

# Fusion

## BUSINESS

### FUSION POWER TECHNOLOGY DRIVES EUROPEAN BUS PROTOTYPE

A technology developed to meet the needs of a fusion experiment is now a key factor in the success of an environment-friendly bus (right) being tested in three European cities.

The Altrobus hybrid bus is electrically driven with a small diesel engine to charge the batteries and was developed in co-operation between two major European companies, Ansaldo Ricerche and Fiat Iveco. The power inverters and battery chargers the bus uses are based on an application of IGBT technology, developed specifically for the JET project at the Culham Science Centre.

## JET INTO 2000

The new European Fusion Development Agreement (EFDA), which was signed in March 1999, is intended to strengthen the co-ordination of fusion work within the European Union and Switzerland and to continue work with industry towards the possible construction of an experimental fusion machine.

Within the framework of EFDA, a subsidiary agreement, the JET Implementing Agreement, has been drawn up. As Fusion Business went to press the agreement had been signed by seven of the 16 countries involved. It will enable the use of the JET facilities at the Culham Science Centre for a further three years after the existing JET project comes to an end on 31 December 1999.

A JET Associate Leader, Dr Jérôme Pamela, will be responsible for the overall leadership of the JET activities under the new arrangements.

UKAEA will operate the facilities on behalf of the parties to the new agreement with the experimental campaign being carried out by visiting teams of scientists and engineers from all of the parties (including UKAEA).

These changes to the way in which JET is operated mean changes to existing commercial contracts (see page 2).

## Inside..

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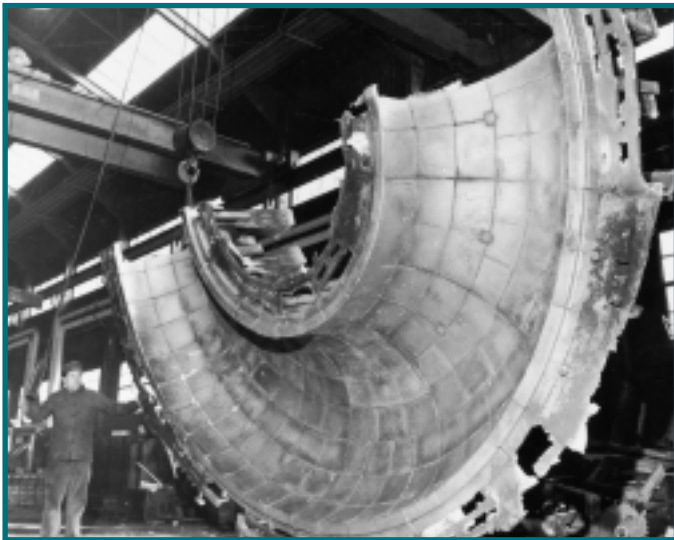
In 1986, when Ansaldo Ricerche were evaluating possible applications of a new power semiconductor device - Insulated Gate Bipolar Transistors or IGBTs supplied by Toshiba - JET engineers were looking for a fast, high power amplifier. A study demonstrated that an IGBT-based system almost perfectly fitted the characteristics needed by JET and Ansaldo Ricerche won the production contract. The amplifiers, with an installed power of 4x4000kVA, were for a long time the most powerful IGBT convertors in the world.

Having worked with JET to develop this technology, Ansaldo was able to transfer the expertise to the transport sector and develop the efficient inverter/chopper needed for the Altrobus hybrid engine.

The close relationship between JET and Ansaldo Ricerche engineers provided the basis for a successful bid to the European THERMIE fund to allow construction and testing of prototypes for the city of Genoa. There is now a total of 100 hybrid buses built to the Altrobus design, with fleets of vehicles on test in three Italian cities.

# ALUMINIUM ALLOYS – A STRONG CANDIDATE?

Although the fusion community makes use of aluminium and aluminium alloys (see picture below), there has been, historically, a tendency to favour stainless steels\* for all but the most specific structural and cryogenic requirements. A recent visit to Vickers Bridging (Wolverhampton) has prompted the question of whether fusion and other industries could make more use of aluminium alloys by utilising the latest CADesign techniques (including finite element and lifetime analysis) and fabrication methods.



*HBTX1A Conducting Shell*

## TENDER & CONTRACTS UPDATE

Fifteen UK companies have been nominated by the Fusion Industry Programme in the last three months to tender for the following European fusion programme project work:

- Cryomechanical Pumps and fabrication of Endoscope bodies for the CIEL project at CEA, Cadarache, France.
- Supply of three Reactive Power Compensation Modules for the Asdex-Upgrade Project at IPP Garching, Germany.
- Supply of Pumps for Divertor Cooling/Extension of Pipes for the W7-X Fusion Project at IPP Greifswald, Germany.

A total of 78 UK companies has been asked if they would like to be nominated for work on the fourteen fusion projects advertised so far in 1999. During that time, the Fusion Industry Programme has made more than seventy separate nominations, with several companies nominated for more than one project. Eight of the fifteen companies nominated for the most recent work have been nominated for the first time this year.

If your company would like to be added to our database for future fusion projects, please email us at: [fusion.industry@ukaea.org.uk](mailto:fusion.industry@ukaea.org.uk)

Companies such as Vickers can offer aluminium alloy design and machining/fabrication services resulting in structures that (in comparison with the stainless steels used by fusion):

- are of similar strength (e.g. 0.2% proof strengths even in welded regions of over 200N/mm<sup>2</sup>)
- can match stiffness (by appropriate section design)
- are corrosion resistant and non-magnetic
- can be lighter, cheaper and more suitable for recycling.

The photograph (below) shows examples of large aluminium alloy welded/machined structures produced by these techniques for demanding applications (e.g. for the mobile bridges used by the armed services, painted green in the photograph).



Although aluminium alloys are not normally suitable for fusion vacuum vessels (some exceptions are START\*\* at Culham and CDX-U in the USA), these alloys can be used in many other areas and may well result in lower overall costs, particularly when robotic welding is employed. The same advantages, especially the high strength to weight ratios, may well apply in many other industrial applications.

More details from: Shane Hill on 01902 355341 or by email to [shane.hill@vickersdefence.co.uk](mailto:shane.hill@vickersdefence.co.uk)

\* A Guide to Fusion Part 1 (Fusion Business 3)

\*\*A Guide to Fusion Part 3 (Fusion Business 5)

## JET 2000 - CONTRACTS UPDATE

When the JET Joint Undertaking ends on 31 December 1999, all of its contracts will end. UKAEA Contracts staff are therefore working to put new contracts in place.



UKAEA contracts staff

Adverts have been placed in the Official Journal of the European Communities (OJEC) for various service or 'pool' contracts including Building Services, Cleaning, Electricity Supply and a range of equipment maintenance work.

The 'pool' contracts may be placed with one or more companies. Expressions of Interest are now being sought through OJEC and pre-qualification exercises are being carried out.

## CONFERENCE REPORT

The EURATOM/UKAEA Fusion Industry Programme took part in the 5th International Symposium on Fusion Nuclear Technology in Rome to promote UK high technology industry.

A great deal of interest was shown in the work of the Industry Programme, not only by the scientists and engineers at the symposium, but also by delegates from other fusion programmes who are following the UK's lead in trying to forge stronger links between industrial suppliers and the physics and engineering of fusion technology.

Industry Programme Manager Tom Todd gave a talk on the benefits industry has received from its interactions with fusion over the years, including many of the technology spin-offs which have resulted. In doing so, he generated a great deal of enthusiasm from a number of delegates, many of whom expressed the opinion that the presentation was the most interesting and encouraging of the conference!

## HYPERVAPOTRONS

.... an occasional series on technology used in fusion which may have industrial applications

Hypervapotron panels were originally developed for cooling the anodes of very high-power tetrode valves, and have subsequently been used by a number of laboratories, including JET in the UK, for handling the high incident power densities typical of high power particle beams.



The photograph shows a typical hypervapotron arrangement (as used in JET). The individual cooling panels are each 112mm wide and 30mm deep and are constructed from Cu-Cr-Zr alloy. Cooling passages are machined in the panels to obtain a water flow of 3-15m/s within a few millimetres of the front surface. With this geometry, panels have been regularly used on JET at power densities up to 12MW/m<sup>2</sup> for pulse lengths of 30 seconds, with a design suitable for 15MW/m<sup>2</sup> for 5 seconds now under development.

The rugged geometry and modest water flow and pressure drop requirements make this an attractive option for handling high incident power densities. If this high power cooling technique is of interest to you or your organisation, please email [miriam.mason@ukaea.org.uk](mailto:miriam.mason@ukaea.org.uk) or call 01235 464104 and we will put you in touch with the appropriate designers at JET.

### 1999-2000 Fusion and Industry Conference & Events Diary

November 29-December 2 - Fusion Associations Exhibition, European Parliament, Brussels, Belgium.

November 30 - European Energy Foundation Dinner Debate on Fusion, Brussels, Belgium.

May 22-26 2000 - 14th International Conference on Plasma Surface Interactions in Controlled Fusion Devices, Rosenheim, Germany.

May 22-28 - 7th Conference on Intersections between Particle and Nuclear Physics, Quebec City, Canada.

June 12-16 - 27th EPS Conference on Controlled Fusion and Plasma Physics, Budapest, Hungary.

September 4-8 - 21st Symposium on Fusion Technology (SOFT), Madrid, Spain.

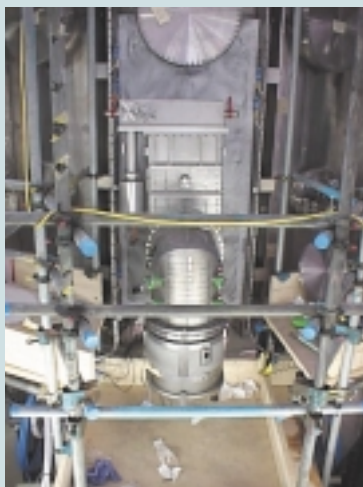
October 4-10 - 18th IAEA Fusion Energy Conference, Italy.

For more details, email [deniese.willis@ukaea.org.uk](mailto:deniese.willis@ukaea.org.uk) or call 01235 463296. *Please note details may be subject to change.*

## A Guide to Fusion – Part 6 Vacuum Pumps

One of the requirements for nuclear fusion research is the attainment of an 'ultra high vacuum' (UHV) within the experimental vacuum chamber. UHV is considered to have been achieved when the pressure is less than  $10^{-7}$  mbar.

Combinations of vacuum pumps are used to remove gas from the vacuum chamber to achieve and maintain the UHV required. The most common arrangement used at Culham consists of turbomolecular pumps, Roots blowers, and rotary pumps connected in series. Each type of pump has its own operating characteristics and these are matched to the requirements. Considerations in the design of the vacuum



*A turbomolecular pump with its isolation valve, mounted on the MAST machine at Culham*

pumping system include: vacuum required, surface area and volume, time to pump down, rate of gas evolution from the walls of the chamber, leaks, and the amount of process gas introduced. Vacuum pumps are often rated for their pumping capacity (throughput of gas) and the largest at Culham are employed on the new experimental facility called MAST. MAST has four turbomolecular pumps (each with a pumping capacity of 3500l/sec or 12000m<sup>3</sup>/hr), two Roots blowers (each 1000m<sup>3</sup>/hr) and two rotary pumps (each 275m<sup>3</sup>/hr). With the vessel conditioning employed (glow discharge cleaning) as well as baking of the vacuum vessel (up to 200°C), a pressure of approximately  $1 \times 10^{-8}$  mbar is expected on MAST.

*Your comments on this edition of Fusion Business are welcome, along with suggestions for articles. Please call 01235 464104 or email [fusion.industry@ukaea.org.uk](mailto:fusion.industry@ukaea.org.uk)*

## YOUR LINK TO FUSION ON THE WEB

The new EURATOM/UKAEA Fusion Industry Programme web site is now available at:

**[www.fusion.org.uk/industry](http://www.fusion.org.uk/industry)**

We are keen to make use of the site to promote companies as part of our efforts to help them win contracts in fusion research worldwide. If your organisation works in fusion or has the capability to be involved in the future and would like a link from the site, email: [fusion.industry@ukaea.org.uk](mailto:fusion.industry@ukaea.org.uk)



### Would you like your company logo to be seen by 25,000 people per week?

Companies are being offered a great advertising opportunity via a link with an innovative astronomy project.

The Fusion Industry Programme is liaising with the University of Bradford as it builds a successor to a robotic telescope, which allows schools, colleges and interest groups to request observations of the sky via the Internet (see Fusion Business 7).

Companies who sponsor the project or provide staff expertise and time to help build the telescope, will have their logos prominently displayed on the telescope's web site which currently attracts 25,000 visitors per week.

If your company would like to be involved please call Miriam Mason on 01235 464104.

### Joining the Industry Team



Miriam Mason is the new Fusion Industry Programme Co-ordinator replacing Louise Ball.

A Modern Languages graduate with a marketing and public relations background, Miriam (pictured left with her daughter Madeleine) joined UKAEA three years ago. She previously worked in management consultancy and a number of industries in Europe and the UK, including broadcasting, manufacturing and engineering.

Enquiries about the Industry Programme can be sent to [miriam.mason@ukaea.org.uk](mailto:miriam.mason@ukaea.org.uk) or you can call her on 01235 464104.

Views expressed herein do not necessarily reflect those of the EURATOM/UKAEA Fusion Association. No liability is accepted whatsoever for errors or omissions contained in Fusion Business. This work is funded by EURATOM and the UK Department of Trade and Industry.