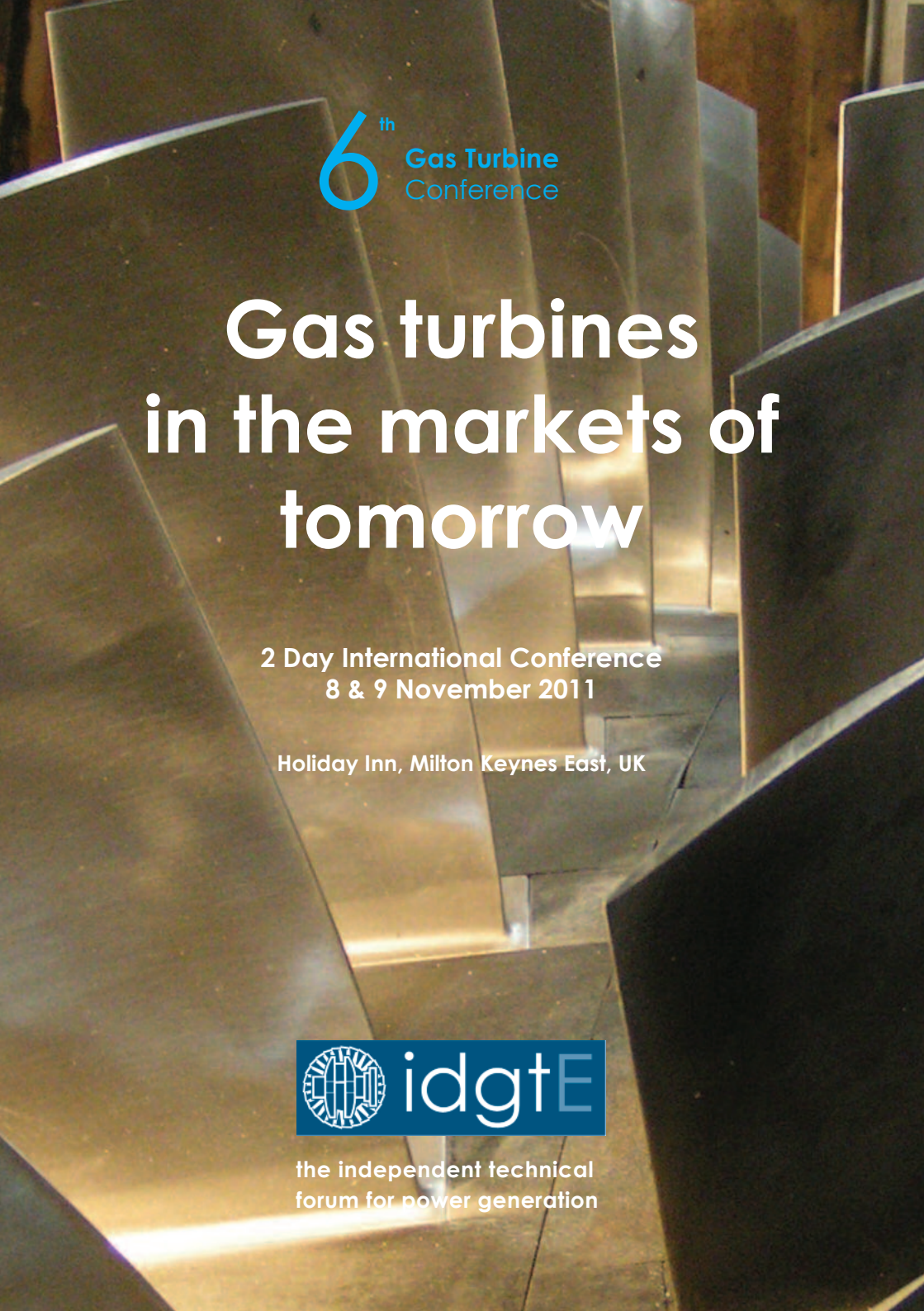

6th Gas Turbine Conference

Gas turbines in the markets of tomorrow

2 Day International Conference
8 & 9 November 2011

Holiday Inn, Milton Keynes East, UK

idgtE

the independent technical forum for power generation

Gas turbines in the markets of tomorrow

Milton Keynes, United Kingdom, 8 & 9 November 2011

Industrial and aero-derivative gas turbines have now been extensively used in power generation for more than 30 years. The earliest plants are approaching the end of their design life and even 'F' technology plant is faced with changes in operation regimes and questions about the benefits of upgrading. This year's conference will examine the changing energy markets and how the latest developments for both future and operating gas turbines address the increasing economic and environmental pressures.

Day 1

08:30 **Registration** and exhibition open

09:00 **Welcome address** - IDGTE President

09:45 **Keynote address** - Tarek Y Ismail - Senior Power System Engineer, National Grid

10:20 **Assessment of flexibility and costs of cycling in existing CCGT plants - an IPP perspective - Kevin Barker, Intergen, UK**

InterGen, a global IPP with four 800MW CCGT plants in the UK and Netherlands commissioned between 1998 and 2004 in its portfolio, has witnessed significant market challenges since these plants entered operation. Looking forward, the electricity market faces further challenges with the introduction of renewables, primarily intermittent wind generation. This means that CCGT plants will have to operate flexibly in the future but, this has potential technical implications for existing CCGTs that may not have been designed for cycling duty.

This presentation will discuss the current operating scenario where the market already requires some flexibility and how increased CCGT plant flexibility will be required to respond to future market conditions. Increasingly, decisions have to be made on whether to cycle existing CCGT or whether to run through. This decision considers many variables, including the cost of cycling and risk of non-return of an individual unit or the entire plant. Low plant flexibility results in greater cycling costs and an increased risk of plant non-return. A case study to improve flexibility in a CCGT plant designed for a low number of starts will be presented.

11:00 **Coffee and tea**

11:20 **Exhibitor session**

Each exhibitor to give a 5 minute presentation to conference.

12.00 **Performance and flexibility - the latest GT26 sequential combustion gas turbine - Matthias Hidderman and Mark Stevens, Alstom**

In order to reduce the cost of electricity in today's challenging market environment and to reduce the CO_2 emissions, high base and superior part load efficiency is one of the key drivers in today's gas turbine development. While introducing new products, the market expectation is to maintain a high level of reliability and availability. For meeting these goals the next evolutionary upgrade package for the GT26 sequential combustion gas turbine has been developed.

The paper will report about the development steps of this upgrade, which evolved from the existing proven design with presently more than 4 million fired hours of the GT24/GT26 fleet. In order to demonstrate the development targets before market introduction, an in depth validation programme following the Alstom Power product development

process has been performed and will be described; use of state-of the-art design tools and features, including aero-engine know-how based on the technology transfer agreement between Alstom Power and Rolls-Royce plc, extensive full engine testing in the Alstom Test Power Plant in Birr (Switzerland) and thermal paint test run of the hot gas path parts. The paper will report on operational experience of this upgrade, which has already been implemented in a front-runner unit, operating reliably for more than 7,700 hours. All design targets regarding performance and emissions have been met. The results of the first regular inspection of the hot gas path revealed that all stator and rotating components were in excellent condition.

12.40 **Lunch**

14:00 **Design implications for CCGT power plant due to the implementation of carbon capture readiness legislation in the UK - Dr Emily Agus and Geoff Miller, Parsons Brinckerhoff**

The UK is one of the first European Union Member States to have implemented the Directive on the Geological Storage of Carbon Dioxide. Through this Directive it is now required that developers of power plants with an electrical output of 300 megawatts or more carry out an assessment to determine whether the power plant could be constructed carbon capture ready. In the UK, the relevant competent authority in respect of energy matters is the Department of Energy and Climate Change. Along with ensuring that the requirements of the Directive are implemented, they have also imposed a more stringent condition that no new power plant at or over 300 megawatts is to be consented unless it can be demonstrated it could be constructed Carbon Capture Ready.

As part of the demonstration of Carbon Capture Readiness, developers are required to provide evidence that there are no known technical barriers to the subsequent retrofit of Carbon Capture equipment. This paper presents a discussion of how this requirement can be satisfied, along with the associated design implications.

14:40 **Challenges faced in maintenance and support of mature gas turbines - S W Elders, Greenray Turbines**

There are a significant number of industrial gas turbine packages still in service, which are over 30 years old. Many are retained in black start or standby duties, others are on base load but whichever, their continued reliability and availability is still of paramount importance. This paper will describe the part that older gas turbines continue to play in the changing markets of today and point to the emerging challenges to be faced by owners and operators of older plants, focusing on the special needs of supporting mature packages and the particular issues that need to be addressed. An overview of the design and lifing philosophy will be provided and the paper will then describe a number of real examples. The issues covered will include remaining life assessments, repair versus replacement, obsolescence, retrofits and upgrades.

The advantages of retaining an OEM based design authority, with access to the original design, will be described. The results of the independent assessment have raised several key questions, and highlighted significant limitations within the rotor life assessment methodology.

15:20 **Coffee and tea**

15.40 **GE aero-derivative gas turbine technology solutions for flexible operation and grid stability - Bulent Mehmeti and Terry Raddings, GE**

As wind and solar energy is used for power generation around the world, the inherent variability of renewable energy sources introduces another factor that affects the operation and stability of the electrical distribution network. Back-up power generation capacity is required to compensate for this variability to ensure the electrical distribution grid remains stable. Aeroderivative gas turbine technology has the required operational characteristics/capability to sustain grid stability. Aeroderivative Gas Turbines (ADGT) are considered among the highest efficiency simple-cycle applications, with a much lower

investment cost per kW than renewable energy. Other key attributes that make ADGT the ideal solution to help stabilise the grid include: full load generation in minutes, the ability to chase the demand load with ramp rates of up to 50 megawatts per minute, and start/stop capability as needed without additional maintenance.

This paper will focus on the LMS100 and LM6000 aero-derivative gas turbine technology and how this can be utilised to meet the demands of augmented flexibility requirements on a grid with an increased renewable portfolio.

16:20 **Advancements in F class gas turbine and combined cycle technology - Marcus Scholz and Terry Raddings, GE**

Combined cycle power plant owners face a changing industry. Renewable energy capacity additions and reduced energy demand have changed operating profiles from base load to cyclic missions. Owners need to minimise costs through improved performance, availability and reliability while meeting increasingly rigorous environmental criteria.

OEMs and service providers are focused on developing products and services to help customers achieve these operational and economic objectives. With more than 35 million fired hours and 700,000 fired starts in its F class fleet, GE has integrated operating experience, emerging trends and owners' insights into its new product development plans.

Driven by changing industry needs, GE has developed and successfully validated several enhancements for F class gas turbines and combined cycle plants that will be reviewed in this presentation. These enhancements involve not only the gas turbine, but also the auxiliary systems that support gas turbine and combined cycle operation. Combustion, controls, part load operation and ramp rates will be some of the features discussed, along with recent F platform developments and milestones.

17:00 **Expert panel and question session**

17:45 **Conference chairman's summary**

19:00 **Conference dinner**

Day 2

08:00 **Exhibition open**

08:50 **Institution welcome**

09.00 **Challenges facing the insurance market in the ever changing UK power market - Eldred R W Clark and Chris Moore, ACE European Group**

This paper will examine some fundamental aspects of the UK power market including 1) the UK Government's climate change committee continuing committment to high levels of nuclear new build and renewable in light of Fukushima and the retail cost of renewables 2) will the UK energy regulator Ofgem remain firm in pressing ahead with a radical overhaul of the retail energy market 3) the UK currently gets about 10% of its power from renewable sources and this has a goal of 15% by 2020 cutting CO_2 emissions by 80% by 2050, 4) the effects of the Large Combustion (National Emission Reduction Plan) Regulations 2007 (SI2007 No.2325) and NERP permits as we approach 2016, 5) the impact of renewables on the generating profile/regime and the perceived effects these have on the insurance market.

It will then go on to examine derived aspects including 1) whether there have been any trends in claims regarding two shifting of plant or pushing the limits on equipment to provide faster start-up times, 2) what we would expect - areas of good practice towards mitigating risk in relation to two shifting 3) introduction of new machines with high efficiency, low load capability and finally 4) provide examples of what we sometimes see in our normal work on sites.

09:40 **Application of automating the process of combustion tuning on large industrial gas turbines - Lee Wilkinson, Gas Turbine Efficiency**

This paper presents results on a new patent pending technology offered by Gas Turbine Efficiency, and its application in automating the process of tuning combustion turbines. The turnkey, customisable, fully automated solution optimises DLN 1.0, 2.0, 2+ and 2.6 gas turbine combustion system performance in real-time. It allows continuous tuning without external operator intervention. Predefined selectable parameters, determined by the plant operator, allow for greater flexibility in matching turbine performance with operational goals. A number of GE 7FA 7241 combustion turbines, operating on natural gas, have been equipped with this system; the results and data obtained is covered in this topic. On-site experience shows an increase in power output, improved combustion and emissions control and the elimination of manual tuning requirements. Experience also shows that gas turbines equipped with the system no longer require post combustion inspection/hot gas path turbine or seasonal tuning. Additional software add-ons for enhancing turbine operation are also available and discussed, including firing curve adjustments to OEM pre-set limits, turndown, peak fire and start-up emissions optimisation.

10:20 **Coffee and tea**

10:40 **Introduction of the SGT-300 twin-shaft gas turbine - Christian Engelbert and Brian Igoe, Siemens**

Since its introduction in 1995 the 7.9MWe SGT-300 has proven a reliable engine for the power generation market with excellent steam raising capability and combined heat and power efficiency. More recently the SGT-300 has proved popular for use with unconventional fuels such as landfill gas, associated and wellheads gases and some examples will be discussed.

Combining the technical capability of the SGT-300 and market demand Siemens has derived an 8.2MW twin-shaft version (SGT-300 MD). The use of proven designs and components achieves state-of-the-art performance whilst ensuring the gas turbine offers robust availability through reliability (material selection) and serviceability (rotor construction and service friendly package). Compressor mapping and blade validation was carried out concurrently to the twin shaft turbine design to address operational stability and high cycle fatigue risk in the speed range of 70-105%.

Working closely with key component suppliers, in-house manufacturing and service have ensured the turbine design achieves the robust and cost effective design for manufacturing and service. This paper details the technical features of the SGT-300 MD twin-shaft gas turbine including packaging and testing.

11.20 **Meeting the market demand for a new turbine in the 35-40MW range - Anders Hellberg and Lynne Anderson, Siemens**

In 2007 Siemens went out to its gas turbine customers and asked questions, aiming to illuminate the gaps in its product range, and the customer requirements on turbines destined to fill those gaps. The 35–40MW output range was appropriate both for smaller power generation units and larger mechanical drives. And what the customers demanded time and again was Reliability, closely seconded by Serviceability – if something did go wrong, it had to be easy to put right, and speedily. The message was clear.

In response, the R&D team in Sweden started work on designing a turbine to fit the bill. Benchmarking of existing Siemens gas turbines was an important feature of the design work, to ensure dependability, as was the 3D environment in which the design took place: a virtual turbine was built, which revealed instantly if there were any limitations as regards spacing, positioning and accessibility of components as regards function and serviceability.

The result is the 37MW SGT-750, launched in November 2010. A twin-shaft machine, with free power turbine, built for both power generation and mechanical drive, the turbine has the potential to achieve efficiency of 40% and downtime of only '17 days in 17 years'.

12:00 **Lunch**

13.20 **Application of an industrial sensor coating system on a Rolls-Royce jet engine for temperature detection - Bernard Charnley, Cranfield University**

Thermal Barrier Coatings (TBC) are now widely used and relied upon to reduce the working temperature of metal parts in the hot sections of a gas turbine. A sensor coating is an adaptation of a TBC that also enables accurate measurement of the material temperature and the health of the coating. This sensing capability is introduced by embedding optically active materials into the TBC and by illuminating these coatings with excitation light. Phosphorescence can be observed that carries temperature and structural information about the coating that would help reduce conservative design margins which are currently needed to ensure safe operation. As a 50°C underestimation of peak temperatures can lead to significant premature failure of the protective coating and loss of integrity, use of this technique could provide significant benefits during turbine development. In addition, the application of an optical on-line temperature monitoring system would help enable the full potential of TBCs to be realised during service providing an early warning of problems and degradation. This in turn will increase fuel efficiency and reduce CO_2 emissions.

This paper describes the experiences of using a variety of sensor coating systems and an advanced optical monitoring system on a Rolls-Royce aero-engine owned by STS and operated by Cranfield University and a large frame gas turbine at Didcot power station. Successful temperature measurements were taken from the combustion chamber, the nozzle guide vanes and the rotating turbine blades. These results were compared with thermocouple and pyrometer results for validation purposes.

14:00 **SGT5-8000H/SGT6-800H Product line - advanced generation of high performance gas turbine - Willibald J Fischer, Siemens**

This paper reviews design and validation of the advanced gas turbine SGT-8000H and associated combined cycle system SCC-8000H, introduced by Siemens Energy. The new SGT-8000H gas turbine, is the result of years of research and development within Siemens Energy. It is based on well proven features of the existing product lines combined with advanced technology. The 50Hz SGT5-8000H is rated 375MW @ ISO and 570MW/60 % in combined cycle. The 60Hz SGT6-8000H is rated 274MW @ ISO and 410MW/60 % in combined cycle. The air-cooled concept offers added value through higher operational flexibility required in deregulated market environment.

The first SGT5-8000H gas turbine was fully tested and validated in 2008/2009 under field conditions in a real power plant enviroment at Irsching 4 Power Station, Bavaria/Germany, in a hosting agreement with E.ON. The Irsching 4 plant was meanwhile converted to a SCC5-8000H 1S single shaft combined cycle unit and with its remarkable results demonstrated during commissioning and initial operation, it represents a milestone in fossil fired power plant technology.

The SGT6-8000H, which is a direct scale from the 50Hz model, will therefore not need a full validation programme. Nevertheless, a full speed full load engine test at the Berlin Test Facility is being conducted to ensure product performance and integrity.

This comprehensive and consequent approach ensures that subsequent "commercial" engines will be brought to market in a risk controlled manner, fully validated based on extensive operating history. First commercial customer projects like the 1,200MW Cape Canaveral and Riviera Clean Energy Centers of Florida Power & Light or the 410MW unit Bugok III of GS EPS (GS Electric Power & Services Ltd), Seoul represent the market introduction phase, with currently eight units in total.

14.40 **Coffee and tea**

15.40 **Mitsubishi advanced large frame gas turbine developments and operating experiences - Yuji Nakashima, Mitsubishi Power Systems Europe Ltd**

Mitsubishi Heavy Industries has recently developed an upgraded 50Hz F class gas turbine and a new gas turbine frame called "J" Series gas turbine. Both designs target high combined cycle efficiency in order to reduce CO_2 and other polluting emissions. The M701F4 incorporates a modified compressor with increased inlet air flow, an advanced air cooled combustor with higher firing temperature, improved turbine cooling technology demonstrated in the G engine and longer last stage turbine blades. Last year, three F4 units started commercial operation; the first in a single-shaft CCGT plant in Japan and two units in a 2+1 multi shaft CCGT plant in Turkey. The performance of the F4 was carefully monitored during tests at the plant in Turkey. A net plant efficiency of more than 59% and high levels of plant flexibility were confirmed. This paper describes the operating experiences and performance validation of the M701F4 gas turbine highlighting the design features that enable it to operate successfully in modern power generation markets where efficiency, flexibility and reliability are paramount.

This paper also takes the opportunity to provide the conference with an update on the "J" Series, the first of which (a 60Hz M501J) entered service in February at "T-point", Mitsubishi's in–house test and verification power plant. This gas turbine is designed to operate with a Turbine Inlet Temperature (TIT) of 1,600°C and a pressure ratio of 23:1 to achieve a combined cycle thermal efficiency of over 61%.

16:20 **Panel discussion**

17:00 **Chairman's summary and conference closing remarks**

Optional Days

Monday 7th November - Afternoon Workshop

Delegates for the conference may attend a free pre-conference workshop running from 1pm-4pm. This will examine the requirements for and experience of flexible operation, including performance and performance monitoring.

Thurday 10th November - Cranfield University visit

Delegates are invited to register for a visit to Cranfield University on Thursday 10th November when Cranfield will set up a demonstration on one of their test cells. This will be an opportunity to see how specific research projects are set up and the facilities available in Cranfield. This is planned as a morning only visit. Places will be limited to 10 only.

Booking Form

I wish to:

- ☐ Register as a Delegate — Rate £475.00 + VAT **Total £570.00**
- ☐ Register as a Delegate (IDGTE member) — Rate £430.00 + VAT **Total £516.00**

Note: The delegate rate is per person and includes half-day pre-conference workshop, two-day conference, tea/coffee at breaks, two lunches and evening meal on the 8th. Single day delegate rates are available on request.

I wish to attend the pre-conference workshop (7 November) Yes ☐ No ☐

I wish to take part in the Cranfield visit (10 November) Yes ☐ No ☐

I wish to book ☐ B&B accommodation for Tuesday night 8 November 2011

Additional accommodation for: ☐ Monday 7 November 2011 ☐ Wednesday 9 November 2011

Delegates will be responsible for paying their own hotel costs directly to the hotel - £89.00 (inc VAT) per night.

There are twelve places available for Student Delegates. Each registered Student Delegate will be given a one year free membership of the IDGTE.

- ☐ Register as a Student Delegate — Rate £85.00 + VAT **Total £102.00** *(does not include evening meal)*
- ☐ Evening meal required for 8 November — Rate £21.74 + VAT **Total £25.00**

- ☐ My company is interested in SPONSORING the conference, please send me more information.
- ☐ My company is interested in EXHIBITING at the conference, please send me more information.

Registration Form

Mr/Mrs/Ms: _____ First Name: _____ Surname: _____

Job Title: _____ Company Name: _____

Address: _____

_____ Postcode: _____ Country: _____

Tel: _____ Fax: _____

Email: _____

Cardholder's address if different from above:

_____

Name of accompanying Person: _____

Special Requirements (if any): _____

Easy Ways to Pay

- ☐ Cheque. Enclosed is our cheque made payable to The Institution of Diesel and Gas Turbine Engineers.
- ☐ Please invoice quoting reference _____
- ☐ Credit/Debit card Visa/Delta/Mastercard Card No: _____

  Expiry Date: _____ 3 digit security code: _____ Total: _____

  Signature: _____
- ☐ Bank transfer payable to The Institution of Diesel and Gas Turbine Engineers to:

  National Westminster Bank plc, Bedford, UK. Sort Code: 60 02 12 Account Number: 51275368

Conditions

No refunds shall be issued for cancellations received after 7th October 2011. However, a substitute delegate may attend in your place. Hotel accommodation in the conference venue is limited and other hotels will be arranged nearby on a first come, first served basis. Delegates should advise the IDGTE of any special requirements at the time of making their conference booking.

Disclaimer

The IDGTE is endeavouring to meet the needs of the industry by transfer of knowledge from presenters to delegates registered for the event. A condition of registration is that the IDGTE, or presenters, cannot be held responsible for the information provided, changes to the advertised information, or for the services provided by the hotel.

Venue Details

Holiday Inn Milton Keynes - East M1, Junction 14, London Road, Newport Pagnell, Buckinghamshire, MK16 0JA.
Telephone: +44 (0)1908 613688.

Please complete and return to:

The Institution of Diesel and Gas Turbine Engineers, Bedford Heights, Manton Lane, Bedford MK41 7PH
Tel: +44 (0)1234 214340 Fax: +44 (0)1234 355493 Email: enquiries@idgte.org Web: www.idgte.org