Underfloor Heating — Old Misconceptions Worn & Truly Dispelled!

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It's Summer — Relax!

Not too long ago BSNews bemoaned the fact that the industry had lost its sense of fun and comraderie, that it was all business, business, business. Well, recent weeks have demonstrated that, while working hard, it can also still play hard.

Throughout the last month we have had Wilo at Limerick Races, Armitage Shanks at Croke Park and Grundfos at Glen of the Downs. There were also BTU outings at Newlands and Forest Little, sponsored by Dublin Providers and Air Technology respectively.

In addition there were a number of other, less publicised, promotional events and activities, including smaller parties who travelled to foreign shores.

While BSNews constantly decries the lack of professionalism in some industry sectors — and will continue to do so — it applauds those who understand that it is equally important to tune out and have some fun. Well done all concerned.

Expansion on 'Da Banks'

With €2 billion spent on major construction projects over the last three years alone, Cork has undergone a massive transformation.

However, rather than mark the completion of a development phase it is but the beginning with similar sums already allocated for additional development in the coming years. See page 10.
Heat Merchants Launch The Savanna Compact Range

In keeping with the Heat Merchants philosophy of providing top-quality products at a competitive price, Heat Merchants have teamed up with Stelrad, the UK’s market leader in central heating radiators, to provide customers with the Savanna range of compact radiators.

The Savanna range comes complete with all the features expected from a market leader. Combining the most sophisticated production resources in Europe, with substantial investment directed towards testing and verification of performance data, has resulted in the creation of a high-output Savanna radiator for heating performance that exceeds expectation.

Strictly controlled independent laboratory testing ensures that all Savanna radiators are guaranteed to perform to a maximum working pressure of 116 psi (8 bar) and conform to BS EN 442 — the European Standard for radiators. As a measure of the all round dependable quality and performance, the Savanna range comes complete with a 10-year manufacturer’s warranty.

A range of 77 models provides extra sizing flexibility and covers a multitude of application requirements. With four heights, ranging from 300mm to 900mm, and lengths from as little as 400mm up to 2000mm, the Savanna range can offer a size and style to fit the most challenging of application requirements. The elegant, integrated top grille and side panels have been specifically designed to eradicate any movement, providing a tight, professional fit that will remain in place, even after storage, transit and installation.

As you would expect from a radiator with the Stelrad pedigree, the Savanna convectors are precision welded directly onto the waterways for greater efficiency and economy, with flexible connection options for the highest of commercial and domestic application specifications. They can be fitted to floor standing brackets where situations such as tiled walls present installation difficulties.

The Savanna range is manufactured under ISO 9001 in the UK and every radiator comes wrapped in robust, practical packaging that will keep the product pristine, right through to handover. Protective through storage and transit, the new packaging design also allows installation prior to removal.

Stelrad have the European background to assist and deliver total quality to Heat Merchants, with the emphasis on ensuring that each product is manufactured and painted to perfection and that it provides homes in Ireland with styled heating that lasts. Heat Merchants will continue to offer customers the high level of service and after sales service they have come to know and expect from the company.

Contact: Branches Nationwide. www.heatmerchants.ie

Plan Expo 2005 — Built Environment Showcase

Plan Expo, Ireland’s premier showcase for the built environment, will take place from Thursday, 10 November to Saturday, 12 November, 2006 in Dublin’s RDS. Endorsed by the Construction Industry Federation (CIF) and the Royal Institute of Architects in Ireland (RIAI), the show brings together something like 250 exhibitors from home and abroad, representing the entire construction sector.

Managing Director of Expo Exhibitions commented: “Plan Expo exhibitors offer innovation, new products and pioneering new construction techniques aimed at architects, building contractors, consulting engineers, building services contractors, property managers, property developers, surveyors and interior designers. All the industry’s premier brands will be featured, including Century Homes, Kingspan, Moy Isover, Marvin Architectural, Geberit and Pilkington glass.

This year a major focus for the show will be off-site construction, from specialist exhibitors in timber, metal and pods manufacturing, to master classes on the benefits and best uses of off-site construction. Visitor “trail-style” information guides will highlight specific areas to make sourcing a particular product type or company easy.

Ireland has a long tradition of producing quality natural stone used in cladding, flooring, worktops and hard landscaping and this year an exciting addition is the inclusion of a special feature area dedicated to local quarries and leading suppliers of stone from around the world.

Other key attractions at Plan Expo 2005 include the Opus Architecture and Construction Awards; A series of Master Classes covering a wide range of topics; the Product of the Show Awards; and the International Pavilion.

Contact: Stephen Murtagh, Expo Exhibitions. Tel: 01 - 295 8181; www.expo-events.com/planexpo
SANYO are proud to introduce the ECOi Mini, our new range of small capacity 2 pipe heat pump VRF systems. Specifically designed for the UK and Irish markets, the ECOi Mini sets new standards of performance and flexibility with an EEL category A rating across the range and connectivity of up to 10 indoor units to a single outdoor unit.

Forming a new key part of the SANYO VRF line up, the ECOi Mini is compatible with the indoor units and controls as the rest of our electric and gas powered ranges.

- 11.2kW, 14.0kW and 15.5kW cooling capacities
- Single phase power supply
- 1 amp start current
- DC inverter technology and R410A
- Diversity ratio of 50 – 130%
- 150m pipe runs
- COP of 4.06 for 4HP model
- Cooling to -10°C / heating to -20°C

Designed to be easy to apply, install and maintain, the ECOi Mini fulfills the market need for highly efficient, and flexible air conditioning.

SANYO - a good solution all round.
Heavenly Harvest

It is easy to take water for granted, especially when it is free. However, though Minister for the Environment Dick Roche assures us that there are no current plans for domestic water charges, it must only be a matter of time. Between now and then there will almost certainly be shortages and possibly rationing.

We are all using more and more water. An ordinary shower uses half as much water as a bath but a power shower actually uses more. If even half the population of Dublin turned off the tap when brushing their teeth, nine million litres would be saved every day!

You can do more than just conserve water. Rainwater harvesting can be done by almost everyone and you don’t need to be a farmer to bring in this unusual crop. Rainwater collected from your roof is stored in an underground tank and can be used for WC flushing, clothes washing and garden watering, saving up to 50% of the amount which a normal household gets through. It is so soft it is lovely to wash with, there is no limescale build up in your pipes and appliances, and it uses less detergent.

There are several chemical-free systems on the market and they can be seen at the Self-build Extend & Renovate Show to be held at Punchestown, Co Kildare on Friday, Saturday and Sunday, 2 to 4 September 2005.

Sustainability is a major theme of the show which has 200 exhibitors, all related to the show title of building, extending or renovating your home. Clive Corry, organiser of the event said: “Visitors travel to the show from every corner of Ireland - even flying in from Donegal! They are looking for information and advice to successfully complete their building project and we have it all for them here under one roof.

“Finance, insurance, design and construction along with a huge variety of products and materials such as bricks, roof tiles, windows and doors for the building envelope; kitchens, bathrooms and fireplaces for the inside. We even have a ‘Design Island’ of top Irish manufacturers of handmade lighting, furniture and metalwork.

“The show unusually combines hi-tech with sustainability and traditional skills. You can watch live demonstrations of thatching, lime plastering and hemp-walling while, at the same time, order your whole house wiring system to bring computers, home cinema and sound systems into every room of the house.

“To ease your conscience after all this expenditure you can run it sustainably with energy from wind turbines, solar roof panels and geothermal heat pumps.”

The show runs from 12 noon to 8pm on the Friday, and 10am to 6pm on both Saturday and Sunday. Entrance fee is €10; parking is free.

Contact: www.self-build.ie

Wavin Investment Drives Innovation

Wavin Ireland has further expanded its production capacity in Balbriggan with a €0.75 million expansion of its Hot Mix plant. This investment reflects Wavin’s commitment to ongoing product development with a view to further enhancing customer service.

“Over the years we have consistently upgraded the Balbriggan facility and the current expansion is part of an ongoing investment in our business”, said Larry Carr, Wavin’s Managing Director.

“Indeed, over the past five years we have invested almost €10 million in plant and equipment, including an extension to the production facilities in Balbriggan and a new Distribution and Logistics Centre.

Coperion Waeschle, Italy, designed and supplied the new hot mix system in line with Wavin’s requirements. It was built by local mechanical and electrical contractors, Laser Engineering, and Listec Electrical, Belfiewstown, Co Meath.

The project — which took 15 months to complete — was managed by Patrick Moore, Wavin’s Engineering Manager, and involved a cross-functional team from engineering, operations and finance. “The provision of the additional hot mix stream will increase the plant’s capacity by 30% and provide extra flexibility by allowing different pipe recipes to be made at the same time”, said Patrick Moore.

Contact: Larry Carr, Wavin Ireland.
Tel: 01 - 802 0200;
email: ie_info@wavin.com
Halton Kitchen Canopies - clean operation, clean benefits

Ever thought of exhausting at low level or into a basement carpark? Now you can

With Halton 'Capture Jet' & 'Capture Ray' Kitchen Canopies the benefits are:
- smaller ducts & fans - reduced energy consumption - reduced project cost - commercial kitchens in new locations - elimination of grease & odours - reduced risk of fire - energy recovery is now possible - guaranteed comfort conditions in the kitchen

- site references:
  - Marriott Hotel Galway - Doonbeg Golf & Country Club, Clare - Dublin Bus - Burlington Hotel, Dublin - Radisson Hotels Galway & Sligo - Carton House Hotel, Maynooth - Fás DunLoch & Waterford

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To learn more please book a CPD presentation or visit www.entropic.ie/kitchenvent.htm
Sanyo — ‘Small Is Beautiful’

In its continuous effort to provide the all-round air conditioning solution, Sanyo has introduced the innovative ECOi Mini range of small capacity VRF systems. Specifically developed for the European market, this small, 2-pipe heat pump VRF system offers premium quality air conditioning for small to medium sized projects.

Barry Hennessy, National Sales Manager, SANYO Air Conditioners Ireland explains: ‘The ECOi Mini range will enable us to further grow and strengthen our position in Ireland by entering the rapidly-expanding sector for small VRF systems. These systems currently account for approximately 20% of the total VRF market in the UK and we are confident these units will have a similar impact on the Irish market. In line with Sanyo’s corporate policy of only producing products that support sustainability, the range offers some of the highest efficiency ratings on the market, and they are one of the quietest!

“The three models in the range offer between 11kW and 15.5kW of cooling capacity, and incredibly flexible solutions with the capacity for up to a class-leading 10 indoor units to be connected to one, single-phase condensing unit. With an indoor diversity ratio of 130% and a maximum pipe separation of 150m, just one 6HP ECOi Mini could condition, for example, 10 hotel bedrooms with a 2kW load”.

The ECOi Mini range features the latest DC inverter technology which, when combined with R410A refrigerant, provides EEL Category A efficiency, with the 4HP model offering a market-leading COP of 4.06 in cooling and 4.34 in heating.

Sanyo has also designed the new range with European environmental considerations in mind. It features the lowest outdoor unit sound levels in the industry (51dB(A)) in normal mode and just 48dB(A) in silent mode for the 4HP model), ensuring easy specification of the system in urban locations where noise is often a key concern. It can also provide cooling at -10°C and heating at -20°C, again significantly better than comparable VRF brands.

All the outdoor units share the same compact dimensions which simplifies transportation, siting and installation. Contractors and specifiers can select from Sanyo’s range of 10 indoor unit styles and full control packages which now include the TouchScreen controller and web-browser.

Contact: Barry Hennessy, National Sales Manager or Sinead Duffy, Sales Executive, Sanyo Airconditioners Ireland. Tel: 01 - 403 9900; www.sanyoaicon.com

Grundfos Gets A For Energy-Saving

The new series of domestic circulator pumps from Grundfos bears the European “A” energy rating, indicating exceptionally low annual energy consumption. These new pumps are all members of Grundfos’ family of Alpha Pro pumps which feature lifting heights of 4m, 5m, and 6m. Joining this new product line are new models of the established Grundfos Alpha+, UPS, and MAGNA families of circulators. Several of these models also feature “A” energy ratings, even as flow reaches a maximum of 40 m³/hour and a maximum head of 12m.

In creating low-energy pumps, Grundfos significantly contributes to reducing the energy consumption of the over 120 million circulators in use in the EU today. With approximately 10% of these pumps being replaced each year, Grundfos’ new pumps benefit the individual user — and society as a whole — by reducing the demand on electrical power supply. Grundfos has been instrumental in developing and promoting the establishment of the EU energy-labelling scheme. Now all pump packaging will feature the well-known A-G energy label, complete with an indication of the energy class in which the pump lies. An average circulator pump, which the majority of the heating installations in Europe utilise, will receive an energy class D or E rating. The energy consumption of an A-rated pump is lowered by 75% compared to the consumption of the average circulator pump installed today.

Contact: Gordon Barry, Grundfos Ireland. Tel: 01 - 408 9800; email: info-ie@grundfos.com

https://arrow.tudublin.ie/bsn/vol44/iss7/1
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THE NEW SAVANNA RADIATOR RANGE

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- Conforms to BS EN 442.
- Guaranteed to perform to a maximum working pressure of 116psi (8 bar).
- Comes with 10 year manufacturer's warranty.
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www.heatmerchants.ie

The comfort of incredible flexibility

Multi F, with its single phase power supply and inverter technology, is ideal in applications of up to 9.0kW, whereas Multi FDX, a mini-VRF system, can be used in applications up to 16.0kW, thanks to its use of distributor boxes that allows several indoor units to be run from a single outdoor.

MULTI F/FDX

- Works with: Art Cool, Wall Mounted, Cassette, High & Low Static Ducted, Convertible
- Ranging from 4.0kW to 16.0kW
- Both systems allow maximum pipe runs of up to 25 metres for every indoor unit. Multi FDX allows extra pipe length with the use of distributor boxes
- Up to 8 indoor units to 1 outdoor
- Refrigerant: R410A
- Energy rating: Class "A" (Depending on system configuration)

As easy and flexible in their installation as they are in their operation, Multi F and Multi FDX typify the thinking that we’re putting into the Comfort Zone: to provide equipment and services that allow everybody — contractor, specifier, property manager and end user — to feel the benefit.

Whoever you are, welcome to the Comfort Zone...

Core Air Conditioning Ltd
Tel: 01 - 409 8912
Email: info@coreac.com

Dean & Wood Ireland Ltd
Tel: 01 - 451 4100
Email: dwi@dean-wood.com
Cylon Expands Management & Accelerate Growth

Cylon Controls Ltd, the largest privately-owned manufacturer of building controls in Europe, has strengthened its management team with three senior appointments as a key part of the strategic business plan which will see turnover double over the next five years. Alan Long has been appointed as Sales Director, Jennifer Egan joins to manage an enlarged Customer Services Team and John Fallon takes the role of Product Marketing Manager.

These significant new appointments mark a new period of expansion for the company. In business for over 20 years, Cylon is renowned for reliable building management solutions. The latest generation of UnitronUC32 web-enabled controllers now provides breakthrough flexibility and energy savings. Based on this exciting new product range Cylon is making the additional sales and marketing investments to double in size. There is a special focus on the UK with an expanded sales and support team and the German market where Cylon has recently set up an office.

Commenting on the appointments, Sean Giblin, Managing Director at Cylon said: “We have a loyal customer base and a great track record which we are leveraging for further growth. I am delighted to welcome Alan, Jennifer and John to Cylon, each of whom brings solid experience of growing companies in industrial high-tech markets.”

Nederman Acquires Vent-Equip

Nederman Ltd has just acquired Vent-Equip Ltd, the Wicklow-based dust, fume and vehicle exhaust extraction specialist.

Nederman already has a wholly-owned division in Northern Ireland called Slanair Systems and this new acquisition now gives an comprehensive all-Ireland cover. Both companies will now be rebranded Nederman Ireland.

Former agent Harold Engineering will now become the principal distributor for Nederman Ireland.

Smile: Versatile Heating Controller From Honeywell

Honeywell has introduced Smile, a versatile new heating controller for both underfloor and radiator heating, and hot water in large homes and small public buildings. True to its launch theme “Simplify your life”, Smile is designed for simple operation and easy and fast commissioning, while providing excellent value for money.

Smile has an ingenious user panel with a large back-lit LED display and a single rotary control that is also a push button. It makes it easy to select, change and confirm set values and times.

Smile’s built-in weather compensator control responds to outside temperatures, ensuring comfort and economy. Users can also select separate heating profiles such as “holiday”, “economy” and a “party” profile that prolongs the evening heating period.

Smile is suitable for boiler heating alone or with additional solar heating. It can be used as a single-unit system or in complex boiler control schemes, with up to five Smile controllers wired in series via a 2-wire bus. It is available for either wall mounted or panel installation.

Contact: Honeywell. Tel: 0044 1344 656443; HVACProductsUK@honeywell.com

Climate Protection Award For York

YORK International is the only HVACR company to have been honoured with a 2005 Climate Protection Award from the US Environmental Protection Agency (EPA). YORK was recognised for its pioneering work and ongoing development of energy-saving technologies applied to chillers, specifically with regard to electronic variable speed drives with their dramatic energy saving potential.

YORK has been widely recognised that the indirect effect of electricity consumption is the largest contributor to greenhouse gas emissions. The application of VSDs will typically reduce annual energy consumption of a centrifugal chiller by 15/25 %, which means a significant reduction in CO₂ emissions.

Contact: Andrew McEvitt, York ACR. Tel: 01 - 466 0177; email: yorkdublin@ie.york.com
Superior Control at Unexpected Prices

Manotherm Ltd, the preferred source for practical and affordable flow metering solutions, has introduced the new Dwyer Model NVII needle valve range for use in most gas and liquid applications, including shut-off and throttling for pressure gauges, and flow instruments.

With a one-piece, hot-forged brass body construction, tamper-proof design and blow-out proof stems, years of trouble-free service can be expected.

The Model NVII can withstand pressures as high 2000 psi and temperatures up to 180°C. Even under such extreme conditions, these valves maintain their flow coefficient superiority over the competition.

Another groundbreaking Dwyer product range is the new Series 641RM Air velocity transmitter with cable for monitoring precise airflow. The Series SFI-100T sight flow indicator/transmitter is a low-cost and durable flow transmitter, constructed of a robust, solid brass body for industrial use and has output for flow rate and totalisation.

Low-cost solutions for monitoring and controlling temperature for heating and cooling applications are also available in the Series TSS and TS2 digital temperature switches.

Many other new valves being introduced are two-piece hand level brass ball valve (Series BV2MB); low-cost brass needle and ball valves, which have blow-out-proof stems (Model NVII & Series MV); two-piece SS flange and three-piece SS sanitary ball valves that are electric and pneumatic actuated (Series BV2 & BV3); and low-cost, compact angle seat valves (Series SAV) to meet many environmental challenges.

Contact: Bob Gilbert, Robert Gilbert and Noel Walsh, Manotherm.
Tel: 01 - 452 2355; email: info@manotherm.ie

Employment Increase At Wavin

Wavin Ireland has further expanded its workforce with 17 new full-time jobs at Balbriggan, Co Dublin. The jobs have been created in both the production and distribution areas of the plant.

This brings the full-time employment level at Wavin to 185.

This increase in jobs at Wavin comes on the heels of the announcement that the production capacity in Balbriggan has been increased with a €750,000 expansion of its Hot Mix plant.

Over the past five years Wavin has invested almost €10 million in plant and equipment, including an extension to the production facilities in Balbriggan, and a new Distribution and Logistics Centre.
Sanyo’s Evolution Puts Greater Emphasis on Air Conditioning

Manager UK & Ireland explains: “The company realises that chasing turnover in the consumer electronics market with mass-produced products is not its speciality. Sanyo is a technology-driven, development company and moving forward we want to offer products that support sustainability and meet environmental long-term needs rather than short term fads.

“We will also look to have more synergy between our divisions, so expect future air conditioning products to include higher COPs, carbon dioxide compressor technology, solar powered options and rechargeable cells to reduce power consumption. Being part of the Sanyo E & E division (Energy and Ecology) will mean that air conditioning will be at the heart of this ‘Third beginning’ (marking Toshimasa Iue, the founder’s grandson, becoming COO) and ensure that the company’s growth in the air conditioning market will continue and, if anything, increase.

“Having been part of a panel discussion over the recent launch weekend in Osaka, Japan, there is a true belief within the company that this is what everyone wants. The earthquake last October that destroyed one of our semi-conductor factories, hit the company hard. This, however, has become somewhat of a catalyst to new thinking within the workforce and the average Japanese worker really does believe in working for the ‘greater good’ and are looking to embrace the new beginning.

“Sanyo Air Conditioning has just registered its 7th consecutive quarters growth. We appear to be succeeding in a tough market – a bit more sun would help but when your strength lies in strong products that offer good commercial, as well as environmental sense, such as GHP and high COP VRF, the sun only adds the icing to the cake and should never be considered when building a business plan. I think that companies that do may as well bet on red and black at a casino.

This “Third Beginning” will also see Sanyo look to boost its brand through stronger marketing and a consistent message. The Sanyo Evolution Project is well and truly underway and will lead to a much stronger and focussed company, which can only be good for the customer.

Contact: Barry Hennessy, National Sales Manager or Sinead Duffy, Sales Executive, Sanyo Airconditioners Ireland.
Tel: 01 - 403 9900; www.sanyoaircon.com

Expansion on ‘Da Banks’

With €2 billion already invested in public and private development projects over the last three years — and similar amounts allocated for ongoing/future projects — Cork is currently undergoing a radical transformation. There is a new-found sense of pride and optimism which is reflected in the booming construction sector and massive opportunities for building services.

BSNews is currently compiling an in-depth analysis of these opportunities and will present the results in a dedicated Cork feature in the October issue. As such it is the perfect vehicle for product and services suppliers to the sector to get their message across to architects, consultants, contractors and other key specifying decision-makers.

To participate in this special feature contact Joe Warren at Tel: 01 - 288 5001; email: joe@pressline.ie
Sanyo Airconditioners, the fastest-growing air conditioning company in Ireland, is looking to appoint a Senior Technical Consultant to enable us to continue and increase our service levels to consultant engineers in Ireland.

The successful candidate will have proven technical ability, be fully conversant with air conditioning and refrigeration systems, and be able to present and deliver project designs, as well as company presentations and CPD training.

Comprehensive training will be given to the successful candidate.

Remuneration package includes a generous basic salary, an executive company car, health and pension schemes and company bonus.

If you are looking to become an important element in a successful team and you want to let your true ability shine through, then this is a golden opportunity.

Apply in strictest confidence to the HR Department on email at: stcposition@sanyoaircon.com

Potterton Myson Ireland

A challenging opportunity has arisen and applications are invited for the position of Area Sales Manager (South) with Potterton Myson Ireland. Reporting to the National Sales Manager, he/she will be responsible for the operational management of the specified area.

Residing in the relevant area and working from home, you will be responsible for managing and developing customers in the area, including merchants, contractors, specifiers and local authorities, whom you will provide with all types of information regarding business. Managing an effective policy, you will meet sales targets associated with the product ranges, as well as preparing business plans based on budgeted target achievement, relevant to the accounts which you manage.

With a proven track record of selling construction/heating products — preferably in a similar market — you will have excellent interpersonal skills combined with IT skills and a determination to succeed. Working to tight deadlines and achieving sales targets will be critical to your success.

An excellent remuneration package is available to the successful candidate with a company car and expenses, in addition to pension and health insurance schemes.

Please apply in writing to:
National Sales Manager, Potterton Myson Ireland Ltd, Belgrand Road, Dublin 24.
IMI’s ‘Copper File’ Sets New Industry Standards

Irish Metal Industries Ltd — a subsidiary of Yorkshire Copper Tube which is part of Europe’s largest manufacturer of copper plumbing tube — has introduced a comprehensive product and technical data guide entitled ‘The Copper File’.

As the first of its kind for the industry, ‘The Copper File’ signals a new era in customer support, providing consultants, specifiers, installers and stockists with extensive information on the company’s product ranges and a comprehensive technical guide on the use of copper plumbing tube. ‘The Copper File’ includes:

— Individual new brochures dedicated to specific products, including the recently-extended Yorkex range;
— Technical information and guidance on the application of the products with an option to receive information updates.

Conor Lennon of Irish Metal Industries told BSN in that they had identified a clear need for a comprehensive guide to their large range of products from all sectors of the industry.

He commented: “We are committed to being the copper plumbing tube supplier of choice and the introduction of ‘The Copper File’ is testament to our commitment to quality customer support. No other manufacturer of copper plumbing tube provides such comprehensive literature. Products, regulations, standards and installation practices are constantly changing and our update service provides a mechanism to ensure that subscribers are always aware of the latest developments. The Copper File provides a reference document for all matters relating to the specification and application of our products.”

To receive a free copy of ‘The Copper File’ and to register for updates, readers can apply online at www.yct.com. Alternatively, call ‘The Copper File’ hotline on Tel: 0044 845 130 2881.

Honeywell Wireless Underfloor Heating Controls

A picturesque Cornish cottage has a specially-designed heating system providing underfloor and radiator space heating in four separately controlled zones, as well as domestic hot water. The system in the extensively-refurbished and extended home uses Honeywell programmers, timers, thermostats and valves throughout and was meticulously designed and installed for superior comfort and reliability.

To avoid drilling the walls and damaging decorations, two of the home’s three Honeywell CM67 programmable thermostats have the wireless RF option. All system components — including the boiler — are carefully hidden from view, using roof space and a boiler room constructed under extended eaves at the side of the cottage.

The four central heating zones are: the main house, heated by radiators; a 45m lounge with underfloor heating; a kitchen and conservatory totalling 70m heated by radiators, a 4 oven AGA and an AGA Companion; and towel rails, which operate through a dedicated 40-litre reservoir cylinder governed by a thermostat and motorised valve.

Contact: Paul Manning, Honeywell Control Systems. Tel: 0044 797 445 1034.
If you are buying or building the house of your dreams, don’t you owe it to yourself to install the best heating system available?

Comfort - Gentle and even heat - creates a feeling of well being.

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Tel: 01 816 5020 Fax: 01 816 5025
Myson Radiators is a leader in the supply and manufacture of a wide range of heating appliances, including panel and decorative radiators, fan convectors, towel warmers and valves. However, it is now also emerging as a major player in the growing underfloor heating market.

Underfloor heating is a method originally utilised by the Romans but now Myson is using the latest technology to bring the system up-to-date. Advances in new material technology and research into heat transfer have made it possible to achieve cost-effective warm water underfloor heating that provides both energy efficiency and high quality performance. Underfloor heating has become an increasingly popular choice and is now widely acknowledged as one of the most effective methods of obtaining uniform heat distribution and high comfort levels. It also has numerous benefits. Some select it for its delivery of heat at low level, while others enjoy the design freedom it gives owing to its concealed pipework. The system also has low maintenance costs and frees up valuable wallspace.

The Myson underfloor heating system can be used in all floor areas and is ideal for glazed rooms such as conservatories where there is little or sometimes no wall space. It is suitable for use with all types of wet central heating systems including gas, oil or solid fuels and conventional, combination or condensing boilers. It can also be introduced into mixed heating systems, for example, underfloor heating could be used on the ground floor with radiators upstairs.

To work effectively, underfloor heating requires water temperatures of between 45°C and 55°C. This is easily obtained by blending flow water and return water from the underfloor with the thermostatic mixing facility supplied. Systems can either be simple loop for an individual room up to approximately 16sqm floor area, or double or multiple loop systems for larger areas.

The Myson underfloor system is designed for all floor types. The most popular system utilises screeded floors. It comprises an edging strip, which is laid against all external and internal walls, providing both edge insulation and an expansion zone for the screed. Flatjet insulation is laid onto the concrete slab and a flow and return manifold is fitted in a central location. Difustop cross-linked polyethylene pipe is connected to the flow manifold and is then laid out in the required pattern. Myson supplies the recommended heating layout pattern. The pipes are held in place with U-clips and finally the pipework is connected to the return manifold.

Myson underfloor heating systems are suitable for most floor finishes, including ceramic tiles, timber and carpets. However, some modifications need to be made for certain surfaces. For example, a flexible adhesive should be used on ceramic floor tiles and it may sometimes be necessary to include a reinforcing mesh in the top quarter of the screed. This will accommodate the expansion and contraction of the floor due to heating and will avoid cracking of the tiles.

With plastic surfaces, the floorcovering and the adhesive used should be suitable for temperatures of 40°C. Both wood and carpets will restrict the heat transfer and this must be taken into account at the design stage. When using timber, it is essential that one with a low moisture content is used. If a timber with moisture content of more than 10% is used there is a risk of shrinkage during heating, resulting in gaps between the planks. Carpet and underlay combinations must not have a thermal resistance of greater than 1.5 Tog. Also, if carpets are to be stuck down, the adhesive used must be suitable for temperatures of up to 40°C.

Myson offers a complete heating design service, which specifies underfloor pipe layouts, controls and boiler applications. This results in a unique integrated heating system with a performance guarantee supported by Myson's expertise.

Contact: Sales Office, Potterton Myson. Tel: 01 - 459 0870; email:post@potterton-myson.ie

https://arrow.tudublin.ie/bsn/vol44/iss7/1
Join me at the top!

With the four new stars from Grundfos
The well-known energy label - now also for circulator pumps. A represents low-energy consumption and G high consumption. Selecting an A labelled pump gives energy savings up to 80% compared to the market standard pump marked D

Read more about the energy label on www.energyproject.com
As one of the foremost pump manufacturers in the world, Calpeda's production philosophy is based on two main principles — having the flexibility to offer customers what they want, when they want it, and then making sure it will work when installed. Sounds simple and straightforward but, as is so often the case, today's emphasis on so-called sophistication and complexity very often militates against simplicity.

"Calpeda has not fallen into this trap", says Graham Fay, Managing Director of Calpeda Ireland. "We pride ourselves in our ability to identify with the needs of the marketplace, to anticipate what its future requirements are, and to devise appropriate product ranges to satisfy that need.

"To that end we conduct extensive market research, both here in Ireland and throughout the world, and relay the result to our dedicated product development teams who are constantly looking to design ever-more innovative products. "But it is not just design for design sake. The primary objective is product performance with a view to ensuring compliance with all regulatory and accreditation criteria, whatever the application and country of usage. Hence the emphasis on quality, both of the materials used and the manner in which the manufacturing process is carried out and monitored.

"Individual machine tool operators are responsible for taking continuous samples of components to check quality. This process is supported by a central quality control management team that ensures component accuracy using high-tech, precision, calibration apparatus.

"Every single Calpeda pump is rigorously tested at each production stage and then put through an exciting computer test regime when it finally comes off the line. The process ends with a unique clean robot-painting facility, after which the pumps are packaged, and then shipped."

Calpeda's headquarters are located in Montorso Vicentino, just outside Vincenza in Northern Italy. It is a region famous for steel making and machinery industries, with Calpeda capitalising on the vast specialist skills of the many local machine tool manufacturers. Working closely with these suppliers Calpeda has developed specialised machine tools which are customised to its own requirements, along with innovative engineering solutions which optimise component use.

While undoubtedly production-driven, Calpeda does not manufacture products for stock. Right from the very first production stage, each pump represents a specific order. A unique barcode identifies it with the order and that stays with it as it progresses right through the manufacturing process towards final assembly and testing.

The scope of the Calpeda portfolio is all-embracing and includes— close-coupled centrifugal pumps; end-suction centrifugal pumps; horizontal and vertical multi-stage pumps; self-draing whirlpool pumps; self-priming swimming pool pumps; centrifugal pumps with open impeller; self-priming liquid ring pumps; self-priming jet pumps; gear pumps; vertical submerged pumps; submersible drainage pumps; submersible sewage and drainage pumps; multi-stage, clean water, pumps; submersible borehole pumps; electronic regulators for pumps; pressure boosting sets; and fire-fighting sets.

"As the foregoing clearly demonstrates", says Graham Fay, "Calpeda pumps are not merely about products but rather pumping solutions. Whether it is a commercial, industrial or domestic application we have the answer. We also have a network of authorised dealers with the expertise to provide comprehensive technical, application and installation support — in conjunction with Calpeda Pumps (Ireland) — across the entire portfolio."

Contact: Graham Fay or Stephen McDowell, Calpeda Pumps (Ireland).
Tel: 01 - 825 8212;
email: sales@calpedaireland.com
Polytherm Heating Systems Ltd
Radiant Heating Systems

Warmth everywhere it's needed. From floor, ceiling and walls, Polytherm has the systems and ideal solutions.

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New Build, residential and commercial. Polycomfort®
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Wall heating using pre-assembly units. Polyspo®
District Heating — pre-insulated pipes. Calpex®
Sprung flooring systems for sports hall. Polysport®
Heat pumps for outdoor installation. Geopack®

Published by ARROW@TU Dublin, 2005
Wavin Pex Ideal For Underfloor Heating

Wavin has been the pioneer and leading innovator of plastic pipe systems technology in Ireland for almost half a century and has added to that reputation by perfecting a range of cross-linked polyethylene pex pipes in Irish dimensions for plumbing and heating applications, including underfloor heating.

Wavin Pex Plumbing and Heating Solutions is ideal for those hard-to-reach places that every installer encounters. This new Wavin Pex brings plumbing and heating pipe production to a new level in terms of flexibility, strength and application.

Wavin has rigorously tested and re-tested this pex pipe in extremes of temperature to produce the ultimate pex pipe for hot and cold applications. This is the highest-quality product on the market and it far exceeds the requirements of Class S service conditions as specified in BS 7291-1-2001. It also carries the Irish Agreement Board Certification, Certificate No: 04/0201. It is fully approved for both open and closed central heating systems, underfloor heating, and plumbing applications.

As Wavin Pex weighs only a fraction of the weight of copper, it is lightweight and easily transportable on site. It comes in a range of coil sizes and straight lengths to allow for short and long pipe runs without the use of connectors.

Packaged in plastic wrap-around with easy access through the centre, it can be uncoiled with little effort. For ease of measurement the pipe has markings every metre.

Wavin Pex is available in a range of dimensions. It is suitable for all plumbing applications and includes an internal oxygen barrier making it the choice for central and underfloor heating applications, as well as tap water installations.

The pipe has been rigorously tested with IS EN 1254 brass compression fittings and Irish Dimension Tectite push-fit Fittings. Copper inserts are required as internal support before attaching a fitting to the cut end.

Wavin offers the full range of Tectite push-fit fittings for use with Wavin Pex pipe. Tectite is ideal when working with limited tool space in those hard-to-reach places, giving more flexibility for better plumbing solutions.

Wavin Pex can be jointed using Wavin Pex brass compression fittings to IS EN 1254. The pipe should be cut smoothly and squarely with a purpose-made pipe secateurs or hacksaw, and may need to be trimmed or filed to allow for a good joint. A copper pipe support insert should be placed into the pipe end after the nut and olive have been placed on the pipe. Push the pipe and olive into the fitting and screw the nut tightly to complete the compression joint.

Over the period of its life Wavin Pex pipe will not be damaged by freezing temperatures. The internal bore is smooth and is not liable to accumulation of scale in hard water areas. Pipes will not corrode under the action of soft water. Thermal expansion is accommodated within the length of a pipe run, reducing movement and subsequent creaking noises on joists, etc. Low thermal conductivity values mean that hot pipes are cooler to touch and the incidence of condensation on cold pipe is reduced.

The Wavin Pex oxygen barrier greatly reduces the ingress of air into the system, thus reducing the corrosion within a central heating system. Wavin Pex has a product guarantee of 25 years against defects in materials and manufacture, and has a life expectancy in excess of 50 years.

Wavin Pex is a high-performance material, which is flexible and durable. Due to its high impact resistance, less damage can be done on site, thus creating less waste.

Contact: Wavin Ireland. Tel: 01 - 841 5000; email: ie_info@wavin.com; www.wavin.ie
The ATC Electric Underfloor Heating System is especially suited for remodelled floors and new construction projects. This easily installed system is ideal for bathrooms, kitchens, conservatories, shower rooms and any general area where ceramic stone tiles are laid.

The cable mats or cable can be installed for direct heat (say in bathrooms/shower rooms) or background/comfort heat (say in kitchens). The option of semi-storage heat is also now available.

By using electric underfloor heating, typical operating temperatures can be 1-2 degrees lower than conventional heaters, reducing energy costs by up to 10%. A very user-friendly thermostatic programmer TH-132AF controls the ATC underfloor system. This programmer maintains the floor temperature level to your exact needs 24 hours a day, 7 days a week.

Our technical support team provides solutions to a host of heating applications using electric underfloor heating. Send in your requirements either with or without drawings and we will provide a full system design, along with on-site/off-site technical installation support.

For your local stockist please contact our Sales Office.

ATC Electrical & Mechanical Ltd
ATC Head Office & Showrooms
Unit 7, Airton Road, Tallaght, Dublin 24
Tel: 01 - 462 5111 Fax: 01 - 452 0887

ATC Regional Showrooms & Office
Unit 3E, Northpoint House, Northpoint Business Park, Mallow Road, Cork
Tel: 021 - 439 7860
Email: sales@atc.ie Web: www.atc.ie

For true comfort, efficiency and reliability, choose superior Qual-Pex Barrier pipes and Automix compensating controls.

Call today for a free quotation
Heat Merchants and REHAU have been working closely together since 2002 to bring together a first class service in the supply of underfloor heating in Ireland for both domestic and commercial installations. Over this time project design and development teams have been established, along with a sales network of 37 branches nationwide, and an approved installer panel appointed.

Support is provided in the form of training at the Heat Merchants UFH Academy in Athlone, on-site training, and technical support which is only a phone call away.

Rehau has over 25 years experience in underfloor heating and supplies high-quality systems suitable for a wide range of applications, one of the reasons why Heat Merchants is selling and distributing the Rehau system. Over the years Rehau has extruded and installed millions of metres of its Pe-Xa pipe which is manufactured from crosslinked polyethylene and has a co-extruded Eval Oxygen diffusion barrier. It is one of the best pipes available on the market and is widely recognised across Europe as the most “fit-for-purpose” material for underfloor heating.

Rehau’s fittings are manufactured from DZR brass and over 40 million have been installed. Their manifolds are manufactured from high-quality brass, the main body being a one-piece design. A compact mixer and a range of controls that simplify the operation of the underfloor heating system are also available.

Various control systems are supplied by Heat Merchants depending on the clients requirements. The controls already mentioned regulate the underfloor heating system but Heat Merchants also supplies various weather compensation systems.

The difference in choosing an underfloor heating system supplied by Heat Merchants is that each project is specifically designed. It is project driven and supported to a high level. Typical installations include domestic housing, sports halls, community halls, nurseries, homes, crèches, refurbished old cottages, factory outlets, showrooms, etc.

To support the Rehau underfloor heating system Heat Merchants also offers a wide range of options for high-efficiency boilers from the Baxi and Keston commercial ranges; the Dunstar Heatpump system; Solar panels from Absol; DJG stainless steel cylinders; and Wood pellet boilers.

At present Heat Merchants stocks over 250 Rehau heating and plumbing products and aims to see this stockholding and warehousing operations expand even further. Along with the Rehau underfloor heating system, Heat merchants also stocks Rehau’s flexible pipe system that is suitable for all types of plumbing and central heating applications. Pe-Xa pipe is the main component part of the system with 16mm, 20mm, 25mm and 32mm fittings available. However, larger sizes such as 40mm, 50mm, 63mm, 75mm, 90mm and 110mm can also be supplied for specific projects.

The Rehau Rauthermex product is a pre-insulated pipe system for below-ground application. This is available ex-stock in 25mm, 32mm, 40mm and 50 mm Duo (flow and return). However, a variety of other sizes are also available, ordered project specific, in the Uno (single pipe). Applications include heating flow and return, hot and cold potable water, secondary water supply and secondary water circulation.

Heat Merchants now stocks the Rehau “Smartsystem 16” which is a system designed for the conservatory (16-32 m2) and small extension (24-45 m2) market. The system is designed to run directly off the existing heating system within the property and is extremely easy to install. It can be used as a separate heating system, with its own controls, to run like a true UFH system.

At present Heat Merchants holds a UFH training day on the second Thursday of every month covering the theoretical side of underfloor heating. On-site training is still held when required. Controls training is being planned for the near future for all controls systems.

Contact: Andrew Lightbody, Heat Merchants Product Development Manager/UFH Engineer, or Eoin McKiernan and Irene Nooney, Heat Merchants UFH Engineers.

Tel: 090 642 4083; 090 644 2311/21; email: ufhinfo@heatmerchants.ie; www.heatmerchants.ie
Unitherm Heating Systems Ltd

8A city east business park, ballybrit, co galway tel: 091 - 380 038 fax: 091 - 380 039
peamount industries, newcastle, co dublin tel: 01 - 627 2532 fax: 01 - 627 2532
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The comfort of underfloor heating is unrivalled by any other system.

 Guarantees At QPL, heating engineers design a system to meet the client’s requirements by working in conjunction with them. From entering in the key factors to a specialist software package, QPL determines each zone / rooms heat requirement that lead to optimum comfort levels.

 The QPL design engineers are continually in liaison with architects, consulting engineers and mechanical contractors. Across the country. Over the years QPL has been involved in many underfloor heating system projects ranging from hospitals and nursing homes to warehouses and car showrooms. Underfloor heating is the solution to any heating difficulty you may have.

 It can take several hours from a cold start to bring an underfloor heating slab up to temperature, providing enough heat output to heat the rooms to the desired temperature. Continually having to heat the floor slab from cold can drive up the fuel consumption for the system. The key to operating an efficient system without the fluctuating ambient temperature is to forget about intermittent circulation, which applies to conventional heating systems, and instead have the system running continuously throughout the heating season.

 Quality Plastics Underfloor Heating designers will individually design each project supplying optimum efficient controls based on their years of underfloor heating experience. The same attention to detail goes into every domestic application as if it were a large prestigious commercial project. This will ensure an efficient, comfortable and trouble-free heating system which ultimately benefits everybody.

 Contact: Sales Team, Qual-PEX Underfloor Heating Department, Quality Plastics. Tel: 021 - 488 4700; email: underfloor@qpl.ie

Quality Plastics Ltd was established in 1970 as a pipe extruding company. Over the years the company has gone from strength to strength and now employs 140 people in both Ireland (Quality Plastics Ltd) and the UK (Qual-Plumb (UK) Ltd). The range of products supplied by QPL is continuing to expand through an ongoing programme of product research and development.

 In 1996, the Qual-PEX Underfloor Heating department was set-up and has grown to a work force of six dealing with quotations, queries, design and technical support, both in-house and on-site.

 The service provided by this department includes design and supply of the underfloor system (via a Qual-PEX pipe stockist).

 The key feature of this quality system is the Qual-PEX 15mm Barrier pipe, which is BS 7291, Class S approved and carries a 25-year guarantee. At QPL, heating engineers design a system to meet the client’s requirements by working in conjunction with them. From entering in the key factors to a specialist software package, QPL determines each zone / rooms heat requirement that lead to optimum comfort levels.

 QPL design engineers are continually in liaison with architects, consulting engineers and mechanical contractors across the country. Over the years QPL has been involved in many underfloor heating system projects ranging from hospitals and nursing homes to warehouses and car showrooms. Underfloor heating is the solution to any heating difficulty you may have.

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 Qual-PEX Underfloor Heating available only from QPL.

Quality Plastics Underfloor Heating

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Irish Metal Industries Ltd

25 Spruce Avenue
Stillorgan Industrial Park
Blackrock
Co Dublin

Sales
Tel: 01 - 295 2344 / 01 - 295 2137
Fax: 01 - 295 2163
email: info@irishmetalindustries.com
web: www.irishmetalindustries.com
Unitherm Heating Systems

The benefits of an underfloor heating system such as comfort, control, energy saving, aesthetics, a healthier environment, etc, are now well known and accepted. There is little doubt a properly-designed underfloor heating system, using quality products, offers the ideal heating solution for private dwellings, creches, nursing homes, hotels, churches, offices, factory floors and public buildings.

Many consultants, mechanical contractors and domestic heating contractors who, for historical reasons, were originally sceptical about the concept of underfloor heating have now embraced the technology, control and efficiency offered by an underfloor heating system.

For many years underfloor heating has been very popular for large private dwellings and the perception was that it was expensive. However, underfloor heating has proven to be an ideal solution on many large housing developments and apartments where internal space is premium. Recent cost analysis carried out by Unitherm Heating Systems have shown the cost of installing an underfloor heating system, coupled with condensing boilers, is now comparable to a traditional radiator system.

The Unitherm underfloor heating system is based upon German technology and experiences over the last 30 years. The system and the products are exported worldwide and have achieved an enviable list of approvals and accreditations in many European countries. The products are manufactured by renowned German companies such as Oventrop GmbH & Frankische.

Unitherm Heating Systems offer PEX pipes with oxygen diffusion barrier in sizes 14mm, 16mm and 20mm. They also offer Turatec multilayer pipes (FE-ALU-PE) in sizes of 16mm, 20mm, 25mm and 32mm.

The central point of the system is an Oventrop stainless steel manifold or distributor which is corrosion-resistant and comes complete with lead-sealable topmeters. The topmeters regulate the heating circuit flow rate and can be read off a viewing glass. For ease of installation Unitherm offer the Oventrop Regufloor regulation station. The station regulates the flow temperature of the heating medium at a constant value by using some of the return flow of the collector and a temperature regulator with contact sensor and a three-way mixing valve. The water in the circuits of the surface heating system is circulated by an electronically-controlled pump, e.g. to regulate flow rate according to demand.

If the system is operated alternatively with heating or cooling water, then the permitted flow temperature must be checked for the surface heating as well as for the surface cooling operation. Unitherm offers the Oventrop Regufloor HC for this purpose, which will keep the temperature of the medium at a constant set value, by mixing it with some return flow. The three-way valve is operated here by a 3-point actuator which receives its signal for heating or cooling from a room thermostat. In conjunction with underfloor heating systems geothermal heat pumps provide the optimal system solution for heat economy and in respect of protecting the environment. A heat pump draws a large part of the heating energy from the solar energy stored in the ground.

Unitherm Heating Systems are associated with one of the leading heat pump manufacturers and energy solutions designers in Europe. Outputs available are from 6kW to 26kW.

Unitherm Heating Systems also offer a complete range of modern high-efficiency gas boilers, wood burning pellet stoves and solar panels. All Unitherm systems are individually designed and supplied with support by mechanical and electrical layout CAD drawings. Unitherm offers a 10-year warranty on all systems designed, supplied and installed in accordance with BS EN 1264.

Contact: Unitherm Heating Systems.
Sales.
Tel 01 - 627 2532; 091-380038;
Peter Lysnkey
(086 - 833 0051);
Declan Kissane
(086 - 833 0062);
Donny Bourke, Oventrop
(087 - 239 7078).

Unitherm Heating Systems

Available in sizes of 16mm up to 63mm.

High Temperature Resistant Polyethylene
Special Adhesive
Aluminum

Regufloor HC for heating and cooling

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Biggest Does Not Mean Best!

Small has the same bite but delivers it with greater care, attention, integrity and flexibility.
Manufactured to the highest specifications and approvals along with a 10-Year warranty, the underfloor heating system from ATC Electrical & Mechanical Ltd is fast becoming the preferred choice for electric under floor heating projects.

This system is ideal for heating under tiled floors in bathrooms, kitchens and conservatories. By heating a large floor surface area, underfloor heating not only makes for a more comfortable environment, it is also a more economical one. It allows typical operating temperatures to be one to two degrees lower than conventional heaters, thus reducing energy costs by up to 10%.

**Grundfos Speed-Control Perfect For Underfloor Heating**

With underfloor heating systems becoming more and more commonplace, the requirement for compatible pumps which can meet the particular needs of these systems has grown in tandem. The big difference between a radiator and an underfloor heating system is the operating temperature. A conventional heating system can be dimensioned for a flow temperature of up to 80°C and a differential temperature at 11°C to 30°C. However, in an underfloor system the flow temperature is never more than 40°C and the differential temperature never more than 5°C to 8°C. As a result, an underfloor heating system always needs a mixing loop to get the right flow temperature.

In an underfloor heating system each room should have its own control, and all pipe circles should be balanced to have the same pressure loss. The pressure loss in the longest pipe circle (never longer than 120m) is used for dimensioning the pump. The high-pressure loss and the low differential temperature in such systems requires a bigger pump than that called for in a conventional radiator system. The flow will be variable and therefore Gordon Barry, Director of Grundfos Ireland, recommends the use of the latest range of Grundfos speed-controlled pump in all underfloor heating systems.

Benefits include easy installation; water lubricated bearings; variable speed; very low noise levels; high-quality material; low energy consumption; long life-span; no need for motor protection; and wide application range.

Contact: Gordon Barry, Grundfos Ireland. Tel: 01 - 295 4926; email: gbarry@grundfos.com
Underfloor heating solutions

WIRELESS AND RELIABLE

Individual room temperature control — comfortable temperatures in any room at any time

Honeywell

For more information contact: Paul Manning on +44 797 445 1034
Polytherm was in at the very early stages of the underfloor heating market's development and can be credited with having pioneered its acceptance and penetration to the point where it is now more commonplace. In that time the technology has evolved considerably, with Polytherm conducting widespread market research and exhaustive market analyses — both in Ireland and abroad — to identify and source the most efficient and cost-effective system. The result of that effort is Polytherm’s Heatrack System which is claimed to be the easiest and cleanest way to install an underfloor heating system.

Heatrack is a patented, concrete-free, underfloor heating system featuring single Heatrack panels which are 1.2m long by 12mm thick and aluminium-backed for greater energy efficiency; special U-turn Heatrack panels (filler strips) which help to make installation neat and easy; and pre-assembled Heatrack panels which offer the same benefits as single panels with the added advantage of being pre-assembled for dramatically-faster installation.

Because they are pre-assembled and folded, these panels are easy to handle and carry. To install, the pre-assembled panels are unfolded, the sections interlocked and fastened to the sub-floor, and the Polytherm tubing “walked” in. Supported by over 25 years of Pex production experience, Polytherm tubing’s electronically-crosslinked polyethylene ensures the most uniform structure. The high-density tubing is constantly monitored and tested to assure the highest possible quality and longevity. It also meets the rigorous ASTM and DIN standards.

Polytherm complete floor heating solutions include a wide selection of expandable and pre-assembled solid brass injection stations and control manifolds. Complete with brackets, they are supplied ready to hang on the wall. There is also a wide choice of non-electric and electric control systems, from single room monitors to the most sophisticated optimisation controls for any radiant heating system.

Among the other underfloor heating systems from Polytherm are:
- Polydynamic: for new buildings and refurbishment of old buildings;
- Polycomfort: for new build;
- Polyconstruct: for commercial applications;
- Polycargo: for industrial and commercial applications;
- Polysport: a resilient system for sports halls.

Polytherm provides the most comprehensive range of products, systems, and design concepts. It is ideally suited for buildings, including commercial and industrial applications. The Geopack comprises a spiro-orbital scroll-type refrigeration compressor, a heat exchanger unit, and all the necessary safety-based control components. The complete compressor system, including the special copper tube energy captor buried in the ground, is fully assembled and filled with refrigerant gas in the factory. This results in a compact, single unit which is ready to install and commission. The above-ground installation makes for easy servicing.

The water-based half of the system, together with the system control panel, is installed as normal in the house. Installation and commissioning is very simple and quick, and can be undertaken with normal plumbing skills. The skills of a qualified refrigeration engineer are not required.

The COP using R407C refrigerant is between 3.9 with the refrigerant at -5°C and water at 35°C, and 5.1 with the refrigerant at 0°C and the water at 30°C. These figures were tested by Cetiat and certified by Promotelec and Eurovent (water to water heat pumps).

Contact: Seamus English, Polytherm. Tel: 01 - 419 1990; email: info@polytherm.ie
WE GO FURTHER

A NEW WORLD IN PLUMBING

Wavin Pex Approved to BS7291-1 2001 Class S has Full Irish Agrément Board Approval.

Wavin Pex is recommended for use with Brass Compression Fittings to IS239 and Tectite Push Fit Fittings.

Wavin Pex is available in Irish dimension 1/2", 3/4", 1" in Coils and Straight Lengths

Wavin Pex is available in all leading Builders and Plumbers merchants nationwide.
Details of the winners at Forest Little Golf Club are as follows:

**Overall Winner**
Des Haughton (34 pts);

**Class 1 (1 - 12)**
Winner — Tony Delaney (34 pts);
Second — Mick Matthews (33.5 pts);
Third — Robert Kenny (32 pts);

**Class 2 (13 - 16)**
Winner — Dave Cranston (34 pts);
Second — Derek Whelan (34 pts);
Third — David Lynch (33.5 pts);

**Class 3 (17 +)**
Winner — Martin McKeon (31 pts);
Second — Sean Brady (31 pts);
Third — Seamus Tully (31 pts);

**Front 9**
Winner — Kieran Ryan (19 pts);

**Back 9**
Winner — Frank Field (19 pts);
Second — Michael Morrissey (17 pts);

**Visitor**
Winner — Liam McGinley (34 pts).

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Details of the winners of the Captain's Outing at Newlands Golf Club, with Dublin Providers as sponsors, are as follows:

**Overall Winner Captain's Prize**
Winner — Ray Byrne (36 pts);
Second — Eamonn McGrattan (35 pts);
Third — Eamonn Vickers (35 pts).

**Class 1 (0 - 12)**
Winner — Bernard Sweeney (34 pts);
Second — Des Prendergast (32 pts);
Third — Eamonn Walsh (30 pts).

**Class 2 (13 - 17)**
Winner — David Lynch (33 pts);
Second — George Carlton (33 pts);
Third — Tony Gillen (32 pts).

**Class 3 (18 +)**
Winner — Terry Maher (34 pts);
Second — Frank Field (33 pts);
Third — Damien Mooney (32 pts).

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**Front 9**
Winner — Michael Kearney (19 pts).

**Back 9**
Winner — John White (19 pts).

**Past Captain's**
Winner — Eamonn McGrattan (35 pts).

**Visitor**
Winner (Mens) — Mark Finnegan (39 pts);
Winner (Ladies) — Marian Maher (31 pts).
Tony Cusack and his team at Wilo Engineering marked the occasion of the company's Silver Jubilee recently by hosting a get-together of employees and selected customers — and their partners — at Limerick Races. It was a fun-filled day which included the Wilo Engineering Maiden Hurdle and, instead of the customary "Best Dressed Lady" award, Wilo's lady guests selected the "Best Groomed Horse" award.

Wilo was founded in 1872 and, while Wilo Engineering in Limerick has a long way to go to match that milestone, the spirit and quality of that 130-plus year pedigree is very much evident in the Irish operation. Throughout the last 25 years Wilo Engineering has achieved market-leading status across the entire building services spectrum in Ireland by supplying cutting-edge products and pump systems which it complements with comprehensive design and technical support programmes.

The occasion in Limerick was also used to unveil the new Wilo logo, along with details of a worldwide sales and marketing campaign which will reinforce the innovative qualities of the latest range of pumps, and pump systems, now coming on stream.

Incorporated within the new logo design is the 'Pumpen Intelligenz' slogan. This epitomises the core philosophy of Wilo and, more especially, the direction of future developments. "At Wilo an emphasis on technological progress continuously heightens the demands for efficiency and reliability of fluid handling systems", says Tony Cusack. "Therefore, we are expanding our application know-how into adjacent market segments and are committed to addressing the challenges of water and wastewater management, for every sphere of application. To that end we listen very carefully to our customers, identify their needs, and then devise sustainable, application-oriented pump products and pump systems to satisfy that requirement.

"Pumping systems are crucial for the basic needs of life and the preservation of our environment for future generations. We at Wilo believe that by providing higher-efficiency and lower life-cycle cost pumping solutions, we can help realise that objective while, at the same time, generating commercial benefit for our trading partners such as specifiers, wholesaler and installers".

Contact: Wilo Engineering.
Tel: 061 - 227 566;
email: sales@wilo.ie
Zehnder ZBN radiant ceiling panels, unlike most other forms of heating, emit heat primarily in the form of infra red electromagnetic radiation, writes Andrew Treacy, Managing Director, Versatile Agencies, who distribute the panels in Ireland.

The warmth given off by infra red radiation only affects surfaces on which it "shines", such as people and objects within the radius of the infra red rays. The air within a room is warmed in turn by the heat given off by the warmed surfaces. The result is that even when the air temperature is typically two or three degrees lower than with conventional air and convective heaters, people are comfortably warm. This translates into a significant reduction in heating costs because of lower heat load requirements.

In radiant heating systems the comfort condition is achieved by using higher radiation and lower air temperature. With Zehnder ZBN radiant ceiling panels heat is radiated from the panel at high level, and it has no effect until it shines upon an object, often the floor. Thus, the floor is warmed directly.

Radiant panels have a low inertia and a higher temperature, and as soon as hot water enters the panels, the radiated warmth is felt within the room. This results in warm up times being significantly reduced, therefore enabling additional flexibility and further savings in heating costs. Other systems which have a high radiant temperature (gas or oil fired; electric element) do not permit even distribution and create wide differences in the area heated.

An advantage of heat transfer by radiation lies in the immediate warming effect on the body without first heating the surrounding air. Temperature perception by a person depends on the heat exchange with the surroundings.

It is worth noting in terms of design that a radiant panel heating system should be designed in the same way as a lighting system. The objectives are the same— to obtain an even distribution of electromagnetic radiation. It is only the wavelength that is different. Perimeter radiant panels are therefore rarely the best way of evenly distributing the radiant heat within a room.

A Zehnder ZBN radiant ceiling panel emits approximately 70% radiant heat and 30% convected heat. The upper surface of the panel is normally insulated, thus concentrating the heat from the water into radiated heat. The room occupants, contents and surfaces absorb this radiant heat, and give off convected heat that, in its turn, warms the air. Like light, a Zehnder ZBN radiant ceiling panel radiates in a 180°C arc around the panel.

System Advantages
Zehnder ZBN radiant ceiling panels are used to heat rooms of 3m to 30m in height. Some examples of areas that have been heated by Zehnder ZBN radiant ceiling panels are production centres, high stacked distribution depots, sales areas, exhibition halls, garages, sports and recreation halls, schools and lecture theatres, as well as many other applications.

The panels are installed at high level from the ceiling. Installation is easy, quick and therefore at low cost. Accessories are proof-tested and designed for trouble-free installation, and are supplied with the main panels. In short, everything is included.

Zehnder ZBN radiant ceiling panels are a heating system also suitable for use in conjunction with low-temperature installations and may, for instance, be used for cooling (overhead cooling).

Major benefits are control, cost and hygiene. Because of the flexibility of the design of the water flow from panel to panel, by taking into consideration the windows and room layout, the heating requirements of a room can be accurately satisfied, giving both high comfort levels and economy in operation. Unlike electric and gas heating, the panels can be thermostatically controlled, giving minute-to-minute comfort and economy.

Because there is minimal convected heat, there is very little air movement, bringing with it the advantage of minimal dust and bacteria movement within the air. This is ideal for hospitals, classrooms, offices or wherever people are likely to gather and the spread of germs needs to be kept to a minimum.

Workshops and showrooms also benefit in that the reduction of dust improves work conditions and reduces cleaning frequency requirements.

Other major factors in support of Zehnder ZBN radiant ceiling panels are that they are noiseless, (particularly important in hospitals, schools, lecture theatres etc); there is no condensation on windows (making them ideal for showrooms); and they do not use any precious wall space. In perforated versions they also provide some sound absorption.

Zehnder ZBN radiant
Comparing Traditional Heating Forms With Radiant Ceiling Panels

Key benefits

- Comfortable, uniform
- Distribution of warmth;
- Long term durability, practically maintenance free;
- Heating and cooling emissions guaranteed;
- Free of draughts, noise or forced air movement with dust disturbance;
- With all the possibilities for applications with alternative energies;
- No energy waste from high temperature gradients;
- Unrestricted use of wall and floor space;
- Good regulation and short heat-up due to low inertia of the system;
- Efficient and cost-effective installation by use of pre-fabricated modular construction with optimum fixing centres;
- High-quality powder painting;
- Special production, ie angled, sound absorbing, interrupted radiant plates (below roof-lights).

ceiling panels are maintenance free, and can be made to order in a variety of aesthetic shapes and forms. They can even be fitted behind plasterboard where they are for all intents and purposes invisible.

With the benefit of thermographic imaging it is now possible to see the effects of radiant heating.
Universities Reduce Energy Consumption & CO₂ Emissions

Dublin’s four main universities — Trinity College, DIT, Dublin City University and UCD — have joined together to form e3, an energy management bureau to leverage the benefits of working together to reduce their total primary energy requirement.

White Young Green — in conjunction with PowerTherm Solutions — have been appointed as the Bureau Service Provider (BSP) to provide organisation and technical expertise for the project. Through their Public Sector Programme, Sustainable Energy Ireland (SEI) is providing 50% of the funding for the project. The project commenced in November 2003 and the aim is to reduce the primary energy consumption of 30 key buildings by 10% over three years. This will result in savings of over €315,000 in energy costs and 3,230 tonnes of CO₂ emissions.

The three-year programme is employing a wide range of techniques to deliver the target savings, including:—
- Operating a website linking to the monitoring and targeting system of all bureau buildings;
- Project commencement studies to establish baseline energy usage for future performance comparisons;
- Training and awareness programmes;
- Focus group meetings and presentations with staff that can influence energy usage in the bureau buildings;
- Issuing weekly and monthly energy reports;
- Concise energy audits focusing on housekeeping measures and identifying technical energy saving measures for further investigation;
- Comprehensive energy surveys in selected buildings.

Campaign posters have helped to raise awareness of the programme amongst the staff and students in each of the universities. Additionally, specially-designed stickers left on PCs, electrical equipment, light switches, etc remind staff and students to switch them off when they are not in use.

Energy Procurement Services
Following competitive tendering by White Young Green with a number of electricity suppliers, the four colleges signed contracts in January 2005 for the supply of electricity to a number of supply points with Airtricity. In addition to reducing costs, this electricity will reduce carbon dioxide emissions as it is generated from renewable sources.

Progress to Date
The e3 bureau has been operating for over 15 months and has so far achieved:—
- A 3.3% reduction in TPER;
- Savings of approximately €120,000 in energy costs;
- A reduction of almost 1,000 tonnes of CO₂ emissions;
- Significant interaction between the universities;
- A group enthusiasm and drive to achieve the targets

Who else can benefit?
A number of other Irish universities have expressed an interest in the e3 Bureau, including the University of Ulster and Queens University Belfast in Northern Ireland. The inclusion of these universities would add a cross-border dimension to the project, linking it with other current all-island energy initiatives. e3 is currently exploring the possibility of sourcing additional funding to allow the Bureau to expand into Northern Ireland.

What next for e3?
The e3 Programme is in its second year and various activities have been planned for 2005. These include:—
- Producing more detailed monthly reports and accompanying summary reports for distribution to bureau buildings staff;
- Implementing the energy saving measures arising from the concise surveys in the bureau buildings;
- Conducting base-load analyses in key bureau buildings;
- Holding quarterly review and monthly steering group committee meetings where common issues and opinions can be discussed between the universities.

Having surpassed the 3% targeted savings initially set for the first year of the bureau, it is hopeful that this trend will continue in the remaining two years and that even greater reductions in energy usage and cost will be achieved throughout the four universities.

Contact: Colman Reynolds, Regional Director, White Young Green
Tel: 01-293 1200; www.e3.ie

A PROBLEM SHARED...
Grundfos Tames Glen of the Downs!

One of the highlights of the building services calendar, the Grundfos Annual Golf Outing once again proved a massive draw with a large turnout of contractors, consultants and merchants participating. Uniquely, this event combines very serious golf with great fun, low handicappers mixing and playing with high handicappers on an "equal" footing.

The venue was Glen of the Downs, a challenging course which, despite the excellent weather, still put it up to the participants. However, they responded magnificently (well, some did!), the winning team coming in with 109pts, followed by 99pts and 97pts for second and third respectively.

As always, the hospitality of Grundfos personnel was flawless. They were on hand at every turn to assist and look after their guests at all points throughout the course, and within the confines of the clubhouse and hotel.

The dinner and presentation of prizes was the only respite from the intensity of the day, the same dedication and commitment applied to the golf being applied with equal vigour to the post-dinner entertainment and fun!

1 — Winning team members: Ben Keane, Bernard Costelloe and Gerry Fitzpatrick
2 — Michael Kennedy, Shea Cuddly, John Redmond and Joe Warren
3 — John O’Meara, Pat Kirwan, Larry Gittens and Chris Murphy
4 — Ray Lucey, John Smith, Liam McDermott and Pat White
5 — Dessie Haughton, Jim Rogers, Des Prendergast and Chris Hanney
6 — Gerry Cleary, Jack Murphy, Ronan O’Donoghue and Paul Allen
7 — Colum Murphy, Philip Bassett, Richard Burke and John Finan
8 — Gerry Henny, John Gillick, Richard Mason and Lawrance Corrigan
9 — Kevin Cullinane, Colin Murphy, Ray Broughan and Donal Varian
10 — Stephen Costelloe, Mark Hollingsworth and Paul Quinn
11 — Michael Kearney, Seamus O’Donoghue, Noel Dempsey and Martin McSherry
Halton Capture Jet Ideal For Food Services

When unable to install kitchen canopy exhaust ductwork to roof level, Café Florence in Tuam, Co Galway, turned to Entropic for a assistance.

On examining the problem Michael Geraghty and his colleagues devised the perfect solution using Halton Capture Ray UV canopies. These canopies effectively destroy grease and eliminate odours, allowing the air to be discharged at low level through the side wall. An additional benefit is that the system is high performing, energy-efficient and extremely cost-effective.

Halton Capture Jet technologies were specifically developed to create comfortable food service environments at reduced operational costs. This applies to both employee comfort and productivity, along with that of the customers of the establishment.

Comfortable thermal conditions decrease the number of accidents in the workplace. When the indoor temperature is too high — over 28°C in commercial kitchens — productivity and general comfort diminish rapidly. Good conditions also reduce employee turnover, especially in kitchen environments. It can also lead to increased productivity, making for a much faster payback time on the initial investment.

Fundamental to Halton Capture jet is design-for-purpose solutions whereby each system is tailored for the conditions of the specific application.

This results in lower installation costs, reduced running costs, and less frequent service intervals as the system is such a clean operation.

Nothing is left to chance with supply and exhaust air systems taken into account to create perfect working conditions. In restaurants, the design approach also eliminates odour migration from cooking to dining zones.

number of successful Halton installations throughout the country”, says Michael Geraghty of Entropic. “They cover all types and size of application, delivering tailored solutions for each specific project.

“We also design, supply and install Halton ventilated ceilings. These are flexible solutions for kitchens where the heat loads are relatively low and aesthetics and openness are appreciated. They employ a Capture Jet installed flush-to-ceiling to guide the heat and impurities to the exhaust sections. Supply air is introduced through low-velocity units.

“In summation, we at Entropic — by virtue of our partnership with Halton — offer unique, dedicated and flexible solutions. Design, engineering and technical support are a vital part of the package, as is the choice of preventative maintenance packages offered”.

Contact: Michael Geraghty, Entropic. Tel: 01 - 610 6170; email: info@entropic.ie.

Top left: Halton UV canopies with supply air, multi-cyclone filters and integrated lighting at Café Florence, Tuam, Co Galway. Above: Red box illustrates just how unobtrusive the kitchen canopy exhaust louvres is. Moreover, not running the ductwork to roof level within the building released additional space for office and car park usage.
Ideal Standard recently unveiled a vast portfolio of new products and bathroom suites at a major reception held in the banqueting suites of Croke Park. This select venue is increasingly gaining popularity because of its high-profile image and the ease of parking.

For its part Ideal Standard went to extreme lengths to present its portfolio in an appropriate style. The purpose-designed settings for each suite were such that the overall impression on entering the display area was one of an architect-designed showroom that would not be out of place in a professional retail setting. Yet the atmosphere was informal and relaxed. Ideal Standard personnel constantly on hand to meet and greet invited guests, and to take them through the displays.

The "open-day" format meant that there was a constant stream of visitors including architects, contractors, stockists, merchants, etc. This also made it easier to discuss the displays in greater detail as the personnel on hand could devote more time to explaining the features and benefits of each range.

Among the collections featured was the new range for Sottini called Secrets by the award-winning designer Robin Levien. This features two distinctive basin shapes — Swirl and Bodoni — which can be combined with a range of core pieces. Swirl is inspired by the effect of a swirl of water around the inside of the bowl of the basin while Bodoni is based on the form of a letter from a beautiful typeface.

By contrast, the accompanying mixers — Alchemy and Artefact — are made from solid brass, plated in chromium and incorporating single lever and ceramic disc technology.

Also featured on the day were Ideal Standard shower enclosures; White & Silver and Create bathroom collections; and Trevi shower kits and thermostatic shower valves.

Ideal Standard Scores At Croke!
Relatively little is known about predicting the level of harmonics in modern buildings and their possible effects on electrical installations. So, before we delve into that subject, I would like to explain briefly what is meant by harmonics.

We start with a simple sine wave that may be used to represent an ac supply and is depicted in Figure A. The frequency of the wave is 50Hz or 50 cycles per second. This wave is called the fundamental frequency wave or the 1st harmonic.

Figure B shows a wave of 100Hz, ie the 2nd harmonic or double the frequency of the fundamental. When the 1st and 2nd harmonics are combined (added together), the outcome is known as a complex wave as is shown in Figure C.

This logic can be applied in reverse. Therefore, the above complex wave can be represented by the 1st and 2nd harmonics etc. Every complex wave can be represented by a combination of harmonics, 1st, 2nd, 3rd, etc. up to very high frequencies.

Now that you have a basic understanding of what is meant by harmonics, the question arises, what cause harmonics to occur and how widespread are they.

The answer is that they caused by most electrical equipment in the office, particularly personal computers, photocopiers and fluorescent lamps. In industrial situations, electric motors, variable speed drives, uninterruptible power supplies are the main culprits. In fact, harmonics are present to a larger or smaller degree in all electrical installations. What harm do they do?

The main harm caused is generation of electromagnetic interference, overheating of capacitors, overloading of power transformers and also overloading of neutral conductors.

The presence of harmonics may not be apparent to the casual observer. Standard ammeters and voltmeters will not detect their presence or reflect their magnitude. Instruments such as spectral analysers are available, however, that will measure the magnitude of the individual harmonic frequencies contained in a complex wave.

The waveform as depicted in Figure D (the voltage wave supplied by the ESB network to DIT Kevin Street as measured in our laboratories. The top of the wave is flattened (distorted) somewhat due to the ESB network supplying other external electrical loads with harmonic content.

The individual harmonic components are shown in Figure E. The Total Harmonic Distortion (THD) of the supply voltage is 2.8%. This may not appear...
We Be Concerned About Harmonics?

Harmonics? Should About ELectrical Circuits that supply a significant number of PCs will indeed experience problems from a cable-sizing point of view and my next article will consider a typical application where this point is demonstrated.

Capacitor Current wave

Distorted Voltage Wave DIT Kevin Street

Complex Wave

Capacitor Current with a Total Harmonic Distortion (THD) of 75%.

Circuits that supply a significant number of PCs will indeed experience problems from a cable-sizing point of view and my next article will consider a typical application where this point is demonstrated.
Plumb Lines

Heard it on the grapevine ...

'EIGHTH WONDER OF THE WORLD'

Unlike the other Gulf States, Dubai has practically no oil reserves and has therefore set its sights on luxury tourism. These tourists are primarily looking for accommodation close to the water, but the problem is that Dubai's coastline is only 30 kilometers long. Enter Sheikh Mohammed of Dubai with an ambitious and visionary plan to create four offshore islands, shaped to generate the greatest possible length of shoreline. Three islands will be shaped like palm trees, while the fourth will effectively comprise 264 smaller islands together, forming a map of the world. Palm Island I (Jumeira) has already been completed while Palm Island II (Jebel Ali), along with The World Archipelago, are scheduled for completion next year. Above: The Jebel Ali is the second island to be built on the coast of the Emirate of Dubai. The Palm Islands have also been dubbed "the eighth wonder of the world."

DANGEROUS NATURE'S CALL
Came across this unusual urinal by San Francisco artist, Clark Sorensen, recently. It is one of a collection of flower-shaped designs made of the same material as commercial toilets and can be installed and used. Don't really know why but it reminds me of one of those exotic, flesh-eating, flowers just waiting to snap up its next meal. Can you imagine it? ... may it's best not to!!!

Untreated Sewage Heats & Cools
Chinese researchers say they have developed a method of heating and cooling buildings using raw, untreated sewage. The method uses a device that heats by extracting heat from raw sewage that has been temporarily diverted on its way to the processing plant. It cools by using the sewage to absorb heat extracted from buildings. The device produces no pollution and uses no chemicals ... apparently.

AMAZING BATHouse FIND
Construction work at a college in Colchester in the UK has uncovered a Roman Bathhouse with its timber-piped springwater supply still running intact. This remarkable find dates from the early 2nd century AD is believed to have been attached to a large Roman villa located on the site. Makes you wonder at the quality of the craftsmanship ... will a comparative installation of today still be uncovered, functioning and intact, centuries from now? Somehow I very much doubt it!

ELEPHANT GRASS ELECTRICITY
The UK’s first major bio-energy power station has been approved. Costing almost €10 million, it will be run on elephant grass grown by a co-operative of 170 local farmers. The two-megawatt steam-turbine engine will supply electricity to 2000 homes.

ACOUSTIC TOILET SEAT
A student in Germany has won a design award for a toilet that reduces noise by 40%. It is aimed at parents who currently don’t flush toilets at night in case they wake up young children. The underside of the seat forms a complete seal around the rim, plus constant contact between seat and lid, when the lid is lowered. Made from polyurethane foams, it is somewhat disconcertingly called Stingray.

ENERGY-EFFICIENT HOMES
Energy-efficient housing developments are now becoming the norm, two of the latest being Chapel Court just outside Monaghan and Mervue in Galway. Both are part-funded by SEI under its “House of Tomorrow” programme, demonstrating just how effectively it combines with private developers to get tangible, energy-efficient, results. Well done all concerned.
ECOLUTION is the new generation of split, multi-split and VRF inverter systems from Mitsubishi Heavy Industries Ltd.

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**Complete Solutions**

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- AFRISO measuring devices cover the following ranges:
  - Pressure: from 0/4 mbar to 0/4.000 bar
  - Temperature: from -80°C to +600°C
  - Level: from 0/60 cm to 0/100 m

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**Manotherm Limited**

4 Walkinstown Road, Dublin 12.
Tel: 01 - 452 2355/452 2229; Fax: 01 - 451 6919
email: info@manotherm.ie

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