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 & Construction Technology



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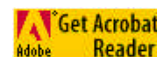
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# CSIRO Harnesses Renewable Energy

Sun, wind and natural gas will generate the energy supply, and the way it is done will be on display, at a landmark CSIRO research facility planned for Newcastle, NSW.

The three renewable energy sources will provide electricity for the new CSIRO Energy Centre at the Steel River Eco-Industrial Park adjacent to the old BHP steelworks in Mayfield. The Centre on a 5 ha site in the 104 ha Park will be the new headquarters of CSIRO Energy Technology, housing laboratories, administration offices and industrial-scale technical testing bays.

CSIRO will use the research Centre to showcase advancements in renewable energy technology and their management.

According to Trevor Moody, Assistant General Manager of CSIRO Corporate Property, the renewable energy sources will provide approximately 500 kW of electricity, the total capacity needed to operate the buildings.

This will be generated from:

- four small fuel cells of around 25 kW each, fired by natural gas and water conversion to hydrogen;
- three small 20 kW wind turbines;
- one 100 kW medium wind turbine;
- a number of building-integrated photovoltaic cell arrays with total output of around 90 kW; and
- two natural gas-fired microturbines with an output of 75 kW each.

During periods of low loads, it is anticipated that excess generation will be fed to the electricity grid, which will provide extra supplies to the Centre during any periods of reduced local generation. The process will be managed by a supervisory control and data acquisition (SCADA) facility which will distribute electricity throughout the system and report on energy quality and quantity.

CSIRO's advanced battery technology energy storage system, with 500 kW of power capacity, will be used to provide load levelling and uninterruptible power supply.



CSIRO is actively seeking industry partnerships to enable ecologically sustainable and alternative generation initiatives to be included in the early stages of the project.

In the energy conservation measures incorporated in the building, high temperature waste heat from energy generation will be collected and used for domestic hot water and winter heating of the office building and laboratories.

Other energy conservation initiatives include the orientation, layout and appointment of buildings to maximise the use of solar energy and daylight; the use of automatic lighting control systems; incorporation of water-saving devices on hydraulic fittings and fixtures; and the use of an energy-efficient underfloor air-conditioning system for the office building.

While passive energy conservation measures will be incorporated into the building and landscape design, active measures will come from the design of

mechanical, electrical and hydraulic services.

Energy initiatives in the Centre are expected to reduce annual greenhouse gas emissions by almost 1200 tonnes. Energy conservation measures will reduce energy consumption to 64% of an equivalent modern commercial building.

Moody says, "We have had six months of discussions with manufactures of renewable energy and energy conservation technology and hope to involve them in contributing to these resources in the building".

CSIRO estimates the cost of the complex at \$28m, without the new energy technology, which is partially funded from a \$10m direct grant from the NSW Government. Master planning for the 5 ha site has had to meet the CSIRO's long-term requirements.

Stage 1, which is due to start construction in mid-2001 and be completed by the end of 2002, is for a 9,500 m<sup>2</sup> complex with laboratory/office buildings on the height of the sloping site and the pilot process testing bays on the flat area, linked by a central spine.

The main buildings comprise a combination of laboratories and administration support offices, library, auditorium, cafeteria and recreation amenities, and a foyer display area where the energy innovations in the building and how they operate will be demonstrated on computer displays.

Project architect, Andrew Broffman of Cox Richardson, says that the building plan is organised around a central circulation spine. The north end of the spine houses principal plant, renewable energy plant and equipment including photovoltaics and wind turbines, and other energy research elements such as fuel cells and battery systems. The south end of the spine houses additional plant, lift, stairs and corridors.

The other building elements are arranged at each end of the circulation spine in locations which respond to their particular needs and site constraints. The laboratories and offices are each housed to the east of the spine in a separate wing on the southern hillside. The process bays and associated facilities are housed on the western side of the spine on the flat part of the site to the north.

A vehicular drop-off is located adjacent to the main entry off the main access road. The reception area is housed adjacent to the drop-off, with the auditorium located adjacent to the reception and display areas.

The management/administrative and laboratory office areas are housed in a three-storey building, and the laboratory facilities in a two-storey building. The staff cafeteria and library are centrally located between the office and laboratory wings with easy access from each.

Two bridges link the office and laboratory wings, giving direct on-grade access and circulation between the labs and the offices. These buildings are of a simple concrete construction with concrete masonry bases, glass infill and barrel vaulted roofs.

The process bays, technical bays, and site store and workshop in the lower part of the site, are similarly simple industrial buildings echoing the elements of the offices and labs. They have ramped access to the main reception lobby area.

In accordance with the design brief from CSIRO, Cox Richardson has integrated the various renewable energy-producing elements into the architecture and landscape.

Broffman says, photovoltaic cells will be integrated into the roof and facade fabric and have various orientations and tilt angles to suit building design and optimise performance.

The fuel cell and microturbines are in the central northern plant area with provision for future additional units of similar or more advanced technologies. Small wind turbines run adjacent to the circulation spine and the medium wind turbine will be located to maximise wind energy capture in the vicinity of the south-west corner of the site.

The landscape design makes use of indigenous vegetation and has a strong emphasis on open space and its integration with pedestrian and cycle access, major communal areas, and local and regional corridors for vegetation/fauna/recreation benefits. Intimate open spaces at several levels have been designed to relate to the use of the buildings. Tree planting will also be used to create buffer zones around the perimeter of the process bays and pedestrian spines.

Moody describes the Centre as essentially a research laboratory, bringing together all the sections of CSIRO Energy Technology in new headquarters on a greenfields site. "But CSIRO likes to do something different with its facilities and we will demonstrate the benefits of renewable energy to the public, which in turn benefits the Australian economy.

"CSIRO is a major drawcard to any city and the opportunity is there for local industry and organisations such as the University of Newcastle to work with us on projects."

#### ***For further information contact***

Mr Trevor Moody  
Assistant General Manager  
CSIRO Corporate Property  
Tel: 61 2 6276 6561  
Email: [Trevor.Moody@cpb.csiro.au](mailto:Trevor.Moody@cpb.csiro.au)

CSIRO is actively seeking industry partnerships to enable ecologically sustainable and alternative generation initiatives to be included in the early stages of the project.



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# Call for More Realistic Rail Fire Assessments

The Austrian tunnel tragedy at Kitzsteinhorn Mountain on 11 November last year has highlighted the social and scientific importance of a new fire methodology being developed by Australia's CSIRO.

The new methodology is being developed by Vince Dowling, Project Leader of the Material Flammability and Fire Protection group at CSIRO Thermal & Fluids Engineering in Melbourne, Australia, and Michael Delichatsios, Technical Director of the CSIRO Fire Science & Technology Laboratory at North Ryde, Sydney, Australia.

Mr Dowling says getting the methodology right becomes even more important in light of the large building program of new and expanded underground tunnel networks worldwide (see below).

## Traditional Fire Engineering

At the heart of the problem highlighted above, are the traditional fire engineering approaches which contain elements of guesswork and fail to recognise the burning behaviour of different materials.

With the development of modelling and other technology such as advanced cone calorimeters, these traditional methods are no longer adequate when designing rail tunnels to contain train fires.

The development of a better understanding of the link between flammability of individual materials and fire size in train saloons needs to be the subject of research by the rail industry in the immediate future. The research should aim to develop fire growth models specifically for use with underground trains. Further, any models developed would need to be validated by full-scale experiments. The number of full-scale experiments need not be great, and in future reduced-scale experiments would be a viable alternative. This research would result in more realistic assessments of fire size in trains in tunnels.

## The Traditional Approach

Rail operators have two concerns when considering the flammability of the materials in their cars. One is the fire behaviour of individual materials, and the other is the severity of the fire should all flammable materials ignite (flashover), and how this will impact on safety and, in underground systems, how it will impact on tunnel design.

The traditional approach to these two problems has been:

- to use one or more fire tests to determine the fire behaviour of individual materials; and
- to use fire load data to estimate likely fire sizes.

By and large the first is provided for in the British Standard (BS 6853-1999) and US National Fire Protection Association Standard (NFPA 130). Both of these Standards use a suite of fire tests to control aspects of flammability such as flame spread and smoke production, whilst BS 6853 also includes a method for measuring toxicity of combustion gases.

Traditionally, fire engineers have used the second approach to estimate fire sizes. The method involves taking the complete fire load and dividing it by an assumed time, and incorporating an assumed efficiency factor. However, fire loads tell nothing about the burning behaviour of materials. For instance, a particular quantity of material such as wood has a fixed fire load, whether or not fire retardants have been added.

This raises a serious issue. The approach penalises materials of good fire performance whilst failing to identify particularly hazardous materials. It also ignores the environment in which the fire is occurring, for example a tunnel where burning conditions are likely to pose a more hazardous environment for human safety.

## New Fire Size Estimation Methods

It is not surprising that the method of estimating fire size by dividing fire load by time is being replaced by methods using measured rates of heat release for all major surface materials. In these methods, total fire size is estimated by adding together rates of heat release for materials. The advantages of this approach, compared to the fire load approach, is that it distinguishes between materials that burn rapidly and those that burn slowly, and it allows for data on complete components to be used. Examples of components that have been tested in the cone calorimeter for rate of heat release are seats, where the cover and padding are assessed together, and floors, where the floor covering is assessed over the floor.

The disadvantages of this approach are that no models have been developed to relate individual fire properties to the fire performance of the car as a whole, and there has been no large-scale experimental validation of the approach.

Our knowledge is therefore particularly poor when it comes to being able to predict what will happen when fire breaks out in railway cars and how the fire will behave in various environments, such as in tunnels.

## Summation of Rates of Heat Release

In 1997, G.J. Duggan published a method that summed rates of heat release per unit area of materials. Duggan used this calculation method to assess cars to be used with the Heathrow Express. He found a maximum 'fire power output' of 5 MW per car.

In Hong Kong, the Mass Transit Rail Corporation (MTRC) has included a requirement that the total nominal heat release rate of all surface materials in a saloon car, when summed together, shall not exceed 5 MW at any time. In order to obtain this data, all surface materials must be tested in the cone calorimeter. MTRC accepts calculations based on the method published by Duggan. This approach assumes that there is sufficient ventilation available to allow all surface materials to be involved in combustion at once, i.e. the fire is free-burning on all surfaces and is not ventilation controlled either locally or



globally. This assumption is at odds with what is known about fire growth in enclosures, and can be shown by experiment to result in overestimation of peak fire size and underestimation of fire duration (CSIRO is currently preparing a paper on this issue).

## Modelling – The Missing Link

CSIRO Fire Science & Technology Laboratory (FSTL) believes the best method to solve the problem of accurate prediction of the interaction of material flammability on fire size is by developing advanced modelling. Modelling can consider the nature and orientation of materials and the influence of environmental factors such as availability of air for the fire to burn.

Fires can be fuel controlled (free-burning) or ventilation controlled. There are simple relationships in existence that give guidance on the likely maximum fire sizes in enclosures such as saloons in rail cars (provided there is sufficient fuel). One of these is Thomas's flashover criterion. Put simply, for a given sized compartment, the larger the openings, the greater the fire size needed to achieve flashover.

With the development of modelling

and other technology such as

advanced cone calorimeters, these

traditional methods are no longer

adequate when designing rail

tunnels to contain train fires.

If we consider the design of typical rail cars that are used underground, they often have open connections between saloons. In a rail saloon that effectively has no end walls, it would require an extremely large fire to produce flashover. In many rail cars designed specifically for use underground, there is insufficient fuel available to achieve flashover. Therefore, it is highly unlikely that all surfaces will burn at the one time. On the other hand, trains designed for use above ground often contain much higher fire loads, and have barriers between cars. In this case fires are more likely to be ventilation controlled. In either case, a situation where free-burning of all surfaces occurs is unlikely to arise.

If we assume a fire spread rate for individual materials based on their observed performance in the cone calorimeter, instead of assuming all surfaces are burning at the one time, we can derive a formula for determining the contribution of that material to the fire.

This method is like a moving average method. It may or may not be conservative. But it may be acceptable for most cases. A development on this approach would be the use of two different spread rates for vertical and horizontal surfaces. The horizontal rate may be obtained from the flooring radiant panel and the vertical from the cone calorimeter. Models for use in the rail industry are currently under development at CSIRO.

## Large-scale Experiments

Whatever approach is adopted, validation by large-scale experiments is essential. The facilities needed to conduct such experiments are calorimeters capable of measuring up to 5 MW. It is not necessary to burn a complete rail car to validate these models. What is necessary is a facility where the internal components of a saloon can be arranged in the same fashion as in a saloon. For instance, there is an ISO 9705 room fire test in which the walls and ceilings are lined with test materials and subjected to fires of controlled sizes. This test can be adapted to represent a section of rail carriage.

Another alternative is to construct a corridor of internal cross-dimensions the same as a saloon, but of shorter length. CSIRO has the capability to do both of these in its 5 MW large-scale calorimeter. Both of these facilities are unique in Australia/South East Asia.

## CSIRO FSTL – Background

CSIRO FSTL is an internationally recognised facility based in Sydney offering fire engineering, testing and research. It is only one of two facilities in the world to be accredited as an independent building materials testing authority by the Government of Japan for testing specific products that are subject to Japan's regulatory requirements.

## Underground Rail – A Growth Industry

As the host of the 2004 Olympic Games, Athens has compelling reasons for addressing these problems and is in the midst of extensive excavation to upgrade and extend its metro. The previous single-lane underground from Piraeus to Kifissia could not cope with the city's 4.5 million inhabitants. Two new lines have been added and further extensions are underway, comprising 21 new stations along 19 km of track. The metro link connecting the city centre with the new international airport has a 5 km underground section but will not be completed before 2005.

In India, New Delhi has no options but to go underground – there is nowhere else to go. The Shahadra–Tis Hazari section of rail, though only 8 km long, will take about 1,000 buses off this congested corridor. It will also cut travel time by half and substantially reduce pollution. The completed system will comprise 31 km of underground line, 64 km elevated and 104 km of track at surface level. The entire system is expected to draw 3.2 million commuters away from other transport modes and take 3,500 buses off the roads.

Bangkok has just completed a section of its first underground system. This is the 8.7 km section from Rama IX to Bang Sue. The Office of the Commission for the Management of Land Traffic believes it could attract about 300,000 passengers a day when the system begins operation next year (*Bangkok Post*, 9 December 2000).

Guangzhou is planning a four-line underground railway network that will be a total of 130 km in length when completed.

Transport planning in Ho Chi Minh City in Vietnam has identified two underground rail lines and one fast train line with a total length of 117.6 km that should get priority.

Beijing plans to add 150 km of underground and light-rail lines to the city's rail network within the next 5 years. Total investment in this will be about US\$3.6 billion.

Construction of a 24 km underground railway line linking Parramatta and Chatswood will soon be constructed in Sydney.

### Authors

Vince Dowling ([Vince.Dowling@dbce.csiro.au](mailto:Vince.Dowling@dbce.csiro.au))  
Michael Delichatsios ([Michael.Delichatsios@dbce.csiro.au](mailto:Michael.Delichatsios@dbce.csiro.au))  
CSIRO Fire Science & Technology Laboratory, Australia

### For further information contact

Dr Dilip Manuel  
Business Development Manager  
CSIRO Thermal & Fluids Engineering  
Tel: 61 3 9252 6000  
Email: [Dilip.Manuel@dbce.csiro.au](mailto:Dilip.Manuel@dbce.csiro.au)

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# New CSIRO Fire Science and Technology Laboratory

Tenders have been called and CSIRO will soon begin building its new \$10m state-of-the-art Fire Science and Technology Laboratory (FSTL) at North Ryde in Sydney.



The new CSIRO FSTL will provide one of the world's most advanced and best-equipped laboratories for fire research.

The proposed facility will cover all aspects of fire safety in the built environment. In particular, it will assist in the development of new science capabilities in fire suppression technology, including methods of extinguishing large industrial fires such as the Longford gas fire and the fire at Coode Island in Victoria.

The CSIRO FSTL will become one of the world's few fully integrated fire facilities. It will offer planners, architects, engineers, designers, builders and regulators comprehensive solutions to the challenges posed by public safety and fire issues in commercial and public buildings, industrial plants, and Australia's bushfire-prone environment.

The Fire Science team has combined its knowledge of the background of the building regulations and scientific methods to make a major contribution to national and international industry projects, especially in the area of material properties and fire resistance. The staff has a proven track record of success in assisting designers to satisfy a range of building codes, regulations and standards safely and economically. Their strength in research is providing innovative methods of **fire safety design** that add value to project solutions for clients. Their work in developing and assessing new **fire-safe materials** is offering alternative solutions to design problems and improving public safety.

### Fire Safety Performance Evaluation and Engineering

Fire engineering assessments are carried out for new and existing buildings, transport and industrial facilities to provide alternative fire safety solutions that comply with the performance requirements of the Building Code of Australia. The latest computer software modelling tools are used, and the results of research allow constant improvement of the existing models and development of new numerical tools. These tools extend from detailed computational fluid dynamics (CFD) models to simple models that can be used by the engineering community and regulators.

Staff of the FSTL are continuing their efforts to develop a credible numerical CFD model that incorporates the combustion process. The FSTL fire engineering methodology is continually undergoing improvement and expansion, including the incorporation of advanced methods of materials performance assessment and expansion into fire risk analysis.

To verify the performance of complete building protection systems, staff of the FSTL perform hot smoke tests. These provide the most rigorous method of assessing and debugging smoke control systems in completed buildings. They provide a means of assessing model predictions, as well as ensuring that fire detection, smoke extraction, and alarm and other fire systems are installed and functioning properly.

### Material Flammability Technology and Reaction to Fire

FSTL specialises in advanced techniques for measuring flammability, corrosion and toxicity. These properties are crucial inputs for fire hazard modelling and for the development of new fire-safe materials. As well as improving current test methods, FSTL is developing a new flammability apparatus which we hope will gain global acceptance.

### Active Fire Protection Technology

Fire protection technology covers active protection systems for new dispersant additives, foams and gaseous agents, as well as sprinklers and fine spray technologies. FSTL conducts intermediate and large-scale tests for fire suppression evaluation and evaluation of fire detection systems.

### Fire Resistance Technology

Fire resistance technology provides fire resistance levels for structural and barrier elements for specific occupancies using validated and new models for fire growth in pre- and post-flashover fires. Large-scale tests in vertical and horizontal furnaces provide the basis for appraisals for different materials and systems. New test and calculation methods are being developed to more accurately predict the performance of fire-resisting elements in combination with other protection means such as sprinklers.

### Research – Key Services

Staff of the FSTL are continuing their efforts to develop a credible numerical CFD model that incorporates the combustion process.

FSTL's research capability ranges from large-scale testing, through small-scale testing to various predictive analytical and computerised tools and proprietary computer software.

### Analytical Tools

Large-scale testing facilities are available for ascertaining real fire performance, including room, corridor, furniture and facade testing. Small-scale modelling and simulations are used to simulate heat and smoke spread, and the effectiveness of control devices such as sprinkler systems. Laboratory-scale testing (e.g. cone calorimeter) is used to obtain material flammability properties (how materials burn) for fire spread and extinction (how easily they are extinguished).



### Computer Software

FSTL develops a range of computer software to assist with predicting fire behaviour and code compliance. Mathematical models for smoke spread include well-mixed compartment models, zone models and CFD models. Models that take materials flammability data and predict fire growth and spread are also used. A combined probabilistic/deterministic model that predicts fire growth and spread and takes account of interaction with other fire safety systems is currently being developed. Present projects include an easy-access version of the fire requirements of building regulations, a database of design fires and prediction software for performance of fire-resistant structural elements.

### Public Transport Fire Research

There are increasingly stringent requirements for public safety in transport infrastructure and in vehicles such as planes, trains, underground transport networks and high-speed ferries. FSTL offers hazard assessment and fire size prediction techniques to assist in the design phase of all transport infrastructure. Hazard assessments address people behaviour and emergency evacuation design. In collaboration with other CSIRO divisions and industry, new lightweight materials and systems are being developed with improved fire performance for the transport industry.

### For further information contact

Dilip Manuel, Business Development Manager, FSTL  
Email: [Dilip.Manuel@dbce.csiro.au](mailto:Dilip.Manuel@dbce.csiro.au)

Ken Anderson  
Communications Manager  
Tel: 61 3 9252 6172  
Email: [Ken.Anderson@dbce.csiro.au](mailto:Ken.Anderson@dbce.csiro.au)

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# Building With Low Indoor Air Polluting Materials and Appliances

Steve Brown, CSIRO Building, Construction & Engineering

Numerous research studies in Australia and other developed countries have shown that the concentrations of many air toxic pollutants are much higher inside buildings than outside. This occurs because modern materials continue to emit air pollutants for long periods after they leave manufacturing plants and are installed as large surface areas of building interiors (e.g. paints, adhesives, carpets, wood panels, furniture). New and renovated buildings are particularly affected by these materials for several months or more after building works. Alternatively, some appliances emit air pollutants by their operation throughout the life of buildings (e.g. unflued gas heaters, photocopiers, printers).

When considered with ABS statistics that show that Australians spend an average of 90% of their lifetimes indoors, it is clear that the major influence on exposure to many air toxic pollutants is the indoor air environment.

It is generally acknowledged that the best way to control exposure to indoor air pollution is to prevent the pollutants from reaching the occupants in the first place by reducing the emissions from materials and appliances – that is, by using low-polluting products. But first we need to be able to measure and compare how products emit air pollutants and then set the appropriate criteria for 'low polluting'.

CSIRO Building, Construction & Engineering's laboratory in Highett has established a state-of-the-art pollutant analysis and environmental chamber facility for assessing and understanding air toxic emissions from manufactured products. It has applied this to paints, carpets, wood-based panels, furniture, office equipment and unflued gas heaters. It is now in the process of cooperating with industry and government to develop the standard product test methods and air toxic emission criteria for future buildings.

In the interim, this note is a response to requests from consumers and building specifiers/designers for selection of low-polluting materials now. There are two approaches that they can use:

- select generic materials that by their nature are *non-emitting* ; or
- seek materials from the growing number of product labelling schemes in other countries.

## Non- and Low-emitting Manufactured Produces

There are many materials that by their nature are known to be *non-emitting* because they do not have volatile pollutant constituents. The best example here is glass and, while hardly a replacement for painted walls and not practical for flooring, it can be used on table-tops, shelving, cupboard doors etc. In this context, our list of *non-emitting* products is as follows:

- glass for table-tops, shelving, cupboard doors;
- granite/stone for kitchen bench-tops, long-lived floor covering;
- ceramic tiles for walls, floors (though low-emission adhesives and grouts will be needed);
- bricks for feature interior walls;
- powder-coated or finished metals or stainless steel for furniture framing, window frames;
- solid woods (from sustainable sources); and
- wool insulation for walls and ceilings.

Based on our current knowledge, *low-emitting* products are considered to be:

- 'zero-VOC' interior paints (no volatile organic compounds (VOCs) added in the manufacturing process), if available, as sealer and topcoat;
- gypsumboard for wall and ceiling linings;
- solid wood flooring with low-VOC, UV-cured lacquer pre-applied in manufacturing; and
- polyolefin floorcoverings.

## Products With Low-emission Labels

Product labelling schemes have been developed in many countries, either supported by environmental or health agencies or by voluntary industry initiatives. These vary somewhat in their stringency. For example, in Denmark and Norway the 'Indoor Climate Label' has a focus on the potential of products to cause odours or eye/nose/throat irritation. The European Commission label for floor coverings is based on odour, irritation, lifetime cancer risk and the known toxicology of the pollutants known to be emitted by such products.

These schemes are published on the Web and many provide databases of the products that have been assessed and have achieved low-emission labels. In some countries, it is believed that it is now possible to specify all the materials needed for building construction based on these databases (e.g. some contain over 300 materials). Many of these materials may not be available in Australia, though some of the manufacturers are known to distribute products here. The following summary is provided for consumers, builders and specifiers of buildings to seek out those products that are or could become available in Australia. **Note that CSIRO neither endorses these schemes nor the products that currently bear their labels. However, it does consider this to be the best available information that it can provide currently to people seeking low-polluting products.**

## Europe

European Union Ecolabel for 'Indoor Paints and Varnishes'

Staff of the FSTL are continuing their efforts to develop a credible numerical CFD model that incorporates the combustion process.

[http://europa.eu.int/comm/environment/ecolabel/paints\\_ varnishes.htm](http://europa.eu.int/comm/environment/ecolabel/paints_ varnishes.htm).

European Association for Environmentally Friendly Carpets (GuT) – established criteria for air toxics emissions from carpets to which it is believed that 75% of European carpets are now manufactured (Website not found).

#### Denmark and Norway

Indoor Climate Labelling scheme initiated in Denmark in 1995 and adopted by Norway in 1998 – a voluntary scheme though recommended by the building codes of both countries. Scheme described in <http://www.uk.teknologisk.dk/1689> and product listing (in Danish) provided in <http://www.teknologisk.dk/dim>.

#### Finland

The Finnish Ministry of Environment funded a voluntary scheme in 1995 called 'Classification of Indoor Climate, Construction, and Finishing Materials' to supplement building codes. Over 300 products now meet the low-polluting criteria (listed pollutants, carcinogens, odor), approx. 20% of available materials. For product listing, see <http://www.rts.fi/M1classified.htm>.

#### Germany

The Federal Environment Agency initiated a widely based ecological label in 1977 and now over 4,500 products from 800 manufacturers use the label. Indoor air pollutant emissions are integrated with other environmental targets (resource use, recycling, global impact) for products such as low-pollutant paints and varnishes, wood and wood-based products, furniture, gas cookers, copiers and printers. Label descriptions and approved products are provided on <http://www.blauer-engel.de>.

#### USA

While product test standards are or have been developed by the American Society for Testing and Material (ASTM), a recent initiative by Underwriters Laboratories Inc. has been to work towards health-based consensus standards (test methods and emission criteria) for residential and commercial buildings; see <http://www.ul.com/eph/iaq/index.htm>.

Voluntary industry initiatives have already occurred. The Carpet and Rug Institute operate a 'Green Label' program for carpet, underlay and adhesive, based on emissions of specific VOCs, total VOC and formaldehyde, and currently more than 50 of each product type is listed on <http://www.carpet-rug.com>.

Air Quality Sciences Inc. lists a broad range of product types that will meet its own Greenguard™ product registry scheme (said to be based on USEPA and German Blue Angel labels, though the former is not known to specify a label currently) on <http://www.aqs.com>.

#### For further information contact

For more information contact:  
Steve Brown  
Tel: 61 3 9252 6000  
Email: [Steve.Brown@dbce.csiro.au](mailto:Steve.Brown@dbce.csiro.au)

Or

Dilip Manuel  
Business Development Manager  
CSIRO Thermal & Fluids Engineering  
Tel: 61 3 9252 6073  
Email: [Dilip.Manuel@dbce.csiro.au](mailto:Dilip.Manuel@dbce.csiro.au)

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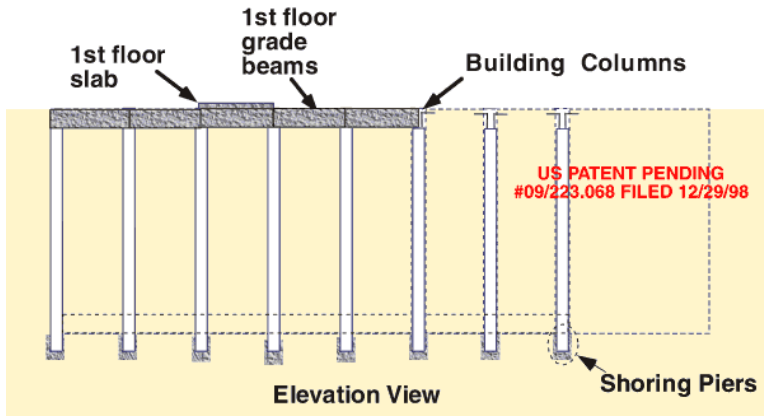
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Last Updated: 23 February 2001

# Major Savings from New US Shoring Method

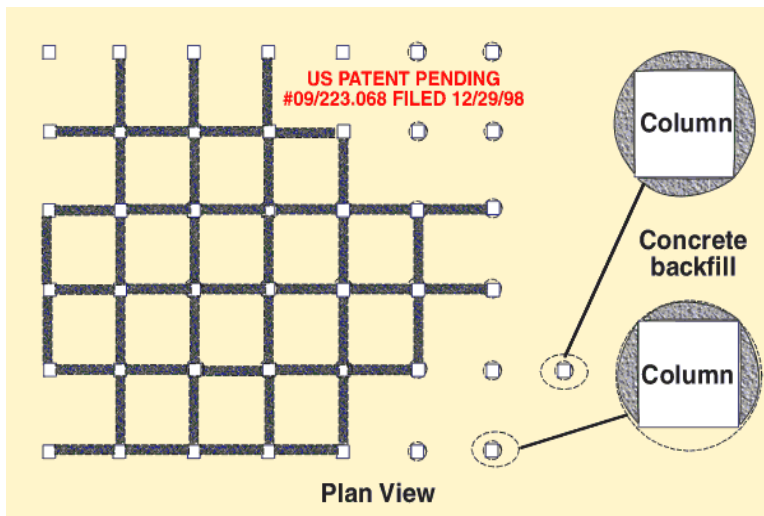
A San Diego engineer has developed a new shoring system which promises to cut construction cost and time. Californian based engineer Rick W. White says, "The new Integrated Foundation Shoring Method (InFoMet) zeros out the shoring cost completely and simultaneously eliminates weeks from the construction schedule".

White says, "The new method also allows for a three to four feet larger building footprint [Ed's note – not applicable in Australia where temporary shoring can be used outside the building footprint] and I'm confident that it will also solve issues related to weather and ground water".

White says InFoMet will save about \$1m and several weeks of time on a typical large building construction project. Patents are pending from the United States Patent and Trademark Office for the Integrated Excavation Shoring Method.



Precast columns are drilled to grade and set in/on concrete shoring piers. First floor beams are CIP on grade; first floor slab is CIP on grade. Building walls begin. Columns extend below footing level to rest upon shoring piers.



Precast columns are drilled to grade & set in/on concrete shoring piers. First floor beams are CIP on grade from building centre; no lateral (earth shoring) load is allowed to stress columns until lateral beams are CIP.

After precast columns are drilled to grade and set in/on concrete shoring piers, concrete backfill is poured around building columns to secure them laterally. Parting compound may be used on columns to prevent concrete backfill from adhering to columns.

Exterior (wall facing) surface of perimeter columns are not backfilled with concrete.

## The InFoMet System

### On-site precasting

Using a small crew, building columns are precast on site and steam cured. All necessary rebar splicing for floor and beam connections are cast into the columns. Or steel I-beam columns are delivered.

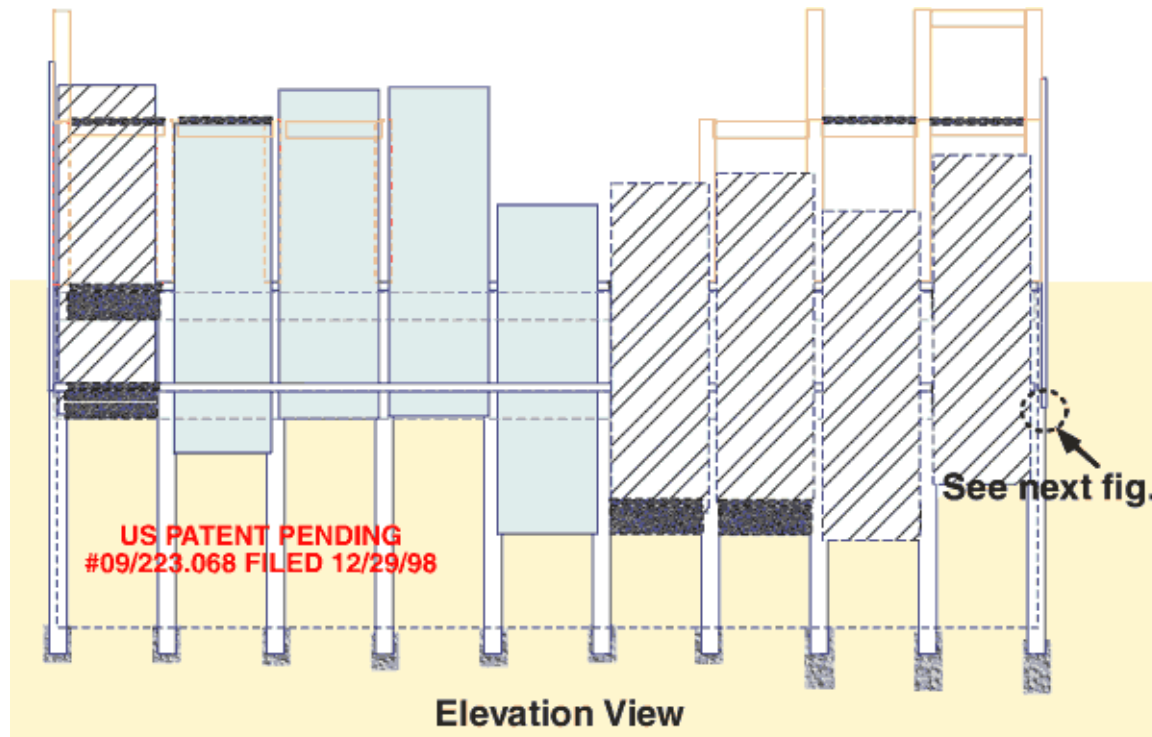
A drill and crew are then brought in and the precast columns (or I-beam columns) are then set to precise elevation into drilled holes (on drilled shaft shoring piers). Shoring piers may be to whatever length necessary to carry the loads contemplated. Column installation continues from the centre of the building, working toward the exterior walls, until complete.

When a few columns have been installed, a third small crew will begin to excavate for the building beams that connect the columns at the ground (surface) level floor. Forms for the cast-in-place concrete beams will be placed in the trenches and the beams will be cast without scaffolding, since the earth (trench bottom) will support the concrete forms. Steam may be used to quickly cure the beams in place. If steel I-beams are used for horizontal structural beams, these beams will be affixed to the columns at the ground (surface) level floor (working in trenches dug between the columns).

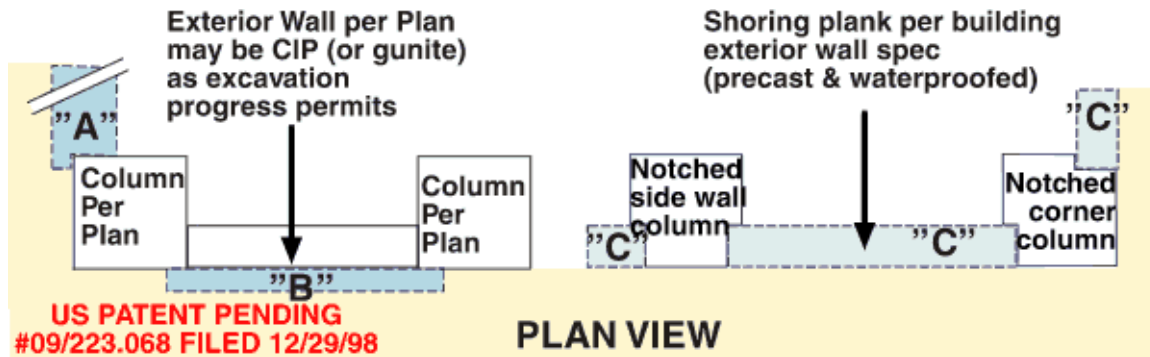
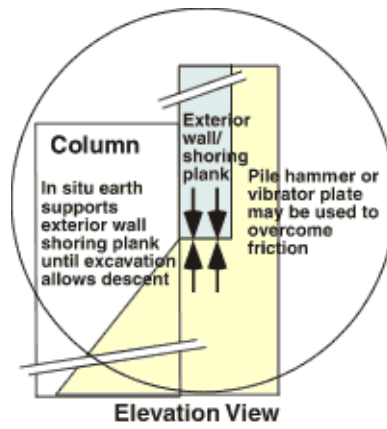
When a few of the ground (surface) level building beams have been cast in position to support the ground level floor slab, a new small crew may begin to cast the ground floor slab (on forms) laid on earth cut to grade. As soon as the beams and slab at the building perimeter have been cast over the underground parking ramp entrances, an earth ramp may be cut in to access the first level of the underground parking. At this point, weather is no longer a factor for the underground construction.

### Excavation as you go

Excavation then proceeds from the centre of the building out to the perimeter walls, cutting only to the depth of (the under side of the next) slab level. As the grade is exposed, the beam casting crew begins casting beams between the columns at the next level down. Again, no scaffolding is needed: the beams are cast in forms laid in trenches. The next floor slab is then cast in place on forms laid on the earth (as the first floor level had been done). Steel I-beam construction would proceed similarly.



Note that exterior wall/shoring plank wall sections may be completely waterproofed per specification before installation; waterproofing may then be protected from soil friction during installation with sheet steel. French drains may be installed at the bottom of (beyond the exterior dimension of) the basement wall sections just as they reach their final elevation



**Virgin earth shoring**

Above grade, exterior building (basement) walls (which will act as shoring panels) are precast (by the same slab casting crew) in the typical tilt-up method. The exterior building (basement) walls are then steam cured and waterproofed. Sheets of lightweight steel may be affixed to the precast exterior (basement) walls to protect the waterproofing material from damage during the installation process. As these exterior wall panels cure, they may be stood into place around the building perimeter and supported in alignment with temporary bracing. The unexcavated earth (around the building perimeter) beneath the exterior wall/shoring panels supports the panels as they are stood into alignment.

Below the ground (surface) level building slab, excavation, beam pouring and slab casting is accomplished from the building centre outwardly toward the building sides. From the inside of the gradually enlarging excavation, sloping earth sidewalls are left in place (within the building basement dimension), sloping upwardly to the bottom of the building perimeter grade beams which support the ground (surface) level slab. These natural undisturbed earthen slopes perform as an earth shoring wall around the inside of the building perimeter.

As the perimeter of the building comes into view beneath the ground (surface) level (building perimeter) grade beams, trenches for building beams are dug from alternate interior columns to their counterpart exterior columns. Care is taken to leave the sloped earth shoring in place on either side of the trenches that are dug so that the lateral building beams may be placed between the interior columns and building perimeter columns.

Once this next level of beams are placed, the sloped earth shoring may then be dug away, working from the top down, with the slope angle being maintained (with a track loader, for example). As the earth is dug away from beneath the exterior wall/shoring panels, they slide down into place by force of gravity. Wooden blocks may be bolted to the panels to help guide their alignment. As the excavation proceeds, the shoring panel/building exterior wall panels may be vibrated or driven into place. This sequence repeats until all below grade slabs are cast.

**Drainage**

Once all below grade slabs are cast and exterior building wall/shoring panels are near to their final resting place, French drains may be installed beyond the exterior dimension of the building walls (by digging from inside the basement dimension). In severe ground water conditions, or in silt/sand tidal conditions (such as San Diego where pumping of ground water is no longer allowed near the harbour), ground water may be incrementally pushed below the work zone by air-pressurising the inside of the building basement.

**Other major advantages**

With InFoMet, building of the above ground portion of the building may begin as soon as the below grade columns are placed. With InFoMet, the building site dimension usually lost to soldier piling shoring may be used for an enlarged building footprint. With InFoMet, it may be possible to go beyond four floors below grade.

**Background – Soldier Piling**

The sequence procedure for large building basement construction has remained unchanged for decades. Under the current practice, the basement excavation is accomplished before any construction of the building or the basement may begin. But in order to excavate for the basement, the building contractors must first 'temporarily shore' the boundary of the excavation in order to prevent neighbouring structures from falling into the excavation. Shoring, as the process is called in the trade, typically employs a method known as soldier piling.

Soldier piling involves drilling holes and installing large steel H-beams (aka I-beams) in concrete, typically 80 feet deep. After the H-beams are drilled and cast in concrete, wooden planks are placed by hand behind paired flanges of the H-beams, as the excavation proceeds. This removes the cost of temporary shoring.

On a typical large building, 90 m x 61 m wide building footprint, with a four level, 12 m deep basement/parking lot, the soldier piling shoring cost would equal around US\$1m. Time for the shoring design and installation adds to the building cost. And, the shoring system subtracts several feet from the site boundary area available for the building. The amount of savings on the above example project using InFoMet would exceed US\$800,000.

**For further information contact**

Rick W. White  
 Box 191313  
 San Diego, CA 92159, USA  
 Email: [firecat@znet.com](mailto:firecat@znet.com)

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 Last Updated: 23 February 2001

# Dismantling the Myths About Cold Climate Corrosion\*

Long-held views about corrosion in cold climates have led to the development of almost mythological beliefs that have been dispelled by recent scientific endeavour.



Automatic weather station at Enigma Lake near Terra Nova Bay station

For example, a body of scientific evidence has now dispatched the view that cold dry climates such as those in Antarctica produce nil or extremely low corrosion. Now a new international scientific collaboration has shown that the methodology for calculating corrosion rates needs to be changed if we are to better protect our historic heritage in Antarctica, and valuable infrastructure.

This view is implicit in ISO 9223, which effectively says that one estimate of the time of wetness of a surface can be used worldwide.

A new testing program just completed at Terra Nova Bay on the Ross Sea in the region known as Northern Victoria Land in eastern Antarctica, has shown that the accepted international standard for calculating corrosion does not in fact apply in these cold climates.

## Cold Climate Corrosion – Background

Traditionally it has been long regarded that atmospheric corrosion is low in the very cold regions of the world because of the prevailing dry and cold climates. While this has been demonstrated for regions in Antarctica remote from the ocean, marked corrosion problems are observed on both historic and current buildings located close to the Antarctic coastline. Measurements of atmospheric corrosion rates at these sites have yielded results similar to some temperate environments. These observations are in conflict with the current international definition of the time that a metal surface is wet and can therefore corrode.

Antarctic corrosivity data thus raised fundamental questions about the time of wetness (TOW) criterion in the International Standard ISO 9223. This is defined as 'the period during which a metallic surface is covered by adsorptive and/or liquid films of electrolyte that are capable of causing atmospheric corrosion'. The standard points out

that 'wetting of surfaces is caused by many factors, for example dew, rainfall, melting snow and a high humidity level', and the calculated TOW of corroding surfaces can be estimated as the length of time when the relative humidity is greater than 80% at a temperature greater than 0°C.

A note in the standard qualifies this criterion and indicates that other factors such as metal type, object orientation, corrosion products and pollutants on the surface, may influence the TOW. However, the standard considers 'the criterion usually sufficiently accurate for the characterization of atmospheres'.

Recent experiments have thrown doubt on this. In a study conducted at temperate and tropical sites within Australia and three tropical Asian sites, TOW was measured directly on the surfaces of zinc specimens using the gold grid method discussed below (Experimental). The ISO criterion did not predict well the high TOW for tropical and temperate marine Australian sites and a tropical marine Asian site (Phuket, Thailand), nor a moderate TOW for an inland-tropical Australian site.

On the basis of meteorological data, the TOW for the Antarctic locations is much lower than at the comparable temperate locations previously studied. It has also been previously noted, however, that the long hours of sunlight in the Antarctic summer may raise the surface temperature of dark objects considerably above the surrounding air temperature, but that the temperature rise is inadequate to totally volatilise an electrolyte layer.

Confounding this is the observation that when the Scott expedition historic huts at Cape Evans (New Zealand Ross Dependency) were cleared of ice, the artefacts inside them which had suffered little corrosion in the previous 60 years started to corrode at significant rates without being subject to heating by direct solar gain.

## Salt deposition

Examination of the role of salt deposition in Antarctic conditions has recently revealed that because of the general absence of rain and consequent leaching, unusually high levels of sulfate and chloride are retained in corrosion products. The chloride levels in rust from continental Antarctic sites far exceeded those for specimens from temperate marine sites, and the sulfur levels were comparable to those on specimens exposed at true industrial sites. The high concentrations of salts that could be found on a metal surface in the absence of regular washing by rain could logically be expected to increase corrosivity. In addition, the phenomenon of depression of the freezing point of salt solutions is well established by other researchers.

Given the significance of corrosion occurring unexpectedly in consistently cold conditions, particularly in the presence of salts, and given that the majority of Antarctic research stations are located close to the sea, corrosion could present an unforeseen risk for modern buildings which are generally designed presuming minimal corrosion rates.

The information to be derived from this research is also believed to be of practical benefit in the preservation of historic metal artefacts and building components at the abandoned bases of the Scott (1902–1904, 1911–1914) and Shackleton (1907–1909) expeditions at Ross Island.

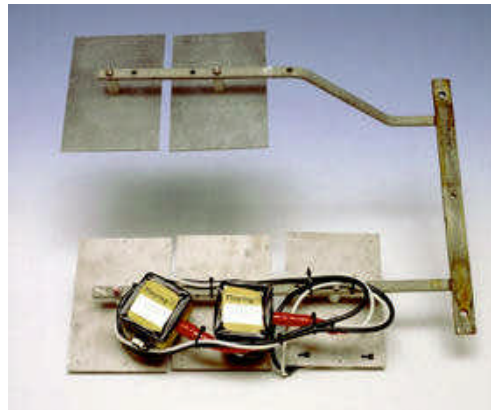
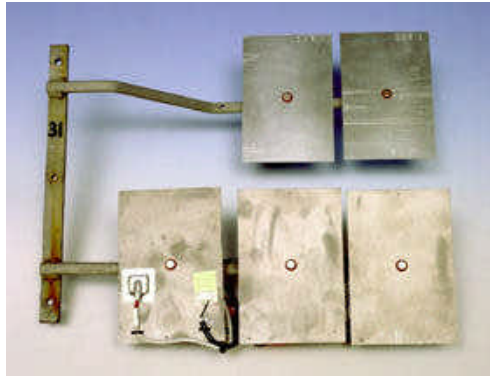
Hence, in order to better understand the conditions under which corrosion may occur in cold climates, an experimental program was devised which would demonstrate whether corrosion could occur when temperatures were too low for corrosion

to occur according to ISO 9223.

### The Experiment Site

It was decided that a suitable coastal site should be selected where temperatures are consistently low, but without any complicating factors such as anthropogenic pollutants from diesel generators that are generally used for producing electrical power. The Australian bases Mawson, Casey and Davis were unsuitable for the experiment as they all lie at latitudes of approximately 66–68°S, and maximum temperatures can exceed 0°C in the summer months, especially at Davis station.

The Italian research station at Terra Nova Bay in the Ross Sea area of Antarctica was chosen as a suitable location as detailed meteorological data suggesting that temperatures above 0°C were rare and several meteorological facilities were available which were specifically located away from potential sources of pollution.



Zinc and steel plates mounted on bracket for exposure: (left) front view showing sensors for surface temperature and wetness; and (right) rear view showing data loggers for recording temperature and wetness.

### Details of the Exposure Site

The main feature of the region is the influence of the mountains – orography. The nearby trans-Antarctic mountain range represents the boundary of the polar ice cap. Orographic factors have a noticeable impact on the climate of the region, since they drive the atmospheric flows, giving rise to the dynamic systems prevailing in the area such as the katabatic and barrier winds. The katabatic winds originate over the polar plateau and blow down toward the coast following the valleys that intersect the trans-Antarctic range. In Terra Nova Bay these winds are particularly intense. Such winds usually blow toward the Ross Sea either from SW or NW. Nearby stations to Terra Nova Bay are New Zealand's Scott base and the US base at McMurdo Sound. The actual exposure site was at an automatic weather station near Terra Nova Bay station at an altitude of 21 m and approximately 1 km from the sea/sea ice.

The yearly mean and extreme values of temperatures (°C) of –15.1 to –24.5° (minimum) and –4° (maximum) showed it was ideal to test the ISO criterion of time of wetness.

### Experimental Materials and Methods

#### Materials exposed for corrosion measurements

Unalloyed carbon steel ('mild steel') to Australian Standard AS 1594, a copper-bearing steel used as a standard for measuring corrosion, and high purity zinc (all 3mm thick) were used to measure the corrosion rate at the location.

#### Mounting specimens

For any atmospheric corrosion measurements, appropriate procedures have to be devised for each location for the mounting and exposure of specimens. The conventional methods of holding rectangular specimens on racks using porcelain insulators are often not possible as racks may not exist at any given location, and it may not even be possible to construct them. Techniques have been developed at CSIRO to fix specimens to small brackets using thin bolts and machined plastic mounting spacers inserted into a central hole in the specimen.

Very compact assemblies can be made holding up to six standard specimens, and these can be easily fixed to suitable wooden or metal structural members. The technique has been employed very extensively for corrosivity surveys throughout Australia mounting the brackets onto low voltage power supply poles. Because of the logistical constraints of carrying out any work in Antarctica, especially when air transport of equipment is required, it is imperative that experimental assemblies be as compact and light as possible.

The CSIRO technique is ideal for this application, and the specimens and instruments can be packaged and sealed to ensure their integrity.

One bracket contained duplicate specimens of unalloyed carbon steel 150 x 100 mm, and a third specimen instrumented for surface temperature and TOW; duplicate specimens of zinc 150 x 100 mm were also mounted on this bracket. A second bracket carried duplicate specimens of the copper-bearing steel 100 x 50 mm. All specimens were mounted onto the bracket arms vertically (as opposed to exposure at angles of 45° or 30° which are usually employed).

#### Instrumentation

The additional unalloyed carbon steel plate was instrumented for the measurement of surface temperature and TOW. A temperature logger with an external thermistor was used for surface temperature. This can be seen on the left of the instrumented plate in Figure 1. A wetness logger with a gold grid sensor was used to measure when the metal surface was actually 'wet'. The gold grid sensor is on the right of the instrumented plate in the photo. The values produced by the wetness logger give a value for the conductivity of the surface of the gold grid. The conductivity is related to the thickness of the moisture film on the grid. It should also be noted that the specific conductivity will influence the values produced by the logger, i.e. a thin highly conductive layer may give the same value for wetness as a thicker and less conducting solution. The loggers are extremely compact and are mounted directly on the bracket arms holding the specimens. Readings were recorded at intervals of one hour.

## Transport and Exposure

The experimental set-up was assembled at CSIRO on 1 December 1999 and transported by air to Christchurch New Zealand in late December. It left for Antarctica on board the ENEA supply ship *Italica* on 6 January 2000 arriving in Terra Nova Bay on 15 January. Exposure of the assembly was not carried out at that time due to unforeseen circumstances, and it remained in storage at the station throughout the winter of 2000.

The record of wetness showed clearly that the specimens remained perfectly dry (inside the sealed bag) until after exposure on 29 October. Recovery was on 2 December 2000, giving an exposure period of 34 days. The assembly was returned by air to New Zealand and then Australia. The record of surface wetness showed that the specimens had remained dry in transit.



Specimens and instruments affixed to tower at exposure site

## Key Data Summary

### Corrosion results

The average mass losses and equivalent corrosion rates for the three materials were as follows:

- unalloyed carbon steel 0.215 g, 9.3  $\mu\text{m}/\text{year}$ ;
- copper bearing steel 0.0174 g, 8.1  $\mu\text{m}/\text{year}$ ; and
- zinc 0.067 g, 3.2  $\mu\text{m}/\text{year}$ .

While recognising that the exposure period is short, these corrosion rates are very much higher than one would expect in this environment. Support for the present results is provided by previous measurements at nearby Cape Evans (the site of Scott's hut) using the copper-bearing steel, with a result of 10.8  $\mu\text{m}/\text{year}$ .

### Climatic parameters and surface wetness

The prevailing winds for the duration of the experiment were overwhelmingly from the west. These are the katabatic winds blowing from the polar plateau towards the sea. This demonstrates that at this particular site, salt deposition on the corrosion specimens during the period of exposure would be minimal.

The surface temperature measured throughout the winter period varied from about  $-7$  to  $-33^\circ\text{C}$ , but for much of the time it was below  $-20^\circ\text{C}$ .

The trend for air temperature increased from about  $-20^\circ\text{C}$  to about  $-3$  to  $-5^\circ\text{C}$  during the exposure period but the relative humidity was nearly always below 80%. Table 1 presents key parameters derived from the meteorological data, and the measured surface temperature and wetness. At no time did the relative humidity exceed 80% and the air temperature exceed  $0^\circ\text{C}$  simultaneously and the ISO TOW was consequently zero. However, there were many events of wetness between relative humidities of 50% and 80%, and analysis showed that the measured time-of-wetness (28% of the total time) was almost identical to the time for which the relative humidity exceeded 50% and the air temperature exceeded  $-10^\circ\text{C}$ .

Table 1. Percentage of time for parameters derived from meteorological and measured data

	RH		Ambient temp.		Surface temp. $>0^\circ\text{C}$	ISO TOW	TOW RH $>50\%$ ; temp. $-10^\circ\text{C}$	Grid TOW
	$>80\%$	$>50\%$	$>0^\circ\text{C}$	$>-10^\circ\text{C}$				
Per cent of exposure time	2.4	35.3	0.9	68.6	6.3	0	29.9	28.4

## Conclusion

Substantial corrosion has been measured in the specimens exposed at temperatures well below  $0^\circ\text{C}$ , which is in direct contradiction to the ISO criterion. The general conclusion from the experimental program is that the ISO 9223 criterion for estimating time of wetness (TOW) has been demonstrated to be totally incorrect for cold climates. It is proposed on the basis of the present results, that the TOW in these environments be estimated as the length of time that relative humidity exceeds 50% and the ambient temperature exceeds  $-10^\circ\text{C}$ . This needs to be addressed in a revision of the standard.

A second identical experimental assembly was prepared in October 2000 and transported under similar conditions by air to New Zealand and then Terra Nova Bay for an exposure period of one year. This will allow the experiment to be conducted over a period during which the air temperature is below  $-15^\circ\text{C}$  for over eight months. This experiment will provide solid validation for the first round of experiments and results will be available by early 2002.

\*This is an edited version of the paper, 'Studies in Antarctica help to better define the temperature criterion for atmospheric corrosion' by George King, Wayne Ganther (CSIRO Building, Construction & Engineering Australia, Janet Hughes (National Gallery of Australia), Paolo Grigioni and Andrea Pellegrini (ENEA Italian National Antarctic Research Program). The paper was presented to the NACE International Northern Area Region Conference, 'Shining a Northern Light on Corrosion', Anchorage, Alaska, February 2000.

## For further information contact

George King  
Principal Research Scientist  
CSIRO Sustainable Materials Engineering  
Tel: 61 3 9252 6000  
Email: [George.King@dbce.csiro.au](mailto:George.King@dbce.csiro.au)

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**Last Updated:** 23 February 2001

# Australia to Host 9th International 'Durability' Conference



'Better Buildings for Tomorrow' is the theme of the 9th Durability of Building Materials and Components Conference (9dbmc) to be held in Brisbane, Australia, on 17–21 March 2002.

This international event will highlight ways in which research into the durability of building materials and components can be undertaken and used to improve the performance of buildings of the 21st Century.

A full program is planned for the conference, and will include the examination of major changes which have taken place in our thinking when we discuss the meaning of 'durability' in building materials.

The focus has now shifted away from the traditional approach where the building material was considered an isolated part of the building and assessed independently. Whilst the challenges associated with 'pure materials research' are no less challenging, today materials are being increasingly assessed as part of a complete system, which is assessed for performance and durability over its total life cycle. This systems engineering approach means taking into account fire, structural and durability performance and concepts of sustainability and life-cycle analysis. The systems engineering approach also encompasses factors such as the influence of the building on the environment and the health of the building's inhabitants.

Today these concepts cannot be applied without considering information technology. Consequently, the themes of recent conferences have shifted dramatically from the early conferences, where the emphasis was on such issues as concrete performance, to one where sustainability, life-cycle performance and 'IT in construction' have become major considerations.

This conference, whilst focussing on the durability of materials in construction, will provide one of the major opportunities in the world to study these materials in a fully integrated manner, and to meet practitioners from other areas who will provide synergistic interactions.

Industry has recognised that there is considerable advantages to be gained in integrating materials research into the complete construction process, and as the design process (and in particular CAD systems) start to utilise durability concepts and data, the process will move very quickly to completion. This will allow us to better address society's expectations of more 'sustainable' buildings, and challenging concepts such as the completely recyclable building.

The technical program will be based around the title of the conference – 'Better Buildings for Tomorrow' – and the conference will have a number of plenary presentations. However, the major technical base for the conference will be the parallel technical streams, comprising presentations and posters. This year poster sessions will be presented as short 10-minute presentations in addition to the physical poster, and to recognise the extra work that is required for this type of presentation a **prize** will be awarded for the best poster. The final structure of the streams will depend on the number and type of papers submitted, but will focus on the following themes:

- Durability of Construction Components & Systems
- Predictive Models and Methods
- Design, Service Life, Condition Assessment, Maintenance & Asset Management
- Life-cycle Costing & Analysis
- Construction Standards – Methodology & International alignment
- Fittings & Furnishings – Their Effect on Building Performance
- IT in Construction
- Historic Buildings

All papers for the conference will be fully refereed and will be published as a CD-ROM produced from the authors' originals. Papers will be available on the conference Website (<http://www.dbce.csiro.au/9dbmc>) before the conference, accessible by a password issued to all registered delegates. Abstracts of all papers will be issued as part of the official conference program.

Abstracts are now invited on the conference themes and should be submitted using the form located in the Call for Papers (<http://www.dbce.csiro.au/9dbmc/conference/callforpapers.cfm>) section of the conference Website.

The Organising Committee for the Durability of Building Materials and Components Conference comprises:

- The International Council for Innovation and Research in Building and Construction ([CIB](#))
- International Union of Testing & Research Laboratories for Materials & Structures ([RILEM](#))
- American Society for Testing and Materials ([ASTM](#))
- National Research Council of Canada ([NRCC](#))
- National Institute of Standards and Technology ([NIST](#))
- Royal Institute of Sweden ([KTH](#))

This conference follows on from preceding conferences held in Canada (1999), Sweden (1996), Japan (1993), UK (1990), Singapore (1987), Finland (1984), USA (1981) and Canada (1978).

We all look forward to your involvement in the Conference.

**For further information contact**

Stewart Burn  
Chairman 9dbmc  
Tel: 61 3 9252 6000  
Email: [Stewart.Burn@dbce.csiro.au](mailto:Stewart.Burn@dbce.csiro.au)  
<http://www.dbce.csiro.au/9dbmc>

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Last Updated: 23 February 2001

PRESS ROOM

## New Invention Overturns Age-Old Mixing Methods

Press Release 18 December 2000; Ref: 2000/334

**Australian scientists have produced a revolutionary new mixer that is five times more energy efficient than traditional industrial mixing for everything from explosives to cosmetics.**

The now patented CSIRO Rotated Arc Mixer (RAM) can also mix thick fluids better than any other mixer.

Inventors Dr Guy Metcalfe and Dr Murray Rudman of CSIRO Thermal & Fluids Engineering say, "The RAM overcomes many mixing problems. For example, static mixers used in cosmetics manufacture have baffles, plates and constrictions that result in regions that clog and cause material build-up".

"Stirred tank mixers used in the dairy industry, can suffer from large stagnant regions (badly mixed regions leading to waste raw material) and high energy consumption. Stirred-tank mixers are also normally characterised by regions of high shear (turbulence)."

Dr Rudman says that the regions of high shear may destroy delicate products or reagents, such as the biological reagents involved in fermentation in food processing.

Similarly, regions of high shear may produce poor mixing in explosives, resulting in inferior explosive performance.

Regions of high shear may also disrupt the formation and growth of particles or aggregates in a crystalliser (sugarcane processing). Alternatively, fibrous pulp suspensions may catch on the baffles or plates of a static mixer, leading to blockage and regular production downtime.

The basic configuration of the RAM is an outer cylinder that rotates around a fixed inner cylinder, which has flow apertures cut at strategic locations depending on the material being mixed.

As the outer cylinder rotates, fluid is moved axially through the inner cylinder. The viscous drag from the outer cylinder, which acts on the fluid in the region of each flow aperture, sets up a secondary (transverse) flow in the fluid.

Dr Metcalfe says, "The key to the RAM's success is these forces that produce very effective chaotic mixing of highly viscous fluids in either batch or continuous (through-flow) modes".

"Depending on the specific application, suitable combinations of flow rate, rotation rate and flow aperture are chosen, based on the mathematical models and methods developed by our team."

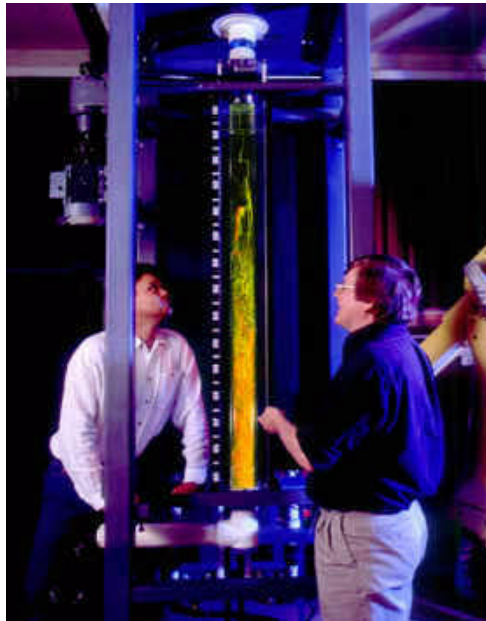
The CSIRO team is confident of the versatility of the RAM.

"Performance relies on fundamental kinematics of fluid motion which are valid for all fluids and therefore has wide application", says Dr Rudman.

A typical competitor for through-flow applications are static mixers, against which the RAM has been benchmarked. Some demonstrated characteristics of the RAM are:

- It can mix twice as well as an equivalent commonly used static mixer
- It consumes five times less energy
- It has very low shear, but effective mixing
- No stagnant regions
- Easy to clean
- No internal surfaces (baffles, plates, etc.) for material to build up on
- Easier to scale-up to plant scale as flow fields are the same irrespective of size
- Is designed for very high viscosity fluids

Dr Metcalfe says, "The concept for the RAM came out of blue-sky mathematical research aimed at overturning traditional mixing design".



"We had an idea about an ideal mixer, and developed mathematical models to see how it would perform and then we produced the real thing. Needless to say we are extremely excited about the possibilities of the CSIRO RAM."

CSIRO Thermal & Fluids Engineering is currently designing an industrial-scale RAM for a specific industrial operation to demonstrate its effectiveness to industry.

"Now that we have moved past the development of a successful laboratory prototype we are keen to find industry partners to commercialise this exciting new technology", says Dr Rudman.

***For more information contact***

Dr Dilip Manuel  
Business Development Manager  
Tel: (61 3) 9252 6073  
Email: [Dilip.Manuel@dbce.csiro.au](mailto:Dilip.Manuel@dbce.csiro.au)

Ken Anderson  
Communications Manager  
CSIRO Building, Construction & Engineering  
Tel: (61 3) 9252 6172  
Email: [Ken.Anderson@dbce.csiro.au](mailto:Ken.Anderson@dbce.csiro.au)

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URL: [www.dbce.csiro.au/inno-web/0201/mixer.htm](http://www.dbce.csiro.au/inno-web/0201/mixer.htm)  
Email Innovation Online: [information@dbce.csiro.au](mailto:information@dbce.csiro.au)  
Last Updated: 23 February 2001

## Future of Adelaide's Water Supply

*Press Release 19 January 2001; Ref: 2001/22*

**A CSIRO study indicates it is now possible for Adelaide to consider a future water supply free of its dependence on the Murray Darling River system.**

Preliminary work by CSIRO's Urban Water Program shows that the Adelaide Hills could provide water for the city's needs all year round with some to spare.

"There is potential to make better use of 168 billion litres per year of rainwater and wastewater currently being lost down city drains and in the sewage system", says Mr Andrew Speers, Leader of CSIRO's Urban Water Program.

"There is an exciting opportunity to learn how to reconfigure urban water supply systems. Adelaide is the obvious place to do this. It will not be possible to recover all of this but it is worth spending the time to work out how much can be recovered.

"The potential recovery from stormwater alone would supply as much as 55 billion litres per year – almost a third of Adelaide's current water needs. We might not get it all but it is seriously worth sitting down and working out how much can be recovered", he says.

In a normal year Adelaide derives 40% of its water or 70 billion litres per year from the Murray and 60% comes from the Adelaide Hills.

Recycling just some of the city's wastewater and run-off could reduce Adelaide's dependence on the Murray to zero and reduce use of water from the Adelaide Hills to less than half the current demand.

This reduced dependency on the Murray could be achieved by using a combination of water-recycling techniques. One such technique is aquifer storage and recovery, which means that Adelaide could store substantial amounts of water in underground aquifers every year, providing more than enough reserves to survive the worst drought. Aquifer storage and recharge stores water without evaporation losses. Large amounts can be moved from winter to summer. Another technique which could be employed is on-site recycling of rainwater and wastewater.

"Such a new-generation water supply for the city already promises savings of more than \$500 million from the reduced impact of Murray salinity and sales of surplus water. This saving would enable this water to be used to help solve salinity problems in the Murray River itself, and also to increase investment in irrigation", Mr Speers says.

This should not be seen as an alternative to the current focus on the Murray River, but rather as part of a suite of solutions being explored, he says.

"It is definitely not a substitute. The State still needs a healthy Murray River. Adelaide will still need access to the Murray in dry years."

The data that reveals this comes from the South Australian Department of Water Resources which, when combined with the research done by CSIRO, identifies huge opportunities to improve water use in cities like Adelaide.

"We need to find the suburbs and locations where the biggest savings are possible. Then we have to work out when the best time to begin the transition. It is likely that many of the opportunities will not be viable until existing infrastructure is upgraded."

The CSIRO review has established a clear picture of how and when Australians use water and how we can improve the management of our stretched water resources. It is possible to make existing water infrastructure much more efficient. In most of our cities, we could do much better. But Adelaide, given the city's focus on water, is the obvious place to start.

By using smaller replacement pipelines linked to off-peak water storage for householders, many millions could be saved from the cost of delivering water to suburban homes.

"What we are suggesting for Adelaide is far simpler than any of these measures – all we are saying is, try recycling what you have already", Mr Speers says.

Building on this work and that by others, CSIRO has submitted a proposal to the South Australian Government that they lead a study to scope the extent of this opportunity for the State of South Australia. There are likely to be significant benefits to the State's water industry both within the State and also as they export the technology developed.

The aim of this pre-feasibility study would be to explore alternative ways of making Adelaide one of the most water efficient cities in the world. CSIRO is proposing to work closely with industry, government departments and the community. It is not proposing to do the study on its own.

The study would:

- Describe how Adelaide stores, distributes and uses water
- Identify the range of technologies that could be used to increase water use efficiency in Adelaide
- Using high level models, existing research findings and existing data sets, assess the savings

- achievable if each of these technologies were introduced
- Provide an indicative assessment of the costs, benefits and risks of introducing each of the technologies from social, economic and environmental aspects
  - Identify the issues that need to be resolved before a project of this nature could be implemented either in part or in total
  - If appropriate, identify the stages needed to progress from pre-feasibility to implementation.

***For more information contact***

Mr Mike Young  
Director, Policy and Economic Research Unit  
CSIRO Land and Water  
Tel: 0408 488 538

Mr Andrew Speers  
Leader, CSIRO Urban Water  
Tel: 0417 425 934

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Email Innovation Online: [information@dbce.csiro.au](mailto:information@dbce.csiro.au)  
Last Updated: 23 February 2001

PRESS ROOM

## High-tech Thermal Vest for Soldier Survival

Press Release 24 January 2001; Ref: 2001/24

**Australian scientists have invented a new high-tech vest to help keep soldiers and emergency workers alive in the searing temperatures of deserts, mines and major fires.**

The vest uses a personal cooling system (PCS), jointly developed by CSIRO and Defence Science and Technology Organisation (DSTO), and is designed to be worn by military personnel underneath NBC (nuclear, biological and chemical) clothing, body armour and other protective uniforms, by emergency services workers wearing protective clothing and by miners working underground.

A new NBC suit just developed by DSTO, when worn with the PCS will allow soldiers to operate for up to four hours in high temperatures when previously only one hour was possible.

Dr Pratish (Bando) Bandopadhyay of CSIRO Thermal & Fluids Engineering says surrounding the body in protective clothing prevents cooling by normal sweat evaporation. This reduces the operational time protective clothing can be worn without greatly increasing the risk of injury.

"The PCS is based on new, patented heat pipe technology which works by collecting body heat through vapour-filled cavities in a vest worn on the body. The heat is then transferred via a flexible heat pipe to the atmosphere with the help of an evaporative cooling heat exchanger", Dr Bando says.

"The heat exchanger is similar in principle to a bush fridge where a cold cloth is put over a container and the temperature drop caused by evaporation keeps the food cool.



"This concept has been demonstrated in a series of experiments conducted by DSTO researchers in which thermal strain has been greatly minimised in soldiers exercising in simulated military operations", he says.

The PCS is expected to have major applications in firefighting, deep mining operations, hazardous chemical clean-ups in industrial operations in harsh environments, and in military operations where high temperatures currently limit strenuous physical exertion to very short periods of time.

It has been launched for commercial development by the joint owners of the technology – CSIRO Thermal & Fluids Engineering and the Defence Science & Technology Organisation (DSTO).

Commercialisation will be undertaken by Freehills Technology Services (FTS) in partnership with the Victorian State Government, through its Technology Commercialisation Program.

FTS will seek commercialisation partners, with ownership rights remaining with DSTO and CSIRO.

FTS is a company within the international law firm, Freehills.

### For more information contact

Dr Pratish Bandopadhyay  
Project Leader  
CSIRO Thermal & Fluids Engineering  
Tel: (61 3) 9252 6000  
Email: [Pratish.Bando@dbce.csiro.au](mailto:Pratish.Bando@dbce.csiro.au)

Dr Dilip Manuel  
Business Development Manager  
CSIRO Thermal & Fluids Engineering  
Tel: (61 3) 9252 6073  
Email: [Dilip.Manuel@dbce.csiro.au](mailto:Dilip.Manuel@dbce.csiro.au)

Dr Tony Lau  
Senior Research Scientist  
DSTO  
Tel: (61 3) 9626 8475  
Email: [Tony.Lau@dsto.defence.gov.au](mailto:Tony.Lau@dsto.defence.gov.au)

Ken Anderson  
Communications Manager  
CSIRO Building, Construction & Engineering  
Tel: (61 3) 9252 6172  
Email: [Ken.Anderson@dbce.csiro.au](mailto:Ken.Anderson@dbce.csiro.au)

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Email Innovation Online: [information@dbce.csiro.au](mailto:information@dbce.csiro.au)  
Last Updated: 23 February 2001

# Conferences & Events

## **6th World Congress of Tall Buildings & Urban Habitat 26 February – 2 March 2001, Melbourne, Australia**

CTBUH  
Tel: 61 3 9682 0244  
Fax: 61 3 9682 0288  
Email: [tguh@icms.com.au](mailto:tguh@icms.com.au)  
<http://www.icms.com.au>

## **Asia-Pacific Conference on Engineering Applications of Composite Materials 27-28 February 2001, Singapore**

CI-Premier Pte Ltd  
150 Orchard Rd #07-14, Orchard Plaza  
Singapore 238841  
Tel: 65 733 2922  
Fax: 65 2353530  
Email: [cipremie@singnet.com.sg](mailto:cipremie@singnet.com.sg)  
<http://www.cipremier.com>

## **3rd Asia-Pacific Conference on Fibre Reinforced Concrete 1-3 March 2001, Singapore**

CI-Premier Pte Ltd  
150 Orchard Rd #07-14, Orchard Plaza  
Singapore 238841  
Tel: 65 733 2922  
Fax: 65 2353530  
Email: [cipremie@singnet.com.sg](mailto:cipremie@singnet.com.sg)  
<http://www.cipremier.com>

## **UDIA 2001 Congress 5-8 March 2001, Adelaide, Australia**

Urban Development Institute of Australia  
Fax: 61 8 8379 8177  
Email: [plevin@camtech.net.au](mailto:plevin@camtech.net.au)  
<http://www.udia.com.au>

## **Timber & Woodworking Show 16-18 March 2001, Claremont Showgrounds, Perth, Western Australia**

Riddell Exhibition Promotions Pty Ltd  
PO Box 153, Drummoyne, NSW 2047, Australia  
Tel: 61 2 9712 5623  
Fax: 61 2 9712 5628

## **ACE 2001: Australian Construction Equipment Expo 23-25 March 2001, Bundoora Quarry, Bundoora, Victoria, Australia**

Exhibitions & Trade Fairs Pty Ltd  
6/40-44 St Kilda Rd, St Kildam Victoria 3182, Australia  
Tel: 61 3 9530 2500  
Fax: 61 3 9530 2600  
Email: [melb@etf.com.au](mailto:melb@etf.com.au)

## **World of Concrete 26 February – 2 March 2001, Las Vegas, USA**

ACI  
PO Box 9094, Farmington Hills, MI, USA  
Tel: 888 652 4962  
Fax: 888 562 3890  
<http://www.WorldofConcrete.com>

## **Outlook 2001 27 February – 1 March 2001, Canberra, Australia**

ABARE  
GPO Box 1563, Canberra ACT 2601  
Tel: 61 2 6272 2265  
Fax: 61 2 6272 2330  
<http://www.abareconomics.com>

## **City as a Stage 2-3 March 2001, Adelaide**

Tel: 61 8 8303 0763  
<http://www.planning.sa.gov.au>

## **WORLDBEX 2001: Philippine World Building & Construction Expo 14-18 March 2001, World Trade Centre, Passay City, Manila, Philippines**

WorldBex Services International  
488 Boni Avenue cor San Joaquin St  
Mandaluyong City, Manila, Philippines 1550  
Tel: 632 531 6374  
Fax: 632 533 2026  
Email: [worldbex@pacific.net.ph](mailto:worldbex@pacific.net.ph)

## **Managing Your Road Assets: 20th ARRB Conference**

### **19-21 March 2001, Melbourne Convention Centre, Australia**

ARRB Transport Research Ltd  
500 Burwood Highway, Vermont South, Victoria 3133  
Tel: 61 3 9881 1662  
Fax: 61 3 9887 9618  
Email: [20conf@arrb.org.au](mailto:20conf@arrb.org.au)

## **Master Plumbers & Mechanical Contractors Association Annual State Conference 22-28 March 2001, Coffs Harbour, Australia**

Opal Cove Resort, Coffs Harbour, NSW  
PO Box 65, Haberfield, NSW 2045, Australia  
Tel: 61 2 9797 7055  
Fax: 61 2 9799 5841

**International Conference on Engineering Development in Shotcrete**  
**2–4 April 2001, Hotel Grand Chancellor, Hobart, Australia**

Mures Convention Management  
Victoria Dock, Hobart, Tasmania 7000, Australia  
Tel: 61 3 6234 1424  
Fax: 61 3 6234 4464  
Email: [conventions@mures.com.au](mailto:conventions@mures.com.au)

**CIB World Building Congress 2001: Performance in Product and Practice**  
**2–6 April 2001, Wellington, New Zealand**

BRANZ  
Private Bag 50908, Porirua City, New Zealand  
Tel: 64 4 235 7600  
Fax: 64 4 235 6070  
Email: [conference.works@xtra.co.nz](mailto:conference.works@xtra.co.nz)

**5th International Conference on Deep Foundation Practice**  
**4–6 April 2001, Hotel New Otani, Singapore**

CI-Premier Pte Ltd  
150 Orchard Rd #07-14, Orchard Plaza  
Singapore 238841  
Tel: 65 733 2922  
Fax: 65 2353530  
Email: [cipremie@singnet.com.sg](mailto:cipremie@singnet.com.sg)  
<http://www.cipremier.com>

**Building Tomorrow's Future**  
**9–11 April 2001, Surfers Paradise, Australia**

Australian Building Code Board  
GPO Box 9839, Canberra ACT 2601  
Tel: 61 2 6213 7713

**China Tile**  
**10–12 April 2001, Shanghai, China**

Ms Sofie Hemeryck  
Keylong Exhibition, E19B, Strength Plaza  
New Hongqiao Business Sq, 600 Tianshan Rd  
Shanghai 200051, PR China  
Tel: 86 21 5289 6776 ext 44  
Fax: 86 21 5289 6066  
Email: [Chinafloor@online.sh.cn](mailto:Chinafloor@online.sh.cn)

**Cities for the New Economy – Development Strategies for 21C Urban Growth**  
**22–24 April 2001, Gold Coast, Australia**

Conference Solutions  
Tel: 61 2 6285 3000

**Australasian Structural Engineering Conference**  
**29 April – 2 May 2001, Gold Coast, Australia**

ICMS  
84 Queensbridge St, Southbank, Victoria 3006, Australia  
Tel: 613 9682 0244  
Fax: 61 3 9682 0288  
Email: [icms@icms.com.au](mailto:icms@icms.com.au)

**Concrete and Development: 1st International Conference**  
**30 April – 2 May 2001, Tehran, Iran**

Building & Housing Research Center  
PO Box 13145-1696, Tehran, I.R. Iran  
Tel: 98 21 8259975  
Fax: 98 21 8255941  
Email: [bhrcconf@www.dci.co.ir](mailto:bhrcconf@www.dci.co.ir)

**Concrete and Development: 1st International Building & Homestyle Show**  
**4–6 May, 2001 Showgrounds Exhibition Centre, Perth, Australia**

Exhibit Exhibition & Publishing Ltd  
Ground Floor, 5 Ord St, West Perth, WA 6005, Australia  
Tel: 61 8 9486 1922  
Fax: 61 8 9486 1933

**Fluid Power Expo**  
**9–10 May 2001, Sydney Showground, Olympic Park, Australia**

Sydney Exhibitor Services P/L  
PO Box 6305, Baulkham Hills BC, NSW 1755  
Tel: 612 9894 8911  
Fax: 61 2 9894 8533  
Email: [Exhibition@exhibitorservices.com.au](mailto:Exhibition@exhibitorservices.com.au)

**12th National Conference of the Facility Management Association ideaction 2001 – People Creating Value**  
**9–11 May 2001, Melbourne, Australia**

Facility Management Association  
PO Box 397, Collins Street West, Melbourne, Victoria 8007  
Tel: 61 3 9620 1100  
Fax: 61 3 9620 1122  
Email: [national@fma.com.au](mailto:national@fma.com.au)

**IBEX: the 17th International Building Exposition**  
**16–19 May 2001, Hong Kong**

Reed Exhibition Companies  
19th Floor, 8 Commercial Tower, 8 Sun Yip St, Chaiwan, Hong Kong  
Tel: 852 2 824 0330  
Fax: 852 2 842 0246  
Email: [inquiry@reedexpo.co.uk](mailto:inquiry@reedexpo.co.uk)

**Ausbuild 2001**  
**24–26 May 2001, Cairns Convention Centre, Australia**

Queensland Housing Industry Association  
79 Constitution Ave, Canberra, ACT 2601, Australia  
Tel: 61 2 6249 6366  
Fax: 512 62575658

**Timber & Working With Wood Show**  
**25–27 May 2001, RNAIA Showgrounds, Brisbane, Australia**

Riddell Exhibition Promotions Pty Ltd  
PO Box 153, Drummoyne, NSW 2047, Australia  
Tel: 61 2 9712 5623  
Fax: 61 2 9712 5628

**Interbuild Australia**  
**3–6 June 2001, Sydney Convention & Exhibition Centre, Darling Harbour, Australia**

Australian Exhibition Services Pty Ltd  
Illoura Plaza, 424 St Kilda Rd, Melbourne, Victoria 3004, Australia  
Tel: 61 3 9261 4500  
Fax: 613 9261 4545

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**3–6 June 2001, Sydney Convention & Exhibition Centre, Darling Harbour, Australia**

Australian Exhibition Services Pty Ltd  
Illoura Plaza, 424 St Kilda Rd, Melbourne, Victoria 3004, Australia  
Tel: 61 3 9261 4500  
Fax: 613 9261 4545

**Information and Communication Technology (ICT) in the Practice of Building and Civil Engineering**  
**6–8 June 2001, Espo, Finland**

Association of Finnish Civil Engineers RIL  
Meritulinkatu 16 A 5, FIN-00170 Helsinki, Finland  
Tel: 358 9 6840 780  
Fax: 358 9 1357670  
Email: [siv.forsten@ril.fi](mailto:siv.forsten@ril.fi)

**Timber & Working With Wood Show**  
**6–8 July 2001, Fox, Moore Park, Sydney, Australia**

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Fax: 613 9261 4545

**Timber & Working With Wood Show  
27–29 July 2001, Royal Adelaide Showground, Wayville,  
South Australia**

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Fax: 613 9261 4545

**Electro Expo  
7–9 August 2001, Brisbane Convention & Exhibition  
Centre**

Electrical Contractors Association  
PO Box 2438, Fortitude Valley BC, Queensland 4006  
Tel: 61 7 3252 7488  
Fax: 617 3252 4320

**Australasian Fire Authorities Council Conference  
10–13 August 2001, Carlton Hotel, Darwin, Australia**

Convention Catalysts  
GPO Box 2541, Darwin, Northern Territory 0801, Australia  
Tel: 61 8 8981 1875  
Fax: 618 8941 1639

**Buildex  
12–14 August 2001, New Zealand Expo Centre  
Showgrounds, Auckland**

dmg World Media  
Level 1, 99–107 Khyber Pass Road, Grafton, Auckland, NZ  
Tel: 64 9 300 3950  
Fax: 64 9 379 3358

**26th Conference on Our World in Concrete & Structures  
22–24 August 2001, Singapore**

CI-Premier Pte Ltd  
150 Orchard Rd #07-14, Orchard Plaza, Singapore 238841  
Tel: (065) 235 3530  
Fax: (065) 2353 3530  
Email: [cipremie@singnet.com.sg](mailto:cipremie@singnet.com.sg)  
<http://www.cipremier.com>

**7th International Conference on Inspection,  
Appraisal, Repairs & Maintenance of Buildings &  
Structures  
11–13 September 2001, Nottingham, UK**

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150 Orchard Rd #07-14, Orchard Plaza, Singapore 238841  
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Fax: (065) 2353 3530  
Email: [cipremie@singnet.com.sg](mailto:cipremie@singnet.com.sg)  
<http://www.cipremier.com>

**Australian Steel Convention  
9–11 September 2001, Christchurch Convention Centre,  
Christchurch**

The Steel Institute of Australia  
PO Box 6040, North Sydney, NSW 2060, Australia  
Tel: 61 2 9957 3133  
Fax: 612 9959 4646  
Email: [sia@steelinstitute.com.au](mailto:sia@steelinstitute.com.au)

**Facility Management  
12–14 September 2001**

Australian Trade Exhibitions Pty Ltd  
PO Box 192, Hawthorn, Victoria 3122, Australia  
Tel: 61 3 9819 0211  
Fax: 61 3 9818 8553  
Email: [facman@ate.net.au](mailto:facman@ate.net.au)

**Timber & Working With Wood Show  
14–18 September 2001, Exhibition Park, Canberra,  
Australia**

Australian Exhibition Services Pty Ltd  
Illoura Plaza, 424 St Kilda Rd, Melbourne, Victoria 3004, Australia  
Tel: 61 3 9261 4500  
Fax: 613 9261 4545

**AUSFENEX 2001 Australian Window Association  
27–30 September 2001, Sydney Convention &  
Exhibition Centre, Australia**

Contact Exhibitions Pty Ltd  
PO Box 620, Turramurra, NSW 2074, Australia  
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Fax: 612 9449 9332

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19–21 October 2001, Melbourne Exhibition Centra,  
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Illoura Plaza, 424 St Kilda Rd, Melbourne, Victoria 3004, Australia  
Tel: 61 3 9261 4500  
Fax: 613 9261 4545

**Royal Australian Planning Institute Annual  
Conference  
28–31 October 2001, National Convention Centre,  
Canberra, Australia**

Conference Logistics  
PO Box 505, Curtin, ACT 2605, Australia  
Tel: 61 2 62 61 6624  
Fax: 61 2 6285 1336

**Corrosion & Prevention  
November 2001, Newcastle, Australia**

Australasian Corrosion Association  
PO Box 634, Brentford Square, Forest Hills, Victoria 3131  
Tel: 61 3 9874 0800  
Fax: 61 3 9874 4800  
<http://www.corrprev.org.au>

**Interbuild Brisbane  
4–6 November 2001, Brisbane Convention &  
Exhibition Centre, Australia**

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Illoura Plaza, 424 St Kilda Rd, Melbourne, Victoria 2004,  
Australia  
Tel: 61 3 9261 4500  
Fax: 61 3 9261 4545

**AURISA (Urban Regional Planning Conference)  
19–23 November 2001, Canberra, Australia**

Australian Convention & Travel Services  
GPO Box 2200, Canberra, ACT 2601, Australia  
Tel: 61 2 6257 3299  
Fax: 61 2 6257 3256

**4th Asia–Pacific Conference on Shock & Impact  
Loads on Structures  
21–23 November 2001, Singapore**

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150 Orchard Rd #07-14, Orchard Plaza, Singapore 238841  
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Fax: (065) 2353 3530  
Email: [cipremie@singnet.com.sg](mailto:cipremie@singnet.com.sg)  
<http://www.cipremier.com>

**Australian Acoustical Society Annual Conference  
21–23 November 2001, Canberra, Australia**

'Acoustics Australia' Acoustics & Vibrations Unit  
Australian Defence Force Academy, Canberra, ACT 2600  
Tel: 61 2 6268 8241  
Fax: 61 2 6268 8276

**2001 International Solar Energy Society Congress  
25 November – 1 December 2001, Adelaide  
Convention Centre, Australia**

Hartley Management Group Pty Ltd  
PO Box 20, Kent Town, South Australia 5071  
Tel: 61 8 8363 4399  
Fax: 61 8 8363 4577

**Building & Construction Indonesia  
26–29 November 2001, Jakarta International Exhibition  
Centre**

Kemayoran Indonesia  
Pt. Pamerindo Buana Abadi, Deutsche Bank Building, 13th Floor,  
Jl Iman Bonjol 80, RI-Jakarta 10310  
Tel: 62 21 316 2001  
Fax: 62 21 316 1981

**10th International Congress of Fracture  
3–7 December 2001, Honolulu, Hawaii**

Elsevier Science  
The Boulevard, Langford Lane, Kidlington, Oxford OX5  
1GB, UK  
Tel: 44 1865 843643  
Fax: 44 1865843958  
<http://www.elsevier.com/locate/icf10>

**International Conference on Development of Coastal  
Engineering  
18–19 December 2001, Singapore**

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<http://www.cipremier.com>

**International Conference on Ocean & Offshore  
Structures  
20–21 December 2001, Singapore**

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150 Orchard Rd #07-14, Orchard Plaza, Singapore 238841  
Tel: (065) 235 3530  
Fax: (065) 2353 3530  
Email: [cipremie@singnet.com.sg](mailto:cipremie@singnet.com.sg)  
<http://www.cipremier.com>

**9th International Conference on the Durability of Building  
Materials & Components  
17–21 March 2002, Brisbane Convention & Exhibition  
Centre, Australia**

<http://www.dbce.csiro.au/9dbmc/conference/index.cfm>

**Indoor Air 2002: 9th International Conference on  
Indoor Air Quality  
30 June – 5 July 2002, Monterey, California, USA**

<http://www.indoorair2002.org>

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