanough
Italo Onederra

Value: $168,700
Report Expected: 25/08/2011
Industry Monitor/s: Steven Stook
ACARP Contact: John Brett

A draft final report is being reviewed by Industry Monitor.

Environment

C15044
Assessment of Seasonal Habitat Characteristics as Predictors of Habitat Suitability for Threatened Ornamental Snake

Footprints Environmental Consultants
Andrew Veary

Value: $228,025
Report Expected: 25/10/2011
Industry Monitor/s: Bernie Kirsch
ACARP Contact: Keith Smith

Field work and associated data collection has been completed in late March. Data analysis has almost been completed and the final report is being prepared. With respect to data analysis, ecological modelling is being undertaken from ornamental snake records collected throughout the Bowen Basin. In addition, we have undertaken preliminary analysis of the venom produced by these snakes. Whilst the level of toxicity of the venom is unclear, the venom appears to affect prey ability to control blood pressure. More information in the final report.

Please email Andrew Veary at andrew@footprintsenviron.com.au for any further information about the project.

C18033
Assessing Impact of Sulphate in Saline Mine Site Discharge in Seasonally Flowing Streams in the Bowen Basin

University of Queensland
Dustin Hobbs
Sue Vink

Value: $324,505
Report Expected: 25/01/2012
Industry Monitor/s: Bernie Kirsch, Carl Grant, Stuart Ritchie
ACARP Contact: Keith Smith

Objectives of this project are to develop:
- A locally relevant toxicity data set for sulphate salts and then to use this data to derive a trigger value for sulphate that is protective of aquatic organisms in Bowen Basin streams; and
- A framework to assist sites to identify the likelihood of non-compliant discharge.

The draft final report is being reviewed. Sodium sulphate was found to be the least toxic form of sulphate. A species sensitivity distribution was derived from sodium sulphate data. The concentration of sulphate that would be protective of 95% of species in the receiving ecosystem was estimated to be 770 mg/L and the concentration of sulphate that would protect 99% of species in the receiving ecosystem was estimated to be 620 mg/L. The risk assessment framework was demonstrated using water quality data from a site. The approach can be used on any site to provide a strategic view of water quality in site stores and assess the likelihood that the concentration of any constituent will exceed trigger values set in the environmental authority.
Objective of the work is firstly to develop a locally relevant salinity toxicity dataset for aquatic organisms in seasonally flowing streams in the Bowen Basin. Acute and chronic tests will also be conducted using commercially available species in accordance with ANZECC/ARMCANZ guidelines.

C18034
Emissions from Blasting in Open Cut Coal Mining

CSIRO
Stuart Day

Value: $276,000
Report Expected: 25/10/2012
Industry Monitor/s: Andrew Speechly
ACARP Contact: Keith Smith

Atmospheric emissions of pollutants from blasting are of concern to communities located close to mining operations, such as in the upper Hunter Valley in NSW. Although some of these emissions are estimated and publicly reported each year through the National Pollutant Inventory (NPI), recent research has shown that the estimates are subject to considerable uncertainty. The extent to which local populations are affected by the emissions is largely unknown.

This project aims to use continuous spectroscopic monitoring for a period of about two years to determine the concentration of NO₂ at the boundary of a large open-cut coal mine. The results of this project may be used to quantitatively determine the contribution of blasting to ambient NO₂ concentrations in surrounding districts. In addition, hydrocarbon emissions from blasts will be sampled and analysed to determine the range of compounds released.

In the past quarter NOₓ levels have been measured by a Chemiluminescent NOₓ Analyser and also two DOAS instruments, one at each end of the mine. While data collection has not been entirely continuous due to maintenance requirements and electricity supply issues, patterns can now be demonstrated in emission levels from on and off the mine site which are related to wind direction, time of day and blasting and vehicular activity.

In the concurrent canister sampling programme to measure hydrocarbons from blast plumes samples have been collected approximately fortnightly. Canisters are placed near the blast area and opened to draw in air from just prior to a blast then closed after the blast. The contents are then analysed using a mass spectrometer and species captured are indentified. Another technique using sorbent tubes to sample blast plumes is also being trialled.

C19018
Use and Water Quality Remediation of Acidic Coal Pit Lakes by Adjacent Aquaculture

Edith Cowan University
Clint McCullough

Value: $156,940
Industry Monitor/s: Digby Short
ACARP Contact: Keith Smith

This project builds on previous ACARP work to examine whether marron wastewater discharges could improve coal pit lake water quality and ecosystem values through stimulating natural bioremediation processes. Simultaneously the project is determining whether disposal of aquaculture wastewater would be a sustainable end use for a typical coal mine pit lake.

Field monitoring of the aquaculture treatment lake and control lakes has now been completed and their chemical and biological data analysed. These data are now being statistically analysed and organised into the field monitoring chapter of our ACARP report. All microcosm and mesocosm experiments are also now completed and their data is largely analysed and written up for submission as separate chapters in the ACARP report. These experiments clearly identified low phosphorus concentrations and not water toxicity as the key factor limiting in the moderate water quality of the Collie Coal pit lakes. These experiments found that doses of only around 60 ppb dissolved phosphorus were able to address this nutrient deficiency and lead to phytoplankton growth rates representative of natural lakes (Figure 1).

Further project technology transfer includes 2 peer-reviewed and published papers at the International Mine Water Association (IMWA) conference in Aachen, Germany in September 2011. We also propose to present this project’s findings at the IMWA conference which MiWER is co-organising in September 2012.

Together with our industry collaborator Premier Coal, MiWER was successful with short-listing of our 2012–2013 ACARP grant application to extend this work’s findings to developing a strategy to amend missing lake macronutrients in coal pit lakes. This proposed research project will seek to evaluate the role simple nutrient additions could play in improving a) pit lake water quality for good-moderate water quality and, b) pit lake ecosystem values both as ways to reduce closure risk and increase miner and stakeholder sustainability.

Figure 1 Successful algal bloom in aquaculture treatment lake following nutrient additions.
### Guidelines for Establishing Ecologically Sustainable Discharge Criteria in Seasonally Flowing Streams

**University of Queensland**  
Sue Vink

- **Value:** $238,000  
- **Report Expected:** 25/02/2013  
- **Industry Monitor/s:** Bernie Kirsch, Carl Grant, Stuart Ritchie  
- **ACARP Contact:** Keith Smith

The objectives of this project are:
- Develop new knowledge for determining the sustainable salt load for the river system;
- Quantify the impact of saline discharge on aquatic ecosystem processes by examining changes in hyporheic (below surface of river bed) microbial community structure and function and the dynamics of system flushing under highly-variable seasonal river-flow conditions; and
- Develop guidelines for flow and water quality conditions that will minimise environmental impacts of mine site discharge.

Six sampling trips have been conducted to capture changes to the microbial community composition in response to the seasonal changes in environmental conditions and after mine water releases. While more detailed sampling has been undertaken in the Isaac River and Cherwell and Boomerang Creeks, a total of 8 creeks have been sampled upstream and downstream of discharge locations.

Based on limited analyses suggests that environmental conditions dictate changes in community structure. There is a large amount of variability in the rates of microbial driven processes. Laboratory experiments suggest that the rates of microbial processes do not appear to be significantly affected by increasing salinity. Additional experiments are required to confirm these results.

### Risk Assessment Tools to Support End Use Decisions for Mined Land of the Bowen Basin

**University of Queensland**  
Bob Maczkowiack, Carl Smith

- **Value:** $250,000  
- **Report Expected:** 25/06/2012  
- **Industry Monitor/s:** Bernie Kirsch, Toni Ward  
- **ACARP Contact:** Keith Smith

No report received.

### Soil Organic Matter and Green Carbon in Rehabilitation: Their Role in the Carbon Balance

**University of Queensland**  
Thomas Baumgartl

- **Value:** $253,200  
- **Report Expected:** 25/06/2012  
- **Industry Monitor/s:** Bernie Kirsch  
- **ACARP Contact:** Keith Smith

Quantification of carbon in soil is commonly used to assess the potential productivity of an area. Accumulation of carbon fractions in replaced soils/spoils can therefore be assessed over time and depth to judge the success of mine site rehabilitation. The primary objective of this research is to distinguish between green (recently decomposed plant matter) and black carbon (e.g. charcoal) or coal derived carbon for the purpose of quantification of these fractions and evaluation of rehabilitation success.

Samples from the first field sampling campaign in 2010 have been processed, i.e. sieved, loose organic matter separated from soil and the soil has been prepared for chemical analysis. Emphasis has been since laid on accessing appropriate laboratory facilities to measure coal, black carbon and total organic soil carbon using different approaches (Walkley-Black; total C (C-N Dumas method), Heanes dichromate oxidation, thermogravimetry; carbon isotope). Collaboration with DERM, University of Pennsylvania, Geosciences Australia and QUT has been established for this purpose.

First results show, that Heanes dichromate oxidation seems to capture total carbon most reliably, i.e. identifies green and black carbon. The Dumas method and Walkley Black fail in the determination of black carbon, although the Dumas method shows the highest carbon contents in samples with little or no black carbon. The differences between Heanes and Dumas may be attributed to effect of carbonates influencing the measurement. Initial trends also show that there may be a site specific correlation between Heanes and Dumas method.

The objective of the employment of various methods is to gain confidence in the accuracy of the analytical approach and comparability of results and to eventually concentrate on a limited number of promising method(s) for green carbon analysis.

### Environmental Offsets: Maximising Ecosystem Services from Biodiversity Conservation

**University of Queensland**  
Damian Barrett

- **Value:** $261,750  
- **Report Expected:** 25/09/2012  
- **Industry Monitor/s:** Bernie Kirsch, Bryan Tiedt, Carl Grant, Frank Ford, Stuart Ritchie  
- **ACARP Contact:** Keith Smith

No report received.
Environmental Offsets are intentional actions that compensate for the residual and unavoidable harm caused by project development. They aim to ensure no net loss of biodiversity value within a region and maintain provision of ecosystem services. This project aims to improve the capability of assessing the value of environmental offsets in terms of biodiversity value, the functioning of landscapes and the trade-offs with economic benefits. The benefits to industry of this work are improved knowledge of where and when offsets are appropriate, development of the scientific basis for credible tools to assess offset performance, facilitating dialogue between stakeholders for the social, legislative and environmental ‘license-to-operate’.

Recent progress in the project includes:

Spatial Optimisation
Considerable progress has been made in the development and testing of the spatial optimisation scheme, dubbed GALAPAGOS (Genetic Algorithm And PArallel Geographic Optimisation Software). Synthetic spatial re-vegetation problems with known solutions have been used to test the robustness of the algorithm, including evaluating the trade-off between processing time and solution ‘fitness’ in the context of fit-for-purpose for a given application. The testing has furthermore confirmed that the dynamically updating spatial rules are functioning as expected, and that compactness and a form of contiguity are being promoted by the re-vegetation algorithm. Based on this testing in a controlled environment, GALAPAGOS is currently being transitioned to operate on real world spatial datasets (The Bowen Basin study site).

Plant functional traits
The 3D variational model data assimilation scheme has been further developed and validated against known model data for single scene applications. Using test data with known solutions confirms that the assimilation-optimisation is effectively retrieving (known) canopy conductance (plant functional trait) estimates. In addition, a water budget model for soil moisture has been implemented and is currently being coupled to the 3D VAR scheme.

C19034
Use of Meteorological Models to Improve Management of Dust from Open Cut Mines
Moraway
Nigel Holmes

Value: $154,100
Industry Monitor/s: Bruce Foster
ACARP Contact: Keith Smith

A draft final report is being reviewed by Industry Monitor.

C20007
Measurement of Dust Sampling in Australian Coal Mines
University of Wollongong
Ting Ren

Value: $119,500
Report Expected: 25/01/2013
Industry Monitor/s: Bharath Belle, Charles Spence
ACARP Contact: Russell Howarth

The main objective of this project is to develop a new dust monitoring methodology to quantify and document both respirable and inhalable dust magnitudes generated from different sources, and assess the efficiency of installed controls for the mitigation of produced dust, using gravimetric sampling as per statutory requirements in conjunction with real-time dust monitors. This data will then be used to create a benchmark or signature for each longwall mine in relation to dust loads from different sources of generation. Once this signature is established, quantifiable testing can be undertaken on new or improved controls to ensure maximum efficiency in removing respirable and inhalable dust. Results from this research project will shed some fundamental and scientific insights into an area of genuine concern to the coal industry.

Work focused on the following:
- Review of current inhalable & respirable dust sampling methodologies used in NSW and other states in Australia as well as overseas - A critical review study has been undertaken to examine current dust sampling methodologies in Australia and the US to identify their procedures, equipment used, merits and limitations against codes, guidelines and standards. Arrangement has been made with Coal Services to visit their dust monitoring laboratory to understand their test and measurement facilities and reporting procedures.
- Survey to Determine Current Dust Control Employed at Australian Mines - Contacts are being made to a number of Australian longwall engineers/operators to complete a survey relating to their current dust suppression controls. Some feedback has been received for further analysis and evaluation.
- Development of a New Sampling Methodology and Field Studies – work has been conducted to develop a new sampling methodology to more accurately measure and quantify dust loads at identified sources of dust generation by carrying out dust monitoring at selected coal mines in NSW. The testing methodology proposed is to use the gravimetric sampling in conjunction with the Thermo Fisher Scientific real-time Personal Dust Monitors (PDM), combined with a comprehensive test program that relates mine external as well as longwall dust sources to the longwall operations. Using this new methodology, a field dust monitoring survey has been completed at Metropolitan Colliery and results being evaluated. Follow up field monitoring arrangements have been made with Mandalong Mine and West Wallsend Colliery in the coming two months.
The objective of this project is to establish the criteria for functioning river landscape units in mining and post mining landscapes. The primary objective of the research will be to define such criteria and describe the performance standards to be achieved for such criteria. It is proposed that the criteria and performance standards be developed in a form suitable for acceptance and adoption by both the mining industry and regulators and provide the mechanism to enable stream diversion licence relinquishment and contribute to orderly mine site closure.

Over two years the project will:

- Document best practice river health management in mining and post mining landscapes in Australia and overseas and document emerging issues in the waterway and wetland management industries that will impact on waterway diversion design;
- Review the success or otherwise of the existing ACARP diversion parameters (that have been adopted by DERM);
- Establish an agreed set of riparian unit criteria (metrics and performance criterion) for post mining landscapes; and
- Investigate the issues and risks associated with diversion construction and operation through mine spoil.

Project components commenced include literature review on best practice advancements in waterway management since the original ACARP diversion related projects (C8030 and C9086); review of the performance of diversions built to the design criteria developed in those earlier ACARP projects (particularly following recent large flow wet seasons); regulator consultation planning.

C20022
Hydraulic Connectivity Between Mines and Adjacent River and Groundwater Systems in the Hunter River Valley

University of Queensland
Betlef Bringemeier
Ling Li

Value: $377,810
Report Expected: 25/05/2013
Industry Monitor/s: Andrew Speechly
John Watson
ACARP Contact: Keith Smith

The proposed work aims to improve understanding of the hydraulic connectivity between mines and adjacent river and groundwater systems in the Hunter River Valley region, and so to develop a set of criteria for assessing the mining impact on the rivers and aquifers, and associated risks. Specific objectives are to:

- Characterise the risks with respect to the uncertainty of the hydrogeological regimes;
- Evaluate the impacts of mine extension on groundwater and surface water;
- Estimate rates of saline groundwater seepage into the pit;
- Assess the impact of fault structures and fracture zones on the strip and high-wall designs and the geotechnical performance of the pit excavation during operations and closure.

Work so far has been focussed on the field investigation component. Various methods and techniques for field work have been established and tested. Preparation of the first field trip, including meeting mine health and safety requirements, has been completed.
In addition, the team has been pursuing the modelling work, currently developing the fracture network generation and flow simulation models. Using the ACARP grant as the leverage, the team has submitted an ARC Linkage project application to expand the scope of the research work and has received good feedback from the reviewers (outcome of the grant application will be known in October 2011).

C20023
Improvement of Haul Road Dust Emission Estimation and Controls at Coal Mines

PAEHolmes
Judith Cox

Value: $244,720
Report Expected: 25/01/2012
Industry Monitor/s: John Watson
ACARP Contact: Keith Smith

The main objective of the project is provide information to the mines to improve the understanding of dust emission generation from haul roads at coal mines, and the role that dust suppressants can play in controlling these emissions. The ultimate aim of the project is to provide the mines with the information and tools to select the most appropriate products for their operations.

In this quarter a literature review has been prepared detailing the current knowledge of dust generation and control and identifying the range of dust suppressant products available. Surveys have been circulated to the NSW mining companies to identify how haul roads are used, together with information on dust control measures that are currently employed. A survey has also been provided to a number of companies that supply dust suppressant products and discussions have also been held with these companies. Preliminary work has commenced on the construction of a mobile monitoring device that will be used on the mine sites to aid in the understanding of dust emission levels across a site.

C20027
Assessing Environmental Safety of In-pit Disposal of Tailings

University of Queensland
Thomas Baumgartl

Value: $268,600
Report Expected: 25/05/2013
Industry Monitor/s: Bernie Kirsch, Toni Ward
ACARP Contact: Keith Smith

There is increasing pressure from stakeholders to minimize land use and the effect of mining on the environment. Tailings produced from washing coal need to be stored securely on site taking into account the scarcity of land to be impacted and to maintain the license to operate. There is potential risk of hydrological and geochemical impacts through the footprint of a tailings facility. Some of the existing voids/pits can be utilised for disposal of tailings. In-pit tailings disposal has the advantage compared to on-ground tailings storage facilities to reduce the risk of surface contamination in case of failure.

The objective of this study is to develop a set of critical parameters relevant for the prediction of hydrological and geochemical behaviour of in-pit disposed tailings. In a further step the use of advanced modeling approaches will determine the potential impact of in-pit disposal, and its applicability and associated risks and benefits for the local environment. Appropriate boundary conditions will be defined, which will support the decision making process on site for the planning and design of the use of voids for in-pit disposal.

In an initial step information and experience about in-pit tailings deposition from a number of mine sites in QLD and NSW will be collated. Data on geology and hydrochemistry will be summarized as the basis for further work. Currently, selected mine sites are visited for this purpose.

Geology

C15033
ESFC-Based Trigger Levels for Monitoring Pit Wall Stability

Sherwood Geotechnical & Research Services
John Simmons

Value: $284,950
Report Expected: 25/08/2011
Industry Monitor/s: Ashley Creighton, Jody Todd
ACARP Contact: John Brett

A draft final report is being reviewed by Industry Monitor(s).

C17023
Effective Slope Monitoring for Open Cut Coal Mines

GroundProbe
Duncan Stovell, George Poropat, Neal Harries

Value: $190,500
Industry Monitor/s: Ashley Creighton, Ben Nell, John Hoelle, Ken Preston
ACARP Contact: John Brett

Two of the three research stream reports for final completion have now been completed and the third report, stream 2 is in final review prior to release. The body of work identified as outstanding in the previous report has now been completed.

The expected delivery of the final reports is late August 2011 and we are at a stage to consider technology transfer method, which is suggested to be workshops in the Bowen Basin and Hunter Valley.
Carried out to determine if this shear wave component yields better results. Next quarter, analysis based on SH-SH wave reflection will be performed.

The following work tasks were performed:

- The position of the drill bit during drilling was obtained and analysed. This information was used to image the coal layers. With the new confirmed co-ordinates of the drilled holes and bit position, the velocity model was updated;
- Computational resolution was enhanced by reducing the grid size to 0.5m for obtaining better resolution of imaging the subsurface coal layers;
- 50 data files recorded at different drill-bit position were used;
- Analysis was carried out for a depth up to 120m although the drilling was performed for a depth of about 43m, and modified reflectivity distributions were then obtained. However, some cross validation on the reflectivity imaging is needed to identify deeper coal layers;
- For greater depths, the P-P reflection was found to be better than SV-SV reflection in imaging the reflectivity distribution due to dominant P-wave radiation of seismic wave emitted from the drill bit; and
- The algorithm for reflectivity analysis was updated with a new feature to include SH-SH wave reflection analysis.

Next quarter, analysis based on SH-SH wave reflection will be carried out to determine if this shear wave component yields better results. Further analysis will be carried out on other acquired drill hole data.

The main objective is to identify the top of coal seam while drilling is in progress using a highly sensitive and precise three-component, down hole seismic measurement system with a recently developed multi-component signal processing technique. In this quarter, the following work tasks were performed:

- The position of the drill bit during drilling was obtained and analysed. This information was used to image the coal layers. With the new confirmed co-ordinates of the drilled holes and bit position, the velocity model was updated;
- Computational resolution was enhanced by reducing the grid size to 0.5m for obtaining better resolution of imaging the subsurface coal layers;
- 50 data files recorded at different drill-bit position were used;
- Analysis was carried out for a depth up to 120m although the drilling was performed for a depth of about 43m, and modified reflectivity distributions were then obtained. However, some cross validation on the reflectivity imaging is needed to identify deeper coal layers;
- For greater depths, the P-P reflection was found to be better than SV-SV reflection in imaging the reflectivity distribution due to dominant P-wave radiation of seismic wave emitted from the drill bit; and
- The algorithm for reflectivity analysis was updated with a new feature to include SH-SH wave reflection analysis.

Next quarter, analysis based on SH-SH wave reflection will be carried out to determine if this shear wave component yields better results. Further analysis will be carried out on other acquired drill hole data.
to account for variable spoil pile composition, for use as predictive tools.

- Application of the results of the research to the design and geotechnical stability assessment, and economic evaluation, of high spoil piles.
- In addition to quarterly progress reports, reporting the results of the project, and conveying the results to the participating mines and to the industry in general.

The results of the laboratory testing of the self-weight, wetting-up collapse, and weathering-induced settlement of scalped clay-rich, weathered rock Jeebropilly spoil are summarised in the following plot.

The results of laboratory direct shear strength testing of scalped clay-rich, weathered rock Jeebropilly spoil are summarised in the following plot.

Scalped spoil samples have been collected from Mt Owen, Mt Arthur and Hunter Valley mines for a campaign of laboratory testing of settlement, weathering and shear strength. In addition, spoil settlement data are being sourced from a number of mines participating in the project.

C19026
Improved Management of the Rock Fall Hazard at the Base of Highwalls

University of Newcastle
Anna Giacomini

Value: $210,880
Report Expected: 25/05/2012
Industry Monitor/s: Jody Todd, Ken Preston, Shaun Booth
ACARP Contact: John Brett

The aim of the project is to gather coal-mine specific data on rock falls and to improve the understanding of the rock fall hazard in the mine sites. This includes the assessment of different mitigation methods by performing in situ experiments and numerical analyses. The outcome of the project will ultimately aid in better refining culvert design for underground portal entries and will assist in redefining other safety measures such as standoff distances in order to minimise risk.

In situ experiments were carried out at Beltana mine in order to improve management of the rock fall hazard at the base of the highwall. Concrete blocks of 44.5kg (shape according EOTA 2008) were released from the top of the highwall at two locations. The first section had no netting installed whereas the wall of the second section was draped with a net. The analysis of the data collected during the experiments shows that the net strongly reduces the bouncing height of the blocks behind the net compared to without the net (see Fig. 1). However, the velocity of the block falling between the highwall and net is not reduced significantly. Indeed, the velocity is much higher than expected, and first results show that the muck pile on top of the concrete culvert and safety berm play a crucial role in the design of a safe mine environment.

A numerical model by using the discrete element method (DEM) is currently being developed in order to investigate the effectiveness of different mitigation methods. The model will allow studying the interaction between block, net and highwall in order to assess the final velocity at impact. The in situ experiments will be used to calibrate the numerical model.

Figure 1. Block trajectory for the test a) with the net, and b) without the net.

C20025
Investigations for Open Pit Geomechanics Using Geophysical Logs

Coalbed Geoscience
Peter Hatherly
Terry Medhurst

Value: $269,400
Report Expected: 25/10/2012
Industry Monitor/s: Jody Todd, Ken Preston
ACARP Contact: John Brett

Effective overburden characterisation presents a key input to the continued deeper development of many of Australia’s open cut coal resources. In this project we aim to address this issue through the development and demonstration of characterisation tools based on the Geophysical Strata Rating (GSR). The GSR has been
established through previous ACARP projects in the underground area and uses geophysical logging data to provide a continuous record of both lithology and rock mass quality. This new project involves development of GSR models in 2D and 3D from current operations and integrating the results with conventional defect and acoustic scanner logs. Through comparison with highwall monitoring and production data we will attempt to provide a basis for improved understanding of highwall stability issues as well as other geotechnical issues in open cut mining such as pit floor stability and blasting.

Work over the past quarter has concentrated on analysing geophysical logging data from two areas at Rio Tinto’s Hail Creek Mine and building 3D GSR models for these areas. The detailed assessment of those models is about to begin.

C20029
Open Cut Mine Wall Stability Analysis Utilising Discrete Fracture Networks

CSIRO
Marc Elmouttie

Value: $136,940
Report Expected: 25/04/2012
Industry Monitor/s: Jody Todd
ACARP Contact: John Brett

The aim of this project is to investigate the use of new, advanced risk analysis techniques for the prediction of both size and stability of potential blocks and wedges in pit walls in open cut coal mines. Tools being used include advanced methods in 3D image analysis, discrete fracture network (DFN) generation, and polyhedral (rock block) modelling. Mine-based validation of the optimal technique will be performed and successful completion of this project will establish the technical base for the development of predictive hazard detection software for general use in the industry.

The first quarter of this project is now complete. Three sites to be used for the project (referred to as Sites A, B & C) have all been visited and photogrammetric imaging completed for sections of highwalls.

Detailed structural mapping of Site A using digital methods is nearing completion. Trials of new visualisation methods to assist with the digital mapping have proved very encouraging. Preliminary structural modelling of site A has been undertaken using customised DFN generation and polyhedral modelling. Some sensitivity analyses have been performed to assess the robustness of the stability and block size distribution predictions.

Results thus far have been encouraging and the project is on schedule. Work is now progressing to similarly analyse the data from sites B & C. Once complete, work will begin to quantify uncertainties associated with the structural mapping, DFN generation and block generation techniques.

Maintenance & Equipment

C16030
DC Motor Duty Meter

CRCMining
Galina Mirzaeva
Terry Summers

Value: $551,066
Report Expected: 25/12/2012
Industry Monitor/s: Edan Stolberg, Tony Egan
ACARP Contact: John Brett

Project has been on hold since November last year. Researcher expects to resume in the near future after discussing the strategies with Industry Monitors.

C18031
Improved System for Dragline Rope Condition Monitoring

Bureau Veritas Asset Integrity and Reliability Services
Adam Van Dyck

Value: $426,400
Report Expected: 25/05/2012
Industry Monitor/s: Shaun Booth, Tony Egan
ACARP Contact: John Brett

In the previous project (C15031) it was demonstrated that it is feasible to use Magnetostrictive Transducer technologies to generate ultrasonic energy in Dragline Pendant ropes of up to 120mm in diameter and for this energy to be transmitted through the rope and socketing assembly.

A MsSR3030R guided wave Ultrasonic Inspection system was acquired and trialled on laboratory rope samples under tension. It was determined that this system was capable of “seeing” a reflection of ultrasound energy from a defect equivalent to 6% loss of overall cross section of the rope.

In this project Bureau Veritas will aim to conduct a field trial of a semi-permanently installed system on a dragline pendant rope assembly. This trial will be conducted in Parallel with the existing Radiographic Inspection regime and the results between these inspection methods compared and contrasted.

We are currently collaborating with a representative from Rio Tinto Mount Thorley Warkworth site to organise the details of the field trial. A DC electromagnet is currently being developed to produce the bias magnetic field required. This is to replace the permanent magnets currently used with the MsSR 3030, to meet the safety requirements of the Mount Thorley Warkworth site.
C20021
Minimal Perception Requirements to Support Effective Remote Control of Bulldozers

CRCMining
Ross McAree

Value: $392,093
Report Expected: 25/03/2012
Industry Monitor/s: Andrew Walker, Dallas Core, Peter Yates
ACARP Contact: John Brett

This project aims to understand and define operator perception requirements for effective remote operation of dozers on coal stockpiles and determine how the feedback information to meet these needs can be optimized to fit within the capacity of contemporary wireless communication channels. Coal stockpiles are chosen because the benefits of remote operation are compelling: removing the operator from the machine eliminates the fatal risk of engulfment should the dozer fall into a void. This project is a joint collaboration between CRCMining Caterpillar, and BMA.

A six degree-of-freedom motion feedback system has been developed which replicates motions of the machine at a remote control operator station. This system has been interfaced to a D8 dozer and Stage 1 testing conducted. These tests will look to quantify benefits of motion feedback.

A 3D high definition visual feedback system has been commissioned in the laboratory and this is scheduled for installation and testing on a dozer in September and October. Evaluation trials of the full perception systems are scheduled to be conducted at Saraji mine in Q1 2012.

C20026
Alternative Rope and Pennant Materials

AMOG
Andrew Potts, Ross Armstrong

Value: $178,800
Report Expected: 25/01/2012
Industry Monitor/s: Shaun Booth, Stephen Watts
ACARP Contact: John Brett

The objective of this project is to identify ways to increase productivity and improve safety of draglines. By conducting a study into alternative rope materials the focus will be to identify any areas of benefit for existing machines and areas of future development for new design machines when using alternative rope materials. The performance and feasibility of alternative rope materials will be compared with the wire ropes currently in use.

During this quarter the following work has been undertaken towards satisfying the objectives of the project including:
- Collation of synthetic and wire rope data including a site visit to Ravensworth mine in NSW to gain a better understanding of dragline operations and obtain data from maintenance personnel;
- Discussions have opened up with synthetic rope manufacturers who will play a key role in providing synthetic rope data for comparison with wire rope;
- Failure mode effects analysis is underway on the four main Dragline rope types using in-house IP and data from synthetic rope manufacturers;
- A socketing technology study is underway comparing synthetic rope termination options with wire rope terminations; and
- A finite element model of an OEM Dragline superstructure has been obtained with analysis now underway to assess the load duties of wire and synthetic ropes.

The project is on schedule and budget with considerable interest and cooperation being experienced from the synthetic rope industry as well as a number of mines.

Occupational Health & Equipment Safety

C17014
Risk - Cost - Benefit, Decision Support Tool - Using Bow Tie Technique

University of Queensland
Gul Kizil

Value: $173,000
Industry Monitor/s: Dave Mellows, John Hempenstall
ACARP Contact: Roger Wischusen

The main objective of this project is to develop a ‘Risk · Cost · Benefit (RCB) Decision Support Tool’ that would enable mining operations to quantify level of risk, assess whether an appropriate technology reduces that risk and calculate the net financial benefit associated with appropriate but significantly expensive risk reduction measure.

To date the project team has developed a novel RCB Decision Support Tool, known as RCBgen (Risk-Cost-Benefit Generator), and Risk-Cost-Effectiveness Model, RCEModel, applicable to mining and other industries.

Currently, the project report writing is in progress. Submitted journal article that focuses on the project’s 1st case study, Truck Collisions, is also being revised in accordance with the journal’s (Risk Analysis) editors’ recommendations. Publication at relevant journals will assist with disseminating the project method and the invaluable findings at a wider scale.
C18029
Using Acoustic Agglomeration to Reduce or Eliminate Dust Loading from Machine House on Draglines

CSIRO
Darren Bates
Patrick Glynn

Value: $417,966
Report Expected: 25/05/2012
Industry Monitor/s: Darren Wood
Steve Dansie
Tony Egan
ACARP Contact: John Brett

We have now commenced the extension of this project and are meeting the timelines of the project program but anticipate some small delays due to the recent flooding in the Bowen Basin.

Acoustic agglomeration of airborne particles has been known for the last 75 years when it was first observed that small particles tend to “stick” together in the presence of an intense acoustic field, thereby forming larger particles. Without impeding the flow of particulate through an air supply duct, a strong sound field can be applied to stimulate rapid agglomeration of smaller particles into larger ones. The larger particles can then be more effectively removed by standard particle capture methods, such as cyclones powered, un-powered, and electrostatic precipitators.

This project is to demonstrate the reduction of dust particulates in dragline machine room. The outcome of the project is to reduce particulates by 99%.

Progress against milestones:
- Large scale air volume testing with introduced dust particulates (ongoing);
- Measuring efficiency of the Dynavane to agglomerated particulates (ongoing);
- Approaching open cut mine sites to fit a prototype Acoustic agglomerator to a working dragline

This project is on schedule.

C19027
Dragline Machine House Dust Control - Field Testing of Alternative Cartridge Technologies

BMT WBM
Bruce Manser

Value: $192,800
Report Expected: 25/01/2012
Industry Monitor/s: Darren Wood
Tony Egan
ACARP Contact: John Brett

During this quarter, BMT WBM prepared and submitted a report to ACARP on the testing conducted by Mann + Hummel (Germany).

Since receiving the Mann + Hummel notification of their withdrawal from the project BMT WBM has been in discussions with the original filter supplier for the AirScrubPro system on the P&H shovels, to see if they have more recent test information on their filters or an interest in providing assistance to develop a better filter. The supplier is currently in the process of responding to this request.

Feedback from the supplier’s in-house evaluation will have a large bearing on the strategies for how this filter project could be progressed. Should feedback be positive, it is envisaged that testing would be carried out with alternative filter designs installed into a shovel as per the original intent of the project, albeit over a reduced timeframe owing to the remaining budget.

Should this supplier identify that no significant improvements can be made to the current filter design, BMT WBM have proposed to the ACARP monitors that it may still be desirable to conduct field testing at a number of sites operating shovels fitted with AirScrubPro systems to obtain a better baseline for the pressure drop vs. flow characteristic over time. By testing several machines, this would allow extraction of a mean trend along with an understanding of the statistical variation that can occur between machines and the effect of the pulse cleaning. Understanding how the pressure drop vs. flow characteristic changes with time for a filter cartridge used in this environment is crucial to being able to progress a design for a cartridge-based dragline filtration system and the associated pulse cleaning system requirements.
C19032
COLLISIONgate: A Vehicle Interaction Causal Factors Database and Risk Management Decision Making Tool

University of Queensland
Gul Kizil
Tilmann Rasche

Value: $98,950
Industry Monitor/s: Dave Mellows, Paul Wood, Tony Egan
ACARP Contact: Keith Smith

The main objective of the project is to establish an online searchable portal, COLLISIONgate: A Vehicle Interaction Causal Factors Database and Risk Management Decision Making Tool.

This project has been aligned with the RISKGATE project and process, and tightly integrated within the RISKGATE framework to develop the RISKGATE Collisions topic. As such, the project utilises Bow Tie Analysis (BTA) method to identify Initiating Events/Causes/Consequences, and Preventative and Mitigative Controls associated with collisions. The process focuses on gathering industry expert input to develop the BTA content; this has been achieved through organising Industry Workshops.

To date, two (one-day) Industry Workshops (Jun 3rd & Jul 18th, 2011) have been held. The workshops were attended by the industry experts representing Anglo American, Peabody and Xstrata. In preparation for the Workshop 1, the team prepared a detailed document identifying and describing potential collision scenarios (Surface & Underground) by energy/hazard.

Both industry workshops accomplished their targeted objectives successfully. Workshop 3 is planned to be held in September and will aim to complete the BTA content.

C20016
Minimise Fume Generation from Blasting

CSIRO
Alastair Torrance
Gary Cavanough

Value: $240,000
Report Expected: 25/03/2013
Industry Monitor/s: Andrew Speechly, Dirk Smith, Robbie Nitz
ACARP Contact: Keith Smith

The first objective of the project is to understand the mechanism for fume production in blasting operations in open cut coal mines. The second and primary objective is to develop a fume production risk assessment matrix. This matrix can be used by coal operations to help prevent fume generation from blasting.

A review on the cause of post blast fume in open cut mining has been completed. From this review it is clear that the cause of post blast fume generation is not well understood and has been attributed to a broad number of conditions. The factors affecting post blast fume generation that are the most commonly stated are product formulation, VOD, density, ground conditions, confinement, water and mode of initiation.

The results of the survey of Australian Open Cut Coal mines identified the main contributing factors to fume generation as product, wet holes and geology. As a result of these findings an independent laboratory is currently being commissioned at CSIRO to measure the following:
- Moisture content of product;
- Ammonium Nitrate content of product;
- Microscopic examination of prill for size analysis;
- Microscopic examination of emulsion for droplet size and crystallisation; and
- Sleep Testing: Assess density and condition of product when confined under pressure for manufacturer specified sleep time.

Suitable methods of delivery of samples to the laboratory are being negotiated. Steps are also being taken to enable the transportation of laboratory equipment to sites in the Hunter Valley and Central Queensland. Thirty detonation pressure and temperature transducers have been made for planned field work in the next quarter.

Overburden Removal

C17024
Load, Haul, Dump (LHD) Analyser and Landform Management System

Earth Technology
Murray Phillips

Value: $260,000
Report Expected: 25/08/2011
Industry Monitor/s: Andrew Roxburgh, Bernie Kirsch, Robert Spencer
ACARP Contact: Keith Smith

A draft final report is being reviewed by Industry Monitor(s).

C20018
Advancing Dragline Performance Analysis

CRCMining
Andrew Jessett
Mark Connolly
Peter Knights

Value: $128,500
Report Expected: 25/03/2012
Industry Monitor/s: Greg Sheppard, Lindsay Ford
ACARP Contact: John Brett

This project will develop and site-test a series of new context-rich dragline performance indicators capable of distinguishing current operating context and comparing current performance against historical performance in similar circumstances and against optimal performance targets.
During this second quarter, the following work has been undertaken toward satisfying milestones 3 and 4 of the project. This includes:

- A classification algorithm has been developed based on the coincident points of the hoist and swing motors;
- The algorithm calculates a loci of “coincident points” based on the swing angle possible within the time required to hoist the loaded bucket a certain distance;
- Coincident points have also calculated for the hoist and drag and the swing and drag motors; and
- Over 200,000 cycles of dragline performance monitoring data from Dragline 302 at Curragh mine have been analysed.

![Figure 1 Proportion of different dig modes (200,000 cycles)](image)

**Figure 1 Proportion of different dig modes (200,000 cycles)**

![Figure 2 Distribution of swing, hoist and drag limited cycles per dig model](image)

**Figure 2 Distribution of swing, hoist and drag limited cycles per dig model**

Figure 1 shows a breakdown of the dig modes included within the sample of 200,000 cycles. Using the coincident limits, cycles were classified as swing, hoist or drag limited. Figure 2 shows the distribution of these cycles as a function of dig mode. It is anticipated that information such as this could be used to improve the design of excavation sequences, or to justify dragline motor upgrades. The coincident limits also permit the analysis of individual cycle trajectories. This is useful in appraising operator performance as well as dig-walk sequencing.

In Q3, these reporting facilities will be coded into the Pegasys reporting system. The project is on schedule and on budget, with no major obstacles expected.

**C20020**  
**Mine Fleet Buffer Modelling**

**LC Engineering**  
Simon Orton

**Value:** $178,400  
**Report Expected:** 25/01/2012  
**Industry Monitor/s:** Murray McKirdy, Tom Cobcroft  
**ACARP Contact:** John Brett

The objectives of the project are:

- To develop a novel fleet buffer modelling system in the area of mine machine fleet coordination and planning across multiple types of fleet; and
- To develop a software tool for site trial.

An extensive data discovery commenced on site in March 2011. An extensive review of site extraction processes has been completed. A full review of mine planning systems occurred in April 2011 to establish proposed program boundary conditions. Since April a detailed software scope has been developed. Currently the LC Engineering IT team are finalising a software tool for site trial. The future plan has the next step completing a program site trial in October to demonstrate effectiveness of the tool.

**C20024**  
**Real Time Continuous Measurement of Blasted Dragline Overburden Bulk Density**

**CRCMining**  
Paul Lever

**Value:** $200,667  
**Report Expected:** 25/05/2012  
**Industry Monitor/s:** Hans Hayes  
**ACARP Contact:** John Brett

This project builds on the results of the real-time bucket bulk density system (C18035) by extending the system to measure in-place bulk density of blasted material. The challenge in achieving this is to register sensor data recorded from different boom and dragline positions while fusing the information consistently. The objective of the project is to develop and test an online system for a dragline that will:

- Integrate blast material bulk density with the blast design to assess and improve blast performance;
- Provide an improved dragline diggability system by integrating the material bulk density into the algorithm, and
- Provide an improved operator KPI that utilises diggability to access dig context.

Evaluation of a commercially available DTM system has come to completion with the notion that while it provides a suitable hardware platform the cost of the system makes it unaffordable on the existing project budget arrangement. Issues around site access and the operational status of the DTM system delayed this project by approximately a month.

The analysis of this data has shown that there is a high reliance on the accuracy of the position and timing measurements between the GPS and scanner. This has allowed us to set the minimum functional requirements of an alternative or custom sensor platform. Functional specifications for the sensor package have been developed and hardware suitability is being investigated. A custom sensor package is being designed for a mine site installation and it is expected that initial site visits for inductions, boom position evaluation and site acceptance will soon commence. Algorithms for extracted terrain volume are in early phase of development.
C20028
3D Scan Matching and Registration for Improved Mine Survey

CSIRO
Nick Hillier

Value: $295,855
Report Expected: 25/08/2012
Industry Monitor/s: Murray McKirdy
ACARP Contact: John Brett

The objectives of this project are to develop a prototype system, with some proof-of-concept components, utilising 3D mapping, long-term mapping, cooperative mapping and simultaneous localisation and mapping (SLAM) technologies to show demonstrable improvement to the mine survey process. Furthermore, the goal of this project is for the proposed method to be robust to losses in GPS coverage and for the map to be generated during the normal operations of mine vehicles.

The two facets of the work are:

- Using SLAM and 3D mapping technologies to create a vehicle mounted sensor package for mapping capable of operating in the open-cut mining environment without the use of a high-end sensor pose reference system; and
- Co-registering disparate survey data sets based on automated co-registration methodologies.

The main focus in the first quarter has been the development and manufacture of a first iteration sensor package for mounting on a test vehicle. This is undergoing final software development and initial data collection is imminent. Work evaluating existing scan alignment technologies on real mine site survey data from a variety of disparate sources (aerial lidar, aerial photogrammetry, terrestrial scanners, dragline DTM) as kindly provided by BMA Peak Downs and LC Engineering has been conducted in parallel with good initial results.

The focus of the next quarter is to evaluate the prototype sensor package’s suitability through the analysis of the collected data and to further extend the development of the scan alignment process in the face of incomplete data sets from dynamic environments.
This project is examining the growing use of multi-stakeholder collaborative approaches for monitoring and managing cumulative impacts, focusing particularly on how these are being applied to the management of water quality (Fitzroy Partnership for River Health) and dust issues in the Bowen Basin (Moranbah Cumulative Impacts Group). The project aims to identify the governance arrangements required to support collaborative approaches for managing and monitoring cumulative impacts in the Bowen Basin. It will:

- Equip the industry with considered and practical governance responses to address cumulative impacts that will enhance the industry’s social license to operate;
- Position the industry to respond to regulatory and policy changes arising from the Queensland Government’s Sustainable Resource Communities policy and the increased attention to the cumulative impacts of coal mining in the Bowen Basin.

A review meeting was held 6 June 2011 at which progress was discussed, industry monitors provided new leads and insights and deliverables for remaining meetings were agreed. The project is seen as highly relevant to the increasing pressures from regulators and communities for companies to work together and with other stakeholders to manage cumulative impacts.

One meeting of the Fitzroy Partnership for River Health was observed on 16th June. This case study of a regional approach to managing cumulative impacts on water quality is one of the key case studies for the project. This group is particularly interesting in that stakeholders represented include other industries (notably agriculture) as well as coal companies.

The project team facilitated a meeting of the Moranbah Cumulative Impacts Group in August which provided an opportunity to test and elaborate the guidelines as applied to this instance of monitoring and management of dust and to document experiences, challenges and learnings in early stages of collaborative, multi-stakeholder processes. This gives a very practical dimension to the research.

The next review meeting is scheduled during October 2011. At this meeting key points about the case studies will be detailed (and a typology of cases presented). The final monitors meeting in March 2012 will involve presentation of draft options and models for governance of cumulative impacts.
COAL PREPARATION

Environmental Improvement

C18042
Maximising Water Recovery with an Operating Paste Thickener

Outotec
GBL Process
Brandt Henriksson
Gotz Bickert

Value: $109,200
Report Expected: 25/06/2011
Industry Monitor/s: Dion Lucke
Philip Enderby
ACARP Contact: Peter Newling

A draft final report is being reviewed by Industry Monitor(s).

C20047
Improved Dewatering, Management and Rehabilitation of Problematic, Clay Rich Coal Mine Tailings

University of Queensland
David Williams
Stuart Whitton

Value: $228,000
Report Expected: 25/03/2013
Industry Monitor/s: Dave Osborne
Ian Brake
Trent Moorman
ACARP Contact: Peter Newling

The overall objective of this project is to understand the behaviour of clay-rich coal mine tailings in order to improve their dewatering, management and rehabilitation. The specific objectives of the project are:

- To identify and sample for laboratory testing a representative range of clay-rich coal mine tailings from the Ipswich, Hunter Valley, Bowen Basin and emerging Surat Basin Coalfields.
- To carry out a systematic review and assessment of current and emerging technologies and options for the management of clay-rich coal mine tailings, and the associated water.
- To carry out a systematic review and assessment of current and emerging technologies and options for the dewatering, transportation, emplacement and rehabilitation of clay-rich tailings, with the aim of achieving lease surrender.
- To geotechnically, rheologically and mineralogically characterise a range of clay-rich coal mine tailings from the Ipswich, Hunter Valley, Bowen Basin and emerging Surat Basin Coalfields, leading to the development, calibration and validation of cheap and quick index tests for identifying the key clay minerals encountered, and the development of useful procedures utilising existing tools for predicting the performance of the clay-rich materials that will report to tailings, taking into account the different chemistries of the solids, the pore water and process water.
- To carry out testing and trials to assess current and emerging technologies and options, and to test identified potential enhancements, including testing the unaided and flocculated settling and dewatering characteristics of various combinations of clay minerals to cover the range found in practice, and geotechnical testing and trials directed towards rehabilitation.
- To carry out a comprehensive cost-effectiveness analysis of the management and rehabilitation alternatives and enhancements identified.

The 24-month work program will investigate the dewatering, management and rehabilitation technologies and options identified above for addressing clay-rich coal mine tailings, involving the following tasks:

- Multi-disciplinary literature review, covering the geotechnical, rheological and mineralogical characterisation of clays, clay-rich coal mine tailings, and water quality effects.
- Visits to a range of coal mines in the Ipswich, Hunter Valley, Bowen Basin and emerging Surat Basin Coalfields, to sample for laboratory testing representative clay materials, clay-rich tailings and water used for coal processing.
- Carry out systematic reviews and assessments of current and emerging technologies and options for:
  - Management of clay-rich coal mine tailings, and the associated water
  - Rehabilitation of completed clay-rich coal mine tailings storage facilities.
- Identification of potential clay-rich coal mine tailings management and rehabilitation enhancements and combinations.
- Geotechnical, rheological and mineralogical characterisation testing of clay-rich coal mine tailings sampled from operating mines and future mining projects, and the development, calibration and validation of index tests to identify clay minerals encountered and predictive tools.
- Unaided and flocculated settling and dewatering testing and trials to assess current and emerging management technologies and options, and to test identified potential enhancements and combinations, for clay-rich coal mine tailings.
- Geotechnical testing and trials to assess current and emerging management and rehabilitation technologies and options, and to test identified potential enhancements and combinations, for clay-rich coal mine tailings.
- Comprehensive cost-effectiveness analyses of management and rehabilitation alternatives and enhancements identified, for clay-rich coal mine tailings.
- Progressive presentation, publication, and early trialling and implementation of the results of the project, engaging industry participants and the industry in general.

Since the last quarterly report, considerable progress has been made on a number of fronts, as follows:

- Samples of commercial kaolinite and montmorillonite clay have been subjected to preliminary sedimentation and rheological testing at a range of initial % solids, to serve as controls for assessing the test results for clay-rich coal mine tailings samples.
- Samples of Jeebropilly clay-rich tailings have been subjected to preliminary sedimentation and rheological testing at a range of initial % solids.
- Samples of New Acland clay-rich tailings have been subjected to preliminary sedimentation and rheological testing at a range of initial % solids.
• The sedimentation behaviour of commercial clays and clay-rich tailings samples, at a range of % solids, in water containing a range of salts, has been assessed.

• A new apparatus has been designed to allow combined sedimentation and consolidation testing of clay-rich slurries.

The manufacture of the full-scale Reflux Classifier has been completed and has been available for installation since the project commenced. A number of proposals for installing the full-scale Reflux Classifier have been considered and referred to in earlier progress reports. This is not a straightforward project because it is necessary to introduce a full-scale RC to a production plant and operate with a non-standard feed and to operate with a range of solids rates.

Discussions on this project are proceeding. A company has approved significant additional funding towards this project to cover installation and a new circuit in a Bowen Basin plant, pending the sourcing of a second-hand screen. A second hand screen has been identified and is being considered. Prospects for finally commencing this project look good.

C19036
Fine Particle Beneficiation - Inverse Flotation

University of Newcastle
John Ralston
Kevin Galvin

Value: $136,400
Industry Monitor/s: Dion Lucke
Paul Revell
ACARP Contact: Peter Newling

The objective of this study is to establish a major step change in the technology used by the coal preparation industry to beneficiate fine particles, especially particles smaller than 0.200 mm. We use the term “Inverse Flotation” to describe the new method of fine coal beneficiation. Particles in a gaseous dispersion interact from the gas side of the gas-liquid interface, either at a planar interface or at the surface of falling drops. By the end of the project we will demonstrate the proof of concept for this technology at a laboratory scale. This is the fourth progress report since the contract was signed. The study has been conducted in two complimentary parts, in parallel

Part 1 Particle Interactions with Water Drops
A novel apparatus has been constructed for this study. Fine particles are distributed via a screen under vacuum, and transported horizontally across the system. Water drops are generated at a controlled rate. We have been conducting experiments using a range of particles covering different levels of hydrophobicity, shape and size. The first experiments, which involved glass ballotini in the size range 38 to 45 microns, showed a steady increase in collection efficiency with the water flux. Finer particles tend to entrain with the air and flow around the drops, and hence show lower collection efficiency by the water drops. Rough particles appear to wet more efficiently than spherical ballotini, while plate-like particles wet more efficiently. For a given particle, hydrophilic particles appear to wet more efficiently. The reproducibility of the initial work was very high, while the reproducibility of the more recent work needs to be assessed through more experiments.

Part 2 Particle Interaction with a Planar Water Surface
The commissioning of the modified trough has been completed resulting in a number of separations. A model feed was used consisting of clean coal and silica, with an overall ash of 34%. Separation produced a 75% recovery of the coal and 50% recovery
of the silica particles, representing an overall ash of 25%. Experiments are proceeding to compare these results with those from a Denver D12 flotation machine fitted with a 4 litre cell and a froth crowder as per Australian Standard AS 4156.2.1 (2004). This machine was fitted with a regulated air supply where the flow rate was monitored. The flotation tests were conducted using a froth depth of 20 to 30 mm, and agitation of 1000 rpm. Flotation times were 0.5, 3, 10 and 20 minutes (cumulative). Initial results indicate that the recovery of fine coal particles is comparable to the performance achieved with the Denver cell in the absence of flotation agents. Reagents such as diesel and MIBC improve selectivity in the Denver cell. Screening of the products to investigate the effect of particle size on recovery in the fine coal fraction is in progress.

C20042
Improving the Treatment of Clay Minerals in Coal Flotation using Saline Water

University of Queensland
Dee Bradshaw
Yongjun Peng

Value: $196,000
Report Expected: 25/03/2013
Industry Monitor/s: Ian Brake, Joan Cowburn
ACARP Contact: Peter Newling

The objectives of the project are to:
- Identify the mechanisms governing the interaction of clay minerals with coal and bubbles with different levels of saline water;
- Develop new methodologies to reduce the viscosity and mechanical entrainment of fine clay minerals in coal flotation;
- Demonstrate the improved coal flotation recovery and product quality in the presence of clay minerals in saline water;
- Provide strategies to manage ores with different clay contents and manage the saline water resources with different salinity on sites; and
- Facilitate the transfer of research findings to industrial practice.

Preliminary studies were conducted in the laboratory to investigate the effect of bentonite (a type of clay minerals) on coal flotation using de-ionised and saline water. It was found that bentonite displayed a different behaviour in the two flotation systems. A trip to Xstrata Oaky Creek Coal during August was finalised. During this trip, pulp chemistry including pH, Eh, DO and conductivity, froth stability and viscosity will be measured from different water and ore samples. Ore and water samples will be identified and delivered to the University of Queensland. A trip to BMA Peak Downs is planned.

C20043
Enhanced Flotation and Desliming Using a Reflux Flotation Cell

University of Newcastle
Kevin Galvin

Value: $179,100
Report Expected: 25/06/2012
Industry Monitor/s: Darren Rangasamy, Dion Lucke, Paul Revell, Philip Enderby
ACARP Contact: Peter Newling

The objective of this project is to investigate the potential to achieve improved fine coal flotation performance and significant desliming using a Reflux Flotation Cell. The flotation is operated like an inverted Reflux Classifier gravity separation process. The feed slurry and gas are introduced, via a downcomer, into the vessel above a system of parallel inclined channels, with the vast majority of the flow passing down through the system of inclined channels to tailings. The inclined channels provide a powerful mechanism for segregating the gas bubbles from the flow, resulting in the gas bubbles and the attached hydrophobic coal accumulating in and rising up through the vertical section. The upper section of the device is fully enclosed by a distributor, apart from the discharge port. Fluidization water is introduced through the distributor, resulting in the fluidization of the froth and the rapid and strong flow of water down through the zone of bubbles. This approach will permit vastly higher wash water rates than is presently possible and will achieve vastly more uniform wash water flow.

This is the first progress report since the contract was signed. The laboratory scale Inverted Reflux Classifier has been constructed and commissioned. Preliminary experiments were conducted using water and model surfactant in order to verify the production of fine bubbles and the basis upon which the system would run. Experiments were conducted using a range of gas fluxes and range of water feed rates, together with a range of fluidisation rates. Surfactant was present in both the feed and the wash water in order to preserve the stability of the bubbles. The initial experiments have demonstrated that the addition of the wash water leads to additional water reporting to tailings, with relatively little change in the liquid flux reporting as foamate. This finding is important because it means the wash water will entrain hydrophilic particles to the tailings. The series of surfactants, DTAB, CTAB, and OTAB produced similar findings, and demonstrated that the liquid foamate depended on the ratio of the feed to gas flux ratio only.

The current phase of work involves the use of hydrophilic silica particles in the feed. The anionic surfactant SDS has been used in this work in order to insure the silica particles remain with the liquid bulk rather than associate with the bubble surface. This work indicates that the inclined channels will permit vastly higher wash water rates, and in turn minimize loss of recoverable product. This phase of the work is continuing.
C20052
Full Scale Gravity-Desliming Using Cascading Reflux Classifiers

University of Newcastle
Kevin Galvin

Value: $215,480
Report Expected: 25/03/2013
Industry Monitor(s): Dion Lucke, Paul Revell
ACARP Contact: Peter Newling

The objective of this project is to investigate the performance of cascading Reflux Classifiers (RC2020) in the gravity separation and desliming of fine coal at full-scale. This project is an extension of the former project C18037, the aim being to assess the scale-up. While there is existing industrial knowledge concerning the gravity separation of fine coal in a Reflux Classifier there is no previous industrial investigation of the RC2020 desliming process at full-scale or of the synergy achieved using the cascading arrangement. There is always uncertainty associated with the question of scale-up given the potential for non-uniform separation to occur in large scale devices.

A cascading sequence of two full-scale Reflux Classifiers will be used to generate a clean coal product from a feed within the size range 2.0 to 0.0 mm. The objective is to use gravity separation to produce a clean coal product down to a particle size of about 0.038 mm or higher, and to deslime the product with minimal coal loss.

A number of proposals for installing the full-scale Gravity-Desliming Reflux Classifiers have been investigated since the project commenced. This is not a straightforward project because it is necessary to introduce two full-scale RCs to a production plant. Clear expressions of interest in hosting this project have been secured, however the precise timeline has not been finalized.

Gravity Separation

C18038
Commercial lab Scale Float-Sink Testing Using Stabilised Suspension of Zirconium Dioxide

CSIRO
Shenggen Hu, Wes Membrey

Value: $196,000
Report Expected: 25/10/2011
Industry Monitor(s): Colin Surawski, Phil Howes
ACARP Contact: Peter Newling

The objective of this project is to carry out further development work to lead up to the practical application of the technique developed in C15057, via:
- Establishing testing rig for commercial lab scale float-sink analysis;
- Optimizing the operational process in terms of agent dosage, colloid milling, accelerated particle separation, recovery of diluted medium and effect of water quality;
- Carrying out commercial lab scale float-sink testing and comparing washability data with those from organic heavy liquids; and
- Establishing standard operating procedures (SOPs) for the use of stabilized suspension of zirconium dioxide in float-sink testing.

The completion of this project will be delayed for 6 weeks as CSIRO QCAT mechanical workshop did not finish the fabrication of a key part of the test rig in time. The final commercial lab scale float-sink testing is being carried out and will be finished by the end of August.

C18041
CPP Feed Washability Prediction from Small Topsize Samples

CPG Resources - QCC
Andrew Swanson

Value: $349,200
Report Expected: 25/02/2012
Industry Monitor(s): Dion Lucke, Ian Brake, Phil Howes
ACARP Contact: Peter Newling

This project is concerned with deriving CPP feed washability distributions (at topsize) based on small topsize representative samples, e.g. those derived from slimcore samples. The primary objective is to improve the validity of data obtained from slimcore pretreatment and analysis data, however the project will also deliver valuable information in respect of information generated from any small representative sample.

The project hypothesis is that coal grain associations (agglomerates of 1 mm grains to form particles of any size distribution interval predicted for a nominated CPP feed topsize) will be able to be predicted based on typical coal grain/maceral associations that are measured for a coal of a particular rank. Coals will be characterised by their coal grain analysis (CGA, at -
1mm level), and these data used as 'building blocks' for predicting the washability distribution of larger composite particles. The ultimate 'big picture' objective is to be able to predict washability based on a single CGA determination for a seam in a given area.

Two coal types are being evaluated (one from QLD and one from NSW), using comparisons between samples collected from slimcores (63 mm dia or similar) and from one LD core (150 mm dia or larger), covering the same seam/working section and each drilled as close as possible to each other.

The laboratory analysis program for the first coal type slimcore and LD sample set is completed and CGA analyses are approximately 80% complete. The CGA analyses are complete for the major work for that coal type, namely the LD core. Data assessment has commenced.

The laboratory analysis program for the second coal type slimcore sample set is complete and CGA samples have been submitted. LD core drilling is imminent.

C19038
Large DMCs are Less Efficient - Fact or Fiction?
Partition Enterprises
Chris Wood
Value: $82,939
Industry Monitor/s: Chris Andrews, Darren Rangasamy, Nerrida Trevethan
ACARP Contact: Peter Newling

This project is on hold.

C19039
Gravity Separation of Ultrafine Coal Using Centrifugal Force
University of Newcastle
Kevin Galvin
Value: $132,400
Report Expected: 25/10/2011
Industry Monitor/s: Dion Lucke, Paul Revell, Philip Enderby
ACARP Contact: Peter Newling

The objective of this study is to produce a new separator suitable for recovering ultrafine feed, less than 0.2 mm by gravity separation. Centrifugal forces will be used to produce a shift in the particle settling regimes, allowing a new separation mechanism to be exploited down to particle sizes less than 10 microns. This high capacity device will compete directly with flotation, and will offer new solutions to processing coal tailings, where conventional flotation has failed. Success in this project will lead to a clear path for developing a full-scale commercial device.

This is the fifth progress report since the contract was signed. Originally the plan was to construct a simplified centrifugal device ($40k), but we will now use a modified full-scale fine coal centrifuge in the project. The full-scale fine coal centrifuge, supplied by Ludowici Australia, arrived late November. We have been proceeding with the installation and commissioning of the system. We have had to re-direct electrical cables across the building to the unit and upgrade the power supply to the laboratory. We have also had to address other issues concerned with the power to the unit, including isolation, and variable speed control.

During the past quarter, the safety cage around the device has been constructed. A craftsman has also completed the two separators. These are due to be installed within the centrifuge. A double annulus feed system has also been completed for providing the feed and fluidisation to the rotating separators. A further shroud and feed support have been completed, and are ready for installation onto the top of the device. The shroud covers the rotating double annulus. The system has also been secured to the floor and levelled. Contractors are proceeding with the wiring and installation of the variable speed drive. We anticipate initial commissioning and production of data during the next quarter.

C19047
DMC Handbook for Process Engineers
HMC Processing
Harvey Crowden
Value: $256,800
Report Expected: 25/10/2011
Industry Monitor/s: Frank Mercuri, Ian Brake, Phil Howes, Rod Fox
ACARP Contact: Peter Newling

This project provides a manuscript for a process engineer’s practical handbook for dense medium cyclones and associated circuitry. The document will be transferred to the Australian Coal Preparation Society for subsequent publication and distribution. The handbook will be a practical guide for coal industry users for:
- Cyclone circuit design, covering feed preparation, cyclones, draining and rinsing, magnetic separators, medium control and magnetite recovery circuitry;
- Upgrade of existing circuits for capacity or process improvement; and
- Trouble-shooting on existing plants, experience on successes and faults.

The emphasis of the work is on practical aspects, for direct use by process engineers, including example calculations and the book will assist a DMC practitioner with directions to the resources available in the ACPS monographs. Leading Australian DMC experts, from various companies and institutions, have either commenced detailed sections or produced drafts for chapters covering:

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Work by Dave Wiseman is in progress to convert the various authors’ calculations to electronic format, mainly Excel, for inclusion in the final book. Dave Wiseman will also provide the section to discuss models and their use with DMC circuits.

C20045
Large Diameter DMC Performance in Low Density/High Near Gravity Environment
A & B Mylec
Andrew Meyers

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Following on from the successful project C17036, “Delineation of Large Diameter DMC Performance”, an additional work program is being undertaken to target more extreme operating conditions for this size of cyclone to deliver information which can be aligned with existing smaller cyclone performance data, as well as the range of currently available efficiency data and associated modelling tools.

This work program will investigate the performance of a very large DMC (> 1450mm cyclone diameter), treating a full size range of ~50 – 1.4wmmm, under a more extreme range of feed pressure and M:C ratio conditions, measuring performance of both coarse and fine particles, identifying critical values for performance deterioration. The important aspect of this test program is that it will target low correct medium densities (~1.35RD) hence operating in very high levels of near gravity when trying to effect a separation.

The following lists some of the key project milestones and status to date:
- Newlands CHPP has been confirmed as the test site for these works using the large inlet, 1450mm diameter DMC (Cyclone inlet ~0.25 x diameter => Effective DSM diameter ~1800mm);
- The project kick off site visit and review of sampling aspects was completed on May 26th with Andy Meyers, Glenn Sherritt and Bruce Atkinson travelling to Newlands;
- A document discussing sampling planning aspects was produced by Bruce Atkinson and this document has been reviewed by A&B Mylec with the subsequently compiled review document outlining the path forward;
- Target feed type for the sampling period will be Wollombi GM seam coal which is forecast to be washed heavily from September to November. The exact target date for the sampling program is yet to be set but will become better defined when the next mine plan/coal haulage schedules are released.

C20050
Linkage of Dynamic Changes in DMC Circuits to Plant Conditions
CSIRO
Bruce Firth
Peter Holtham

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This project has the aim of linking the dynamic behaviour of important process variables around a dense medium cyclone with important plant operating conditions.

The on-line output of the new monitoring instruments at the New Acland coal preparation plant provide a unique information base which can be linked to important plant operating conditions. With the aid of decision tables, models and smart sensor algorithms, this data can provide the necessary understanding of ‘the health of the circuit’ (symptoms), and a diagnosis of the potential underlying causes.

Planning is underway for the installation of new monitoring equipment at the selected plant. Three site visits have been conducted and the prototype of the cross correlation flow meter has been installed. Meetings have been held with site management in regards to updating the information currently being recorded and for the installation of new monitoring devices.

During the next quarter new and refurbished instruments will be installed at the plant. The motion analysers, the thru tile sensor and the product sensor are currently working and information is being logged.

C20051
Effect of Dynamic Changes in Medium Quality on Coal Processing
CSIRO
Mike O'Brien

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The objectives of this project are to:
- Determine the non-magnetics in both multi-looped and single circuit plants over time from start up and from feed mass rate changes so as to determine how widespread the effect;
- Examine the effect that this variation can have on the efficiency of operation of the DMC circuit, and
- Provide a best practice guide to estimate the time required for a loop/module to stabilise after a shutdown or feed rate change. This has particular implications when auditing a DMC circuit.
The first samples have been collected from the plant during a startup from shutdown and after a day of continuous operation. These samples are currently being analysed. Some initial work is being carried out on an instrument method that may be used to determine the non-magnetic’s in the medium samples.

**Occupational Health & Safety**

**C20044**  
Application of Nano Particles to Fine Coal Float Sink Test  

University of Queensland  
Krassen Dimitrov  
Laurie Gibson  
Michael Campbell

- **Value:** $168,500  
- **Report Expected:** 25/03/2013  
- **Industry Monitor/s:** Dion Lucke  
  Jeff Graham  
- **ACARP Contact:** Peter Newling

This project very recently commenced.

**Process Control**

**C19041**  
Sampling from High Capacity Screens  

CPG Resources - QCC  
Andrew Swanson

- **Value:** $98,900  
- **Report Expected:** 25/10/2011  
- **Industry Monitor/s:** Phil Howes  
  Philip Enderby  
- **ACARP Contact:** Peter Newling

This project is concerned with quantifying the bias that is induced by sampling from high capacity (multislope) screens, running high bed depths (~ 200mm or more), using conventional hand-held scoops. The project will also evaluate whether a new design of scoop is able to eliminate, or at least reduce, the bias.

Particles on vibrating screens, larger than the screen aperture, will segregate in the moving bed, according to particle size and density. As the bed of particles overflows the screen and forms a falling stream, the segregation remains with larger particles at the front of the falling stream, and smaller particles to the back. With deep bed operation, and consequently high depth falling streams, it is very difficult, if not impossible, to pass a conventional scoop from the front of the falling stream to the back, and back again, without overflowing the scoop. The consequence is that sample bias is inherent in this technique because either:
- The scoop overflows, with coarse particles preferentially rilling from the scoop; or
- To prevent overflow, the scoop is not passed fully through the stream and back again, such that only a part of the segregated falling stream is sampled.

Australia’s leading sampling expert, Dr Ralph Holmes (CSIRO), has been commissioned to ratify the sampling and testing program, and to assist with result interpretation.

Sampling has been completed using two different types of sample scoop. One is a standard scoop, and the other is a collapsible scoop. 20 sample sets were collected and sized to facilitate statistical analyses of the data. The results show that the standard scoop exhibited significant bias for all sizings based on cumulative percent retained on 31.5, 16 and 8 mm. The collapsible scoop method did not demonstrate any bias. A final report has been prepared and submitted to the ACARP Monitors for review.

**C19043**  
Ultra-Dynamics Non-Nuclear Density Gauge  

ACIRL  
Laurie Gibson  
Trevor Powell

- **Value:** $146,000  
- **Report Expected:** 25/09/2011  
- **Industry Monitor/s:** Frank Mercuri  
  Ian Brake  
- **ACARP Contact:** Peter Newling

The primary objective of the project is to determine the measuring efficiency of a pilot Ultra-Dynamics density gauge installed in series with a standard nuclear gauge within the ACIRL Pilot Plant. This will provide a direct comparison of the gauges accuracy, reproducibility and suitability for use in dense media and tailings circuits.

Project phases 1 and 2 have been completed and Phase 3 work is progress on schedule. A redesign of the ceramic material used in the “Probe meter” sheath material has been undertaken. Project progress and findings are summarised below.

**Phase 1 - Evaluation Gauge Probe Design**  
The ceramic sheath material used in the “Probe meter” has been redesigned. The Spool design has remained unchanged.

**Phase 2 - Pilot Plant Preparation and Gauge Installation**  
The two ultra-dynamics density gauge designs were successfully installed. Data logging of additional meter parameters have been installed, this will provide more data to be used in the evaluation of the density results.

**Phase 3 - Gauge calibration and Pilot Plant Correlation Runs**  
Data collection under various test conditions is continuing. This testwork includes:
- Assessment of the stability and robustness of this calibration;
- The influence of the probe environment and medium slurry properties and composition on this calibration; and
- Evaluation of the effect of a variety of mediums and various contaminate types and levels.
C19046
Measuring the Plant Performance of Modern Spiral Banks
University of Queensland
Peter Holtham

Value: $117,500
Report Expected: 25/01/2012
Industry Monitor/s: Alistair Harriman, Frank Mercuri, Ian Brake, Rod Fox
ACARP Contact: Peter Newling

The objective of this project is to provide the Australian coal industry with reliable supplier-independent, size-by-size data describing the performance of the latest design spiral banks under a range of operating conditions. The data will be obtained by sampling of spiral streams after addition of fine, colour-coded density tracers. The work will be carried out at Warkworth & Red Mountain.

The 36 Warkworth samples have been received and sample drying, splitting and sizing (each into four size fractions) is complete. Counting of the tracers in each of the 144 sub-samples is still continuing. The coarser sizes (-2+1 and -1+0.5) can be counted quite quickly, the finer sizes are taking longer. The most effective method with the two minus 0.5mm fractions is take multiple digital images of the samples under an optical microscope as the microscope stage is systematically moved around, and then count the tracers in each image. Difficulties with colour differentiation in the finer tracers is also slowing the counting progress. Arrangements are being made for the Red Mountain survey to be conducted in September.

C20048
Gravity Concentrator Expert Control System
CPG Resources - QCC
Bob Drummond

Value: $162,900
Industry Monitor/s: Alistair Harriman, Ian Brake, Joan Cowburn
ACARP Contact: Peter Newling

Currently there are over 25 gravity concentrators comprising both Stokes TBS design and LMPE Reflux Classifier design installed and operating in Australian CPP’s treating raw coal fines.

The gravity concentrator principle of operation, requires judicious selection of the gravity concentrator operating variables namely, fluidising water flowrate and bed density operating setpoint settings, to control the gravity concentrator operating cutpoint and hence the fine coal circuit yield and ash outcomes.

Through attrition of experienced plant operations personnel, the operation of the gravity concentrators can become sub-optimal, with operating settings selected on the basis of passed down experience to suit the gravity concentrators operability, rather than for maximising the metallurgical efficiency and yield of the system.

This project’s aim, is to develop new instrumentation that measures the pressure gradient within the sorting column of the gravity concentrator (rather than a point density or pressure at a single elevation in the sorting column). Then determine through onsite sampling at a suitable test plant whether a correlation exists between the measured pressure gradient and the gravity concentrator’s metallurgical efficiency.

If a suitable correlation does exist, then an expert control system can be developed as part of a future study, to optimise the gravity concentrator metallurgical performance by manipulating the operating variables to match an optimum pressure gradient in the sorting column.

The new instrumentation has been fabricated and bench tested and will be installed and evaluated at the test site during August 2011.

C20049
On-line Estimation of Plant Feed Washability
CSIRO
Shenggen Hu

Value: $178,975
Report Expected: 25/07/2012
Industry Monitor/s: Darren Rangasamy, Jeff Graham, Nerrida Trevethan
ACARP Contact: Peter Newling

The objective of this project is to develop a system for on-line estimation of the plant feed washability based on the method described above, via:

- Improving the determination of mass flowrates on screens and DMC yield by combining the measurements from an on-spring strain-gauge-rosette based weight sensing device and the screen motion analyser;
- Developing algorithm and software for the on-line estimation of the plant feed washability;
- Implementing the on-line washability estimation system in a coal preparation plant; and
- Carrying out plant sampling and float/sink testing of the sampled coal, and comparing the float/sink washability data with those from on-line estimation.

The algorithm and software for the on-line estimation of the plant feed washability is being developed and will be initially validated using data from previous ACARP projects. An on-spring strain-gauge-rosette based weight sensing device is also being developed and will be tested on a CSIRO vibration screen before implemented on a plant vibration screen.
General

C15060
Database Management

CPG Resources - QCC
Andrew Swanson
Bruce Atkinson

Value: $235,616
Report Expected: 25/02/2013
Industry Monitor/s: Philip Enderby
ACARP Contact: Peter Newling

This project involves the active procurement and ongoing assessment, interpretation and updating of a user-friendly database for coal preparation unit operation process performance. The project encompasses data from all unit operations including sizing and dewatering. The project also provides a service to industry personnel to assist planning of sampling and analysis programs, in order to maximise information outcomes within available constraints, and to ensure uniformity of interpretation of raw data.

The database incorporates associated data where available, including process configuration, equipment configuration, carrier medium quality (magnetite slurry, process water, where applicable), raw coal type and size distribution, process loading, sampling period, sampling location and technique.

The objectives of this project are to:

- Maintain a single user-friendly CPP equipment performance database encompassing configurations, capacities, operating parameters, size and density float/sink and partition data (as applicable). Users are able to export datasets for use in programs like MS Excel;
- Make the database available for on-line download;
- Provide data that have undergone uniform and consistent assessment and calculation procedures;
- Provide uniform and consistent sampling and analysis "umbrella" procedures;
- Actively promote participation in plant sampling opportunities as and when they arise (e.g. during proof-of-performance testing or other scheduled process audits), with a view to maximising and optimising information that may be obtained within the constraints of any given sampling campaign; and
- Procure and include performance data from new and upgraded CPP projects.

The initial project commenced in March 2006 and has been granted a funding commitment to continue until February 2013.

A dedicated website has been established to allow access to the most recent database at any time. Contact Bruce Atkinson on 02 4937 9911 or 0425 358 897 and refer: www.acarp-unitoperationsdatabase.com

C19044
Improved Automation Reclaim For Uneven Stockpiles

BMT WBM
Russ Morrison
Stuart MacCarthy

Value: $284,690
Report Expected: 25/10/2011
Industry Monitor/s: Brett Ross, Ian Brake, Rod Fox, Scott Langley, Shaun Booth
ACARP Contact: Peter Newling

The aim of this project is to develop a pre-emptive control technique for improving the output from automatically controlled slewing reclaimers, by enabling them to achieve significantly higher average reclaim rates in stockpiles of rapidly varying height and complex geometry.

Work commenced on the project on 15th March 2010. An extension to the programme to include a stockpile laser scanner was approved in December 2010. This is the sixth Quarterly report. Installation of all of the system hardware was finally completed by July 20th and the system is now in the last stages of commissioning. Stockpile scanning trials are due to commence during August.

Long delays in finalising the installation of site wiring and associated cable trays, related to un-availability of the stacker reclaim due to weather conditions at the port, and then to production pressures subsequently, have extended the original project schedule by about 7 months.

While these delays have influenced hardware development, it has been possible to progress the processing software, which is now at a reasonably advanced stage. As a result, we anticipate making relatively rapid progress now with the next phase of the project.
TECHNICAL MARKET SUPPORT

Metallurgical Coal

C17050
Advanced Characterisation of Metallurgical Coals - Coke Properties and Reactivity

University of New South Wales
Sushil Gupta
Veena Sahajwalla

Value: $650,000
Report Expected: 25/07/2012
Industry Monitor/s: Sid McGuire
ACARP Contact: Allen Lowe

A range of coke quality tests are used to assess suitability of coals to make a high quality coke. There is growing interest to understand the role of coal minerals on high temperature coke properties particularly in lower zones of a blast furnace operating under different fuel injection rates. This project aims to characterize and distinguish the effect of 2 injection rates on the modification of lower zone coke properties with emphasis on mineralogy. The project will deliver unique comparative mineralogical data and insight about lower zone coke properties and how they relate to those occurring in cokes under simulated laboratory conditions. This will strengthen international collaboration and PhD training.

Mineralogy, Reactivity and microstructure Lower zone coke samples were examined with oil injection rates of 70kg/t-HM and 110kg/t-HM. Carbon structure and mineralogy of cokes were influenced by the injection rates. The study showed that during higher injection rate, ordering of carbon structure of the raceway cokes was slightly higher resulting in marginally higher raceway temperature. The lower zone coke lumps (+19mm) were characterized by complete absence of mullite and extensive presence of gupeite, wustite and metallic iron phases as well as high amounts of Ca bearing minerals while alkali loading of the raceway cokes was lower at high injection rates. For the same rates, SiC of the physical raceway cokes was higher. Lower zone cokes indicated more porous structure with an overall lower S values during high injection rates. The percentage of +19mm coke lumps did not vary significantly with the injection rate with the exception of marginal lower values of cokes just outside the raceway during high injection rate. The percentage of coke fines increased with increased reactivity of +19mm coke lumps from the same locations indicating a better correlation for high injection rate operation.

C18043
Advanced Characterisation of Coke Microstructure for Use In Prediction of Coke Strength

ACIRL
Phil Bennett
Sushil Gupta

Value: $186,500
Industry Monitor/s: Chris Dempsey
Tim Manton
ACARP Contact: Allen Lowe

The object of the project is primarily to develop an improved methodology for obtaining quantitative measurements of coke microstructure, with a view to the future development of predictive relationships between coke microstructure and coke performance as indicated for example by coke strength. This work is being conducted in Australia and UK which will allow different imaging techniques to be evaluated.

Samples of 4 coals and the cokes produced from these coals in ALS Coal’s Pilot Coke Oven were circulated to project participants. All image analysis of the cokes has been completed by Jenkins-Kwan Technology and Nottingham University.

A final report on the imaging and SEM work conducted by Nottingham University has been completed. A paper on this work will be presented at an international coal science conference later this year.

Jenkins-Kwan Technology has completed a report on the imaging techniques used to classify the fused and non-fused structures of the coke. Initial statistical analysis of the imaging results generated by Jenkins-Kwan Technology has shown that, while there is significant variation over the 20 lumps of each of the 4 cokes for most parameters measured, some interesting relationships have been identified. For example, the amount of inert derived material identified by imaging influences the abrasion characteristics of the coke. All data processing has been completed and a draft report of this section of work circulated to participants and monitors of the project.

Image fusion of SEM and optical images of the coals and product cokes has been completed by ALS Mineralogy and Jenkins-Kwan Technology. The final data analysis and reporting have been completed.

A draft report on the project summarising the findings of the participants will be completed in August. The detailed reports by the participants on their activities will be included into the final report as appendices.
C19049
PCI Combustion Test
University of Newcastle
Terry Wall

Value: $153,200
Report Expected: 25/01/2012
Industry Monitor/s: Morgan Blake, Sean Flanagan, Tim Manton
ACARP Contact: Allen Lowe

The aim of this project is to assess the suitability of drop tube furnaces as a tool for assessing coal combustibility for use in pulverised coal injection into blast furnaces. Drop tube furnaces are far less expensive than pilot scale PCI rigs, reliable and available at many laboratories. The coal’s burnout produced in a drop tube furnace, operated at “standard” operating conditions (very high O/C), is being compared with the burnout produced by the same coal in the BlueScope Steel test program, completed on the BHP-Billiton PCI rig situated at BHP-Billiton’s Newcastle laboratory, and will be extended to char morphology. An assessment of the data of utilisation and performance of PCI test rigs available in the open literature is also being completed.

Drop tube furnace conditions will rank coals based on coal combustibility, or “burnout”, with a quantitative ranking comparison with combustibility from PCI pilot-scale rigs. The results will provide an operating band for PCI coals for combustion with respect to coal volatile matter. This will allow the identification of outliers which are either highly suited or unsuited for PCI when further coals are compared to the operating band. It will also allow future potential coals to be compared to other coals known to perform well in PCI.

The detailed review of the open literature on PCI test rigs and their experimental studies has been completed. Significant differences exist between the 4 types of experimental rigs used to study coals for PCI applications, resulting in differences in the experimental results. Both the constant diameter rigs and the Aachen rigs operated with air based combustion gases produced results with very low burnout when low volatile coals are considered. Distinction was made between the drop tube tests where the coal is fed in a disperse stream or at heavier rates. The summary of the results of this study have been presented to ACARP. The final document will be provided to ACARP this coming quarter.

The drop tube furnace has been found to be an appropriate technique to determine a coal’s suitability for use in PCI based on its burnout performance by comparing the char morphology and behaviour during combustion. Both rigs produce similar chars in both size and form, with some differences in the proportion of the type of char produced. Figure 1 shows that though the coals have been combusted in two very different rigs, the DTF produces results that form the basis for an operating curve for coals used in PCI. Drop tube experiments on two coals are still to be completed.

As we compare the chars from the DTF with the chars from the PCI rig, the experiments need to be completed on the same coal used to produce the PCI chars. Unfortunately, these coals have aged and cannot be used. Replacement coals which match as closely as possible to the original coals has been sourced, crushed and systematically split ready for experimentation. Drop tube experiments on these samples will be completed this quarter.

Char surface areas appear to be dependent on the type of rig used to produce them, with the PCI rig producing chars with higher surface areas than drop tube chars for all but one sample, as shown in Figure 2. This is a surprising result and further analysis of the chars will be required to better understand the mechanism associated with the char’s formation.

Figure 1: comparison of coal burnout of coals combusted in a PCI rig and a drop tube furnace at 21% oxygen

Figure 2: surface areas of PCI and DTF chars

C19050
Development of a Synthetic Sulphur Calibrant and Associated Test Method
HRL Technology
Nicolas Miller

Value: $59,800
Report Expected: 25/08/2011
Industry Monitor/s: Barry Isherwood
ACARP Contact: Allen Lowe

A draft final report is being reviewed by Industry Monitor(s).

C19051
Characterisation of Australian and Indian Coals and their Cokes from Stamp and Top Charged Coke Ovens
University of New South Wales
Graham O’Brien, Sushil Gupta

Value: $221,500
Industry Monitor/s: Sean Flanagan, Tim Manton
ACARP Contact: Allen Lowe
Due to declining availability of high quality coking coal reserves, there has been growing interest in finding ways to prepare high quality coke using low premium coking coals. With the advances of stamp-charging practice in heat recovery as well as by-product coke ovens, it has been possible to utilise a greater percentage of weak coking coals. There is limited understanding of association of parent coal properties with cokes made under stamp charged coking conditions. This research has the potential for new opportunities for low premium metallurgical coal use in India. The project aims to identify the critical coal attributes that influence coke quality under two process conditions as well as understanding potential implications of the variation of coal composition with grain size on coke properties.

All six Australian coals except one have reached at GNRE heat recovery coke plant in India. Coal preparation is underway for making stamp charged cokes. Tata has organised three Indian coals at one of their mine locations and planning is under way for transportation to GNRE facility in India. Five gravity charged pilot cokes have been already made. Grain analysis of five Australian coal samples of ALS pilot coke oven are divided into four size groups (-0.5 mm; 0.5 mm -1 mm; 1.0 mm-2.0 mm and >2mm). Coal grain and mineral analysis of the size separated coal samples and gravity charge pilot cokes are underway.

C19052

Mineral Matter Effects on Coke Degradation in Blast Furnace Samples

CSIRO
David French

Value: $176,800
Industry Monitor/s : Ashley Conroy
Phil Sullivan
ACARP Contact: Allen Lowe

The factors affecting coke degradation in the lower part of the blast furnace are poorly understood. The aims of this project are to provide a quantitative understanding of the mineralogy and mineral matter reactions that occur in the lower part of the blast furnace and determine if the different forms of mineral matter formed as a consequence of these reactions cause major variation in coke reactivity and strength.

Commissioning of the high temperature furnace for preparation of annealed samples for Phases 2 and 3 of the study has been completed and samples have been prepared A micro-tumbler has been acquired and samples prepared for testing. Detailed coke petrographic analysis has been completed of the furnace cokes.

C19053

Measurement of the Plastic Properties of Coal: Characterisation of Uncertainties in the Sapozhnikov Test

ACIRL
Lauren Johnson
Phil Bennett

Value: $169,450
Report Expected: 25/12/2011
Industry Monitor/s : Chris Dempsey
ACARP Contact: Allen Lowe

The primary objectives of this project are to:

- Gain better understanding of the Sapozhnikov test and factors that influence the determination of plastic properties;
- Derive a relationship to predict feed coal bulk density using target size distribution, reflectance and petrographic composition;
- Gain an understanding of how size distribution and bulk density impacts on the plastic properties of a coal measured by the Sapozhnikov test for coals of different rank; and
- Comment on how coal properties influence the packing of coal, how packing of coal influences measured plastic properties and the use of coal plastic properties in the evaluation of coking coals.

All coal testing for stage one of this project has been completed with a draft report submitted to the project monitors in early August.

An extension to this project that is aimed at characterising uncertainties of the Sapozhnikov test has been approved and testing will commence once the automated Plastometer is relocated to ALS Coal’s new facility at Richlands.

C20008

Understanding Coal Grain Effects on Coke Quality

University of Newcastle
Graham O’Brien
Merrick Mahoney

Value: $187,093
Report Expected: 25/10/2012
Industry Monitor/s : Dave Osborne
Steve Brant
ACARP Contact: Allen Lowe

The timing of the project is determined by the availability of the pilot coke oven being rebuilt by BHPBilliton at CSIRO in Brisbane. The latest information I have from BHPBilliton is that we will be able to use the oven for the project in January 2012 which means we would start collecting the coal samples required in about October 2011. There are also some sub-contracts between CSIRO (the new operators of the pilot coke oven) and the industry partners paying for the coking that still need to be signed. I expect them to be signed soon.
C20009
Theoretically Based Coke Strength Index or Indices
Based on Drum Tests

ACIRL
Frank Shi
Phil Bennett

Value: $158,000
Report Expected: 25/03/2012
Industry Monitor/s: Chris Dempsey
Olive Scches
Sean Flanagan
ACARP Contact: Allen Lowe

Very recently commenced.

C20010
Classification of Coke Textures

ACIRL
Lauren Johnson
Phil Bennett

Value: $45,200
Report Expected: 25/03/2012
Industry Monitor/s: Chris Dempsey
Oliver Scoles
Sean Flanagan
ACARP Contact: Allen Lowe

It is known that the microscopic coke composition is directly related to coke quality parameters; however differences in classification are a limiting factor in the use of coke micro-textures in the international community. Despite this, increasingly coke microscopy is being called upon to elucidate subtleties in coke quality assessments.

The objectives of the project are:

- To review the systems and methods used by petrographers to classify coke microtextures, especially in Australia;
- To survey the history and current status of coke microscopy as a means of understanding the interaction of coal components in the formation of metallurgical coke;
- To decide on the most appropriate robust methodology and classification for conducting coke microtextures;
- To compile a reference document (including images) that will assist petrographers to undertake classification of the Microtexture of coke; and
- To conduct a round robin of Australian petrographers to test the proposed classification system.

A literature survey to review the historical published classification methods has been conducted. Contact with coal petrographers within Australia was made requesting participation in the round robin. Work has commenced on documenting the methodology, which will be circulated to the project monitors for approval, and then the cokes for the round robin can be selected. There are two options for the cokes to be selected a blend of several coals of different ranks or 2 coals of different ranks an inert contents. These samples will then be dispatched to Australian petrographers that have indicated that they will participate.

C20011
Relationship Between Roga Test Results and Caking Index Results

ACIRL
Lauren Johnson

Value: $41,030
Report Expected: 25/04/2012
Industry Monitor/s: Barry Isherwood
Morgan Blake
ACARP Contact: Allen Lowe

The aim of the project is to explore critical factors of the Roga and Caking Index, investigate the appropriateness of the precision parameters outlined in the two standard methods, confirm that a relationship between Roga and Caking Index exists for a range of Australian coking coals and demonstrate that this relationship can be used to convert Roga and Caking Index results.

The primary objectives of this project are to:

- Explore critical factors of the two tests on a wide range of Australian coals through published works and experimental data;
- Investigate the appropriateness of current measurement uncertainty (repeatability) parameters;
- Investigate the appropriateness of reproducibility parameters for the Roga test through a round robin of ALS Coal, SGS and Bureau Veritas;
- Confirm that there is a correlation between Roga and Caking Index for a wide range of Australian coking coals;
- Develop a relationship that can be used to convert Roga and Caking Index results.

It is hoped that this project will increase the uptake of the Caking Index within the coal industry and increase the understanding of the role that the critical test parameters have on the results as well as, the effect that coal petrology and rheology have on caking power.

Stage 1: Influence of Critical Test Parameters (10 coals)
Gieseler Plastometer, Proximate Analysis and Petrographic Analysis testing of the ten coals is complete. Testing Series 1-4 and Series 6 & 7 are complete (Figure 1), however Series 5 has not begun due to difficulties in sourcing -0.4mm +0.3mm Gray King Inert Additive. The Inert Additive is expected to arrive this week and testing will commence once the material has been received. A standard Caking Index will be performed on the same coal sample used for Series 5 and compared with original Caking Index results to identify any sample deterioration that may have occurred.

Figure 1: Proposed test program to determine the effect of critical test parameters on the results of the Roga and Caking Index.
Stage 2: Examination of Measurement Uncertainty and Repeatability Round Robin (2 coals)
The 2 coal samples have been sent to the four laboratories (ALS Coal Ipswich, ALS Coal Maitland, SGS Newcastle & Bureau Veritas Newcastle) to undertake Roga and Caking Index tests, as well as a Proximate Analysis for quality check. All results have been received from each laboratory and the Proximate Analysis has confirmed that each subsample was representative. The 2 coal samples were also sent to a Chinese Laboratory for testing, however, these results have not been received.

Stage 3: Examination of the Relationship between Roga and Caking Index (20 coals)
Results from the 10 coals tested in Stage 1 will be used in Stage 3 with an additional 10 coals. Testing on these additional 10 coals is complete.

Stage 4: Reporting
All relevant literature has been reviewed and will be discussed within the report. The published correlations for the Roga and Caking Index that have already been examined will be considered and examined throughout the interpretation of results from Stages 1-3 of this project. As the majority of testing for this project has only recently been completed, data analysis and interpretation is only in its early stages.

C20040
Understanding Exploration Samples by Coal Grain Analysis
CSIRO
Bruce Firth
Graham O'Brien

Value: $115,720
Report Expected: 25/03/2012
Industry Monitor/s: Dave Osborne, Tim Manton
ACARP Contact: Allen Lowe

The project objective is to develop and validate a method for estimating chemical information on individual coal grains for Australian coals of different ranks and demonstrate that for exploration samples grain data can provide chemical and petrographic information and yield estimates of product coal at different ash values.

Approximately eight Australian coals of different ranks will be used to develop and validate correlations between maceral chemistries and coal rank. For each coal, washability testing will be used to produce fractions with different chemical and petrographic compositions. Proximate, ultimate analyses and CSN will be determined on each density fraction and Coal Grain Analysis will be used to determine reflectance fingerprints and composition information on each fraction.

A data analysis method will be used to determine the maceral and mineral densities that correlate with the washability information for the coal. This approach will then be used to determine the chemical attributes (i.e. volatile matter, CHONS, CSN) values for each of the maceral groups that correlate with the chemical attributes for each of the density fractions.

The experimental method has been used to determine maceral density information by conducting CGA analysis on samples obtained from the washability testing of 4 size fractions from a LD core. The testwork showed very good repeatability for the determination of maceral density (Table 1).

<table>
<thead>
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<th>Maceral</th>
<th>Average density (g/cm³)</th>
<th>2*1mm</th>
<th>8*2mm</th>
<th>31.5*8mm</th>
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Next quarter: Maceral chemistry information will be determined and validated for this coal sample. The process will then be repeated for two additional coals of different rank. These results will then be discussed with the project monitors at a review meeting.

Thermal Coal

C18044
Submicron Ash Emissions and Trace Elements from Boiler Simulation Furnace

ACIRL
Don Holcombe

Value: $100,930
Report Expected: 25/10/2011
Industry Monitor/s: Ashley Conroy
ACARP Contact: Allen Lowe

The quantity of each fine size fraction of particulates passing through the electrostatic precipitator (ESP) to the stack will be determined, together with the associated concentration of selected trace elements. Not only is fine ash more likely to escape through a power station stack than coarse ash, but it penetrates deeper into the lungs when breathed, and it carries greater concentrations of some trace elements of environmental concern than coarse ash.

The aim will be to provide health and environmental data for one or two coals, and to prove the measurement procedures so that different coals can be evaluated in future.

In order to obtain valid results when the combustion tests are carried out, it was necessary to firstly become proficient in the exacting methodology of using a cascade Impactor (CI), which separates the sampled ash into its size fractions. Extensive sampling trials have been undertaken, including dedicated runs on one of the intended test coals.

Tests have been carried out with different impactor plate coverings (substrates) where the dust is deposited. Comparison of substrates of glass-fibre paper as well as of aluminium foil covered in grease suggests that the latter substrate appears to collect more dust, and it generates deeper concentrations of some trace elements of environmental concern than coarse ash.

Sampling of fly ash from the ESP outlet while burning a high ash coal gave ash loadings that were inconsistent and sometimes well below the expected amount. The probable cause was the sampled flue gas bypassing the jets and impaction plates within the body of the CI. This has been remedied by fitting rubber gaskets. It now remains to establish the methodology of preparation of the collected ash samples and trace element analysis.
C18045
Combustion Facility Upgraded to Simulate Modern Power Station

ACIRL
Anthony Williams

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A draft final report is being reviewed by Industry Monitor(s).

C19009
The Mercury Treaty - Implications and Responses

Macquarie University
Peter Nelson

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In early 2009 the UN Environment Programme’s (UNEP) Governing Council agreed in a landmark decision, taken by over 140 countries, to develop an international mercury treaty (or other legally binding instrument). This decision potentially has major implications for the coal and mineral processing industries. Coal combustion is the major man-made source of mercury emission. A mercury treaty will intensify pressures to eliminate emissions from coal-fired power stations, and other industrial sources. The objectives of the project are twofold:

- To produce regular briefing documents to ACARP on the development of the global treaty; and
- To facilitate Australian expert involvement in the Global Mercury Partnership for mercury from coal combustion.

The major outcomes and benefits of this project will be:

- Early indications of the likely consequences and impacts on the Australian coal industry of an international mercury treaty;
- The ability of the industry to formulate informed contributions to policy and regulatory developments nationally and internationally;
- Confidence in assessing the market impact of possible legislative, voluntary or economic responses to the mercury treaty; and
- Support for expert Australian input into the development of voluntary actions during the treaty development.

Peter Nelson has provided comment on a World Coal Institute draft publication entitled “Coal Combustion and Mercury” to industry monitor Barry Isherwood. He has also discussed progress on this project with Allen Lowe. Work continues on assessing international developments in the formulation of a legally-binding instrument to manage mercury in the environment. The first briefing note on this project was drafted and forwarded to Barry Isherwood and Allen Lowe for comment in December. Peter Nelson attended the IEA Coal Mercury Workshop in Sth Africa in May 2011, and the 10th International Conference on Mercury as a Global Pollutant in Halifax in July, and a further briefing note is in preparation.
MINE SITE GREENHOUSE MITIGATION

C16048
Removal of Methane from Mine Ventilation Air by Biofiltration

University of New South Wales
Jason Scott

Value: $140,754
Report Expected: 25/01/2012
Industry Monitor/s: John Rich
ACARP Contact: Roger Wischusen

Underground mining is currently the most dominant source of methane emissions from coal mines with 70% of all coal mine methane emitted via underground mine ventilation air (MVA). MVA comprises high flows of air containing low but variable methane concentrations (typically <1%) and is difficult to capture or treat by conventional technologies. This project seeks to use methanotrophic bacteria, sourced from coal mines, on a coal support as a means of reducing the greenhouse gas impact of MVA by converting the methane to carbon dioxide. Converting methane into carbon dioxide reduces the equivalent greenhouse gas emissions by 87%. Over the period May, 2011 – August, 2011:

- Two bioreactors have been running in parallel: Reactor 1 - inoculated with *Methylosinus sporium*; and Reactor 2 - not inoculated. The reactors contain coal samples from Appin colliery as the support and are dosed every three days with Nitrate Mineral Salts (NMS) media. Both reactors are supplied with 1% CH4 (v/v) in air and the effect of gas flow rate (200, 400, 800 and 1600 ml/min) is being studied.
- At a flow rate of 200 ml/min Reactor 1 achieved 28.8% ± 2.5% methane removal efficiency, while Reactor 2 reached 14.8% ± 2.3% methane removal efficiency. Increasing the flow rate to 400 ml/min provided minimal variation in methane removal efficiency for either reactor (Reactor 1 = 24.7% ± 4.1%, Reactor 2 = 16.0% ± 5.5%). At an 800 ml/min flow rate methane removal decreased to 17.6% ± 4.0% and 11.2% ± 4.2% for Reactors 1 and 2, respectively. A flow rate of 1600 ml/min is currently under investigation. The higher methane conversion in Reactor 1 likely derives from its inoculation with *M. sporium*.
- Batch experiments to assess packing material effect on *M. sporium* performance are being undertaken. Polyethylene beads, glass beads, and coal are being compared.

C18047
Horizontal Post Drainage Design

CSIRO
Hua Guo

Value: $360,331
Report Expected: 25/04/2012
Industry Monitor/s: Jim Sandford, Paul O’Grady
ACARP Contact: Roger Wischusen

This project aims to develop a methodology and practical procedures for industry to design optimal horizontal post mine gas drainage. This new drainage method has the potential to capture substantially large and consistent volumes of gas and significantly reduce the concentration of gas in the mine ventilation air which serves to improve mine safety and productivity, increase mine methane utilisation, and reduce greenhouse gas emissions. This new method will provide an alternative approach to longwall goaf gas extraction which requires substantially less surface disturbance than the conventional surface goaf drainage method using vertical boreholes. Numerical modelling of the goaf gas flow for the horizontal post drainage continued. Discussions continued with Blakefield South to design and plan detailed site monitoring programs for the horizontal drainage post drainage operation.

C19054
Ventilation Air Methane Capture Study - Carbon Fibre Composite

CSIRO
Paul Webley, Shi Su

Value: $262,666
Report Expected: 25/11/2012
Industry Monitor/s: Colin Gilligan, Jim Sandford, John Rich, Trevor Stay
ACARP Contact: Roger Wischusen

This project is to advance a new ventilation air methane capture technology based on carbon fibre composite adsorbents toward commercial uptake through large scale unit tests and demonstration, and preliminary economic analysis. Since last quarterly report, a new adsorption column was designed to enhance heat transfer, accommodating the rectangular shaped composite adsorbent materials. It is now under manufacturing process. The new set of moulding equipment with two moulding cells has been successfully commissioned and then used to mould half number of composite adsorbent blocks required for the column. The adsorbent fabrication parameters have been optimised and the adsorbent fabrication will be completed in 2 months. The following photo is of an activated composite adsorbent recently made in rectangular shape. Moreover, a new test unit will be constructed as the current unit is used for a site trial project of CO2 capture.

C19055
Ceramic Block Vent Air Methane Mitigator

CSIRO
Shi Su

Value: $342,696
Report Expected: 25/09/2012
Industry Monitor/s: John Rich, Troy McDonald
ACARP Contact: Roger Wischusen

The overall goal of this project is to develop a novel self-sustaining mine ventilation air methane mitigator in a scalable format, and demonstrate it at an Australian mine as a step towards commercial uptake. For current project phase we will design, construct and
commission the newly-structured prototype VAM mitigator intended to handle ~0.5m³/s mine ventilation air (MVA).

Since the last quarterly report, the project team continued to work on the fabrication of main parts and components for the construction of mitigator unit. Now the manufacturing of parts and components is under control now. The ceramic blocks have been fabricated, and are being shipped to Australia. The metal parts and components are being made as we have signed a contract with a manufacturer in middle July 2011. It is expected that the metal parts and components will arrive in Brisbane in late November. Insulation materials have been ordered as well. Ceramic refractory line for the start-up burner is being made at our workshop using a method we developed about 5 years ago. So it is expected that we will start the unit assembly at QCAT in early December.

C19057
Linear Gas Flow Measurement System for Gas Drainage Boreholes

CRCMining
Bart Pienaar
Paul Lever

Value: $181,026
Industry Monitor/s: Jim Sandford
John Rich
Peter Brisbane

ACARP Contact: Roger Wischusen

The objective of this project is to build on and extend the application and experience of the production of a prototype linear gas flow measurement and management system for gas drainage/production boreholes. This system will be suitable for application in all in-seam drilling applications in Australia (underground and surface to underground deployment). The enhanced system shall incorporate flow models for improved visualization and determination of flow at any point within a borehole.

Gas flow situation tests continue to be conducted at CRC Mining’s Gas Flow Monitoring Test Rig (GFMTR) in Pinjarra Hills. Data analysis is being conducted to help develop the flow models. Fluent models of gas flow are being developed.

Development is underway of a product that provides a simple graphical display of the thermal dynamics inside the borehole. This product would provide a solution that can be integrated into the current program and form the basis of the final product.

A field trial management and safety plan has been written for the proposed field trial at Oakey Creek. Site access has not been finalized since the previous quarterly report. Other sites are being considered.

Fugitive Emissions

C18049
Study of Q3 or Residual Gas Volumes over Time and as a Proportion of the Total Gas Volume

Earth Data
Jess Maddren

Value: $50,000
Industry Monitor/s: Andy Willson
Cecilie Naess
Doug Dunn
Jim Sandford
Paul O’Grady

ACARP Contact: Roger Wischusen

A draft final report is being reviewed by Industry Monitor(s).

C18050
Industry Laboratory Guide for Measurement of Gas Content of Coal (Low Gas Content)

CSIRO
Abouna Saghafi

Value: $105,000
Industry Monitor/s: Andy Willson
Cecilie Naess
Doug Dunn
Jim Sandford
Paul O’Grady

ACARP Contact: Roger Wischusen

In the newly developed Tier 3 method for estimating open cut fugitive emissions (ACARP c15076) the main parameters are the gas content and gas composition of coal and carbonaceous layers in overburden and underburden strata. Correct quantification of the emissions, therefore, relies on accurate determination of seam gas content and its composition.

This project aims to develop a new methodology for gas content testing to address the difficulties associated with measurement of gas content of geological units encountered in open cut and shallow coal mining. It seeks alternatives to the current method of gas content determination which is limited by the level of delectability, uncertainty on the volume of unreleased gas and the accuracy of measurement. As part of the project a new system (method and equipment) will be developed.

CSIRO is assisted in the project by two commercial industry laboratories, namely GeoGAS and Earth Data. While the CSIRO contribute to the project by developing the methodology and provide the design and guidance on the set up of the new method and system, the industry laboratories contribute to the project by building the prototypes for the new gas content measurement system and testing of the new system.

The new methodology will be trialled by measuring the gas content and composition of a number of coal cores from exploration
drillings. Inter-lab comparison will be done to quantify possible variability in the results across the industry labs.

The outcome of the project should benefit the coal industry by providing improved quantification of gas emissions from coal mining.

Progress during last quarter
Project is now completed and the final draft report is being written and would be submitted to the ACARP and project monitors.

An important outcome of the project is the lowering of the detectable limit of gas content, which using the standard method of gas content testing, is about 0.3 to 0.5 m³/t. The new system was used to measure gas content of aged coal samples from two boreholes drilled in Hunter Coalfield. The results demonstrated that the new system is able to measure the gas content of very gas depleted coals. Using the new system gas contents of 0.03 m³/t can be measured with high level of confidence. A method of estimation of uncertainty of gas content determination is also developed.

C19003
Nitrogen in Coal and Its Implications on Gas Content Testing
CSIRO
Abouna Saghafi

Value: $153,317
Report Expected: 25/12/2011
Industry Monitor/s: Andy Willson, Cecilie Naess, Doug Dunn, Jim Sandford, Paul O’Grady
ACARP Contact: Roger Wischusen

The process of coalification generates thermogenic gas consisting predominantly of methane (CH₄), carbon dioxide (CO₂), potentially some higher hydrocarbons and nitrogen (N₂). Previous studies have shown that thermogenic N₂ production mainly occurs at bituminous to anthracite ranks and the volume generated is minimal, normally less than ~5% and rarely up to 10%. Gas analyses currently reported by commercial laboratories however commonly include major volumes of nitrogen. Air contamination and oxidation of coal in presence of air oxygen can explain. However, recent practice of flushing the canister containing the sample with inert gases, such as argon or helium, has not eliminated this ‘anomaly’ of measured gas composition. It is suggested that the ‘excess’ nitrogen could be of biogenic origin due to microbial activities in coal.

In order to determine the origins of N₂ in coal seam gas (CSG), the proposed study aims to verify, quantify and characterise biogenic N₂ in shallow coal seams. In addition, the potential to develop a method to directly determine the origins of N₂ in CSG will be considered.

CSIRO is currently investigating the extent of biogenic CH₄ generation from methanogenic microbial activities and recent studies have demonstrated that denitrifying bacteria are abundant in a variety of Australian coals. These bacteria live in syntrophic relationships with other coal-degrading micro-organisms, but little is currently known about the rates of N₂ production from these communities.

The work program consists of obtaining fresh core coal samples and accompanying meteoric water from exploration boreholes in Hunter Coalfield. Samples will be sealed in purpose-built canisters where the molecular and isotopic composition of gas desorbed from coal will be monitored over a few weeks. Samples, together with collected seam formation water, are then transferred to a purpose built medium which mimic the in-situ conditions of coal. The growth and gas production from denitrifying bacteria will be studied and quantified. Isotope composition analyses of the produced biogenic N₂ and CH₄ will be undertaken with a view to evaluate the potential to develop a method for quantification of different forms of N₂ in coal seam gas. Samples will be taken from 10 coal seams in 2 locations in Hunter Coalfield.

In the course of the last quarter we continued to measure molecular and isotope compositions of CH₄, N₂ and other gases generated from bacterial activities. The measurements are undertaken on treated and control samples. Treated samples contain a mixture of crushed coal, formation water and nutrient. In control samples, coal, formation water and methanol (control) are present. Gas composition and the N₁⁵/N₁⁴ isotope ratio from gas collected from the headspace of the vials are being tested to verify the hypothesis of biogenic production of N₂ from coal.

C19004
Procedure for the Routine Estimation of Gas in Place for Open Cut Mines
CSIRO
Luke Connell

Value: $100,000
Report Expected: 25/08/2011
Industry Monitor/s: Andy Willson, Cecilie Naess, Doug Dunn, Jim Sandford, Paul O’Grady
ACARP Contact: Roger Wischusen

A draft final report is being reviewed by Industry Monitor(s).

C20004
Estimation of the Residual Gas Content in Mined Coal and Coal Waste
CSIRO
Luke Connell

Value: $200,000
Report Expected: 25/02/2012
Industry Monitor/s: Andy Willson, Cecilie Naess, Doug Dunn, Jim Sandford, Paul O’Grady
ACARP Contact: Roger Wischusen

This project will investigate the behaviour of residual gas in mined coal and waste components after mining. The objective of the
project is to estimate the residual gas content in product and waste coal at the point of disposal as this may represent an important factor in the calculation of a mine’s fugitive gas emissions.

Preliminary analyses were performed using numerical simulation with the COMSOL modelling package which considered the gas diffusion limited stage after the pore pressure has equilibrated with atmospheric pressure. The physical arrangement of the product coal is also an important aspect of this problem as it determines the diffusion lengths that gas must travel and thus the rates of gas emission. For these preliminary analyses a relatively small rectangular volume of product coal (of 15m$^3$) was considered with only the upper surface exposed to atmosphere.

The final project report is being prepared.