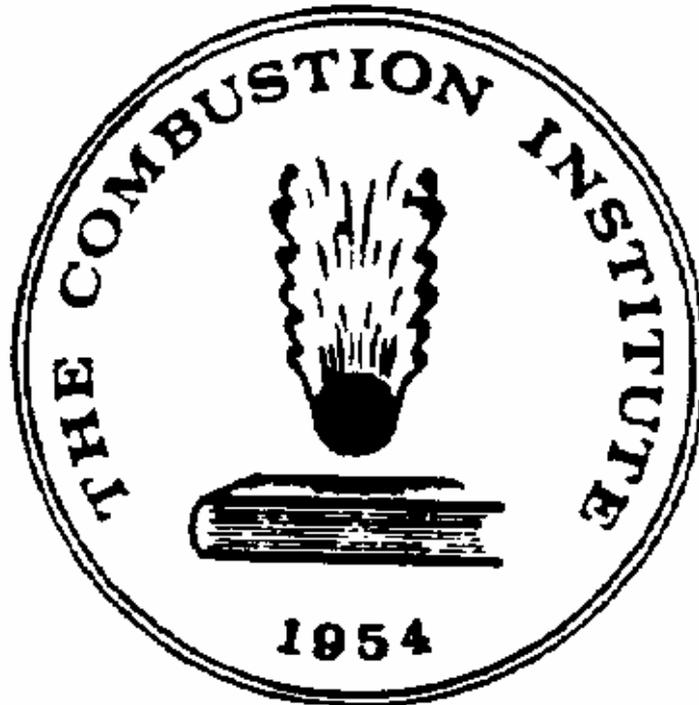


THE COMBUSTION INSTITUTE

(British Section)



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World Wide Web versions of this *Newsletter* at:-
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CONTENTS

• Editorial	3
• Combustion People	4
• Committee of the British Section	6
• AGM of the Combustion Institute (British Section)	7
Minutes of the meeting held on 13 September 2001 in Cambridge	
• British Section Meetings. <i>Can they be improved? How?</i>	10
Chris Lawn asks the questions	
• Proposed Euro-Conference on Clean Combustion	10
• EPSRC Support for Combustion Research	11
• Turbulent Flames: Modelling and Measurement	12
A report on the Spring Meeting of the British Section held at Imperial College London on 26 April 2001	
• The Incineration of Waste Materials	15
A report on the Autumn meeting of the British Section held at the University of Cambridge on 13 September 2001	
• Combustion Chemistry: Elementary Reactions to Macroscopic Processes	17
A report on the Faraday Society Discussion number 119 held at the University of Leeds on 9-11 July 2001	
• Symposium on Combustion Theory	18
A report on a meeting organised by the London Mathematical Society	
• Twelfth Symposium on Problems Connected with the Stability of Explosives	19
A report by John Griffiths on the meeting held in Sweden on 13 to 17 May 2001	
• $V = h(a^2 + ab + b^2)/3$	21
You'll have to read the article by Ken Palmer to solve the equation!	
• A letter from Stig Johansson	23
The Secretary of The Swedish Section for Detonics and Combustion writes to the editor about the British Section <i>Newsletters et al</i>	
• Combustion Calendar	25

EDITORIAL

This edition is going to press shortly after the horrific and tragic events in New York and Washington. I am sure that I can speak for the whole of the British Section when I say that our thoughts have been especially with our colleagues across the Atlantic at this time.

Most of this *Newsletter* was prepared some time ago and I had intended to distribute it before the Autumn meeting in Cambridge. As often happens it was delayed for various reasons, so I decided to wait for a short while longer so that I could include a report on the meeting as well as on our AGM. With the help of Javier Molero I had already put the Combustion Calendar on our web pages, so members may have been puzzled to see the Calendar and not the rest of the *Newsletter* on the web. I have removed the September meetings from this printed version, but if anyone is interested in meetings they may have missed, they are still listed on the web version.

Soon after the previous *Newsletter* (NL 2001-1, January 2001) appeared I had a note from Tom Bowman about John Griffiths' reminiscences on Combustion Symposia:-

One correction to John' recollections of previous Symposia. The first WIP Poster Session of modern Symposia was at the 20th Symposium in Ann Arbor. I should know, as I was the Program Chair of that meeting. This first poster session involved only WIP posters, unlike current practice, and 130 posters were presented. This was such a popular event that it has been continued at all subsequent Symposia - some of the best work is presented in these sessions. A poster session with accepted papers was scheduled at the 18th Symposium in Waterloo, but the practice was discontinued because of author complaints about lack of space (does that sound familiar?) until the 24th (maybe this is what John is remembering). In any event, this all reminds me of just how long I have been in the business!

Thanks, Tom, for that note. It is nice to know that someone reads the Newsletter – I get so little response from members! Other contributions are always welcome. Gratifyingly, at almost the same time, I had a long message from Stig Johannson, an edited version of which appears elsewhere in this *Newsletter*.

In this *Newsletter* members are asked to think about the format of our Section meetings in the light of comments made at the AGM a year ago. Chris Lawn asks how we think meetings could be improved. Several suggestions have been discussed already including the introduction of posters, something tried at the recent Cambridge meeting, and for two-day meetings rather than our traditional one-day events.

Other items in this edition discuss the funding of British combustion research by the EPSRC and report on several combustion-related meetings held this year. Ken Palmer continues his unbroken record with an article inspired by the forthcoming meeting in Egypt. Another bumper edition!

Observant readers will have noticed that I have not included a phone and fax number for me on the cover. This is because I no longer have an office at UCL. I retired early several years ago, but had the use of an office until very recently. The address may still be used for correspondence, although e-mail will be much quicker. Keep the messages and articles coming by whatever means you choose!

Tony Burgess

COMBUSTION PEOPLE

Felix Weinberg

Felix has been elected to the American National Academy of Engineering as a Foreign Associate "for his contributions to the understanding, diagnostics and applications of a wide range of flame and combustion processes".

The Sugden Prize for 2000 was awarded at the AGM of the British Section in Cambridge to G M Abu-Orf and R S Cant for their paper 'A Turbulent Reaction Rate Model for Premixed Turbulent Combustion in Spark-Ignition Engines', *Combustion & Flame*, **122**, 233-252 (2000).

Philip C Bowes (1914-2001)

Philip Bowes, who died at the beginning of this year, was a research specialist in self-heating topics, mainly in solids. After graduating at Imperial College, London, at the beginning of World War 2, he continued there with research into fire problems associated with commodities stored and warehoused in the London docks. After the War he moved to the Fire Research Station, Borehamwood, and continued his research into the self-heating, or "spontaneous combustion", of vegetable oils and fats. He disentangled the relative contributions of microbiological heating, subject to a maximum temperature of about 70°C, and chemical reaction which was often negligible at ambient temperature but became dominant at higher values.

Subsequently he was instrumental in applying thermal explosion theory to spontaneous heating and ignition. A mass of empirical data had accumulated over decades, and this was put on to a systematic basis even though the chemical reactions involved were complex; global reaction kinetics could in fact be used. In consequence, from the results of small-scale laboratory experiments, it became possible to predict the self-heating behaviour of commodities on a full industrial scale in processing, storage, and transportation.

Successful applications of the theory were made to commodities as diverse as hay, activated carbon, wood products, oil seeds, grains, unstable chemicals such as benzoyl peroxide, and non-combustible thermal lagging impregnated with combustible oils.

His book "Self-heating: evaluating and controlling the hazards" (Elsevier, 1984) is an account of his work, and remains outstanding in its field.

After retirement, Bowes moved to Yorkshire, and continued with deskwork at Leeds University. His influence, via his fellow workers and his book, has been worldwide. He was a gentle-man in all senses of the words, and will be much missed.

Ken Palmer

Jan Hansson (1919 – 2001)

Fil dr Jan Hansson died in early February 2001. As Chairman of the Swedish Section of the Combustion Institute for over three decades, Jan will have been known to many Institute members throughout the world. However, he was also an inveterate anglophile and had a number of very close combustion connections in the UK. The UK association probably started in his pre-combustion days when, in the 1950s, Jan studied the kinetics of liquid phase reactions with Professor R.P. Bell, at Oxford. Jan maintained the deepest regard and affection for R P Bell, and perhaps this was reflected in his own quiet and unassuming but purposeful

manner. He also maintained a love for kinetics and, over many years, exploited this in a combustion context within the defence organisation in Sweden, FOA.

Jan believed passionately that the communication of science should transcend all political barriers and, to that end, established a highly successful series of international meetings concerned with the stability of explosives and propellants so that safe storage, and also safe destruction after the “sell-by date”, could be ensured. The “12th Symposium” was held in May 2001 (see elsewhere in this *Newsletter*) and, given the triennial cycle, these meetings have spanned nearly four decades during which there has been acute political sensitivity in relation to defence matters. Through correspondence and visits, Jan cultivated relationships with workers in the former Soviet Union and the Eastern bloc countries and later with China, and he brought these people together, at the Symposia, with delegates from Australia, Japan, North America, South Africa and the UK and other West European countries.

On the technical side, Jan devised a stability test based on weight loss, to replace the “red fuming test”, and he strongly supported the development of new analytical techniques for the surveillance of propellants and to trace the degradation of the diphenylamine stabiliser, such as the use of hplc. He understood well the place of the traditional accelerated decomposition rate tests by exposing propellants to elevated temperatures, but later he became a strong advocate of heat flow calorimetry as a fundamental route to measurement of reactivity closer to ambient conditions, and he worked with instrument manufacturers to further this aim.

As a founder member of the International Pyrotechnic Society, and its President in 1993/4, Jan played a major part in the sharing and dissemination of knowledge about pyrotechnics. In this connection he established also another series of meetings in Sweden, called “Pyrotechnikdagen”.

Jan had many diverse interests and skills, but it was only after many years of friendship that I learned that he was an accomplished sportsman. He was deft with the fencing foil and in his youth his performance on the track over one mile would have been highly respectable in almost any competition. Less active pursuits included philately and chess. His talent as a linguistic may be inferred from the above, and this ability was put to valuable purpose in researching the history of black powder and pyrotechnic substances. Given his ambitions to surmount political differences, it will be no surprise that age difference presented no complication to Jan. Indeed throughout his career he made a special point of befriending and encouraging young research workers. The combustion community is the poorer for the loss of this gentle, modest and kind man.

John Griffiths

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MINUTES OF THE ANNUAL GENERAL MEETING

held at Cambridge University on Thursday 13 September 2001 at 2.10pm

Present:

G Abu-Orf	C Lawn (Chairman)
A R Burgess	F Lockwood
M Brown	J P MacCarthy
P Cadman	K Palmer
R S Cant	M Purvis
P Gray	V Rasaratnam
A N Hayhurst	D B Smith
W P Jones	J Swithenbank
M Kraft	A S Tomlin (secretary)
	A Williams

Apologies for absence were received from D D Drysdale, V Dupont (Membership Secretary), J F Griffiths, G T Kalghatgi (Treasurer), J Smart.

1. **Minutes of the AGM held on 21 September 2000** were signed as a correct record.

2. **Matters arising**

A method of renewing membership by standing order has now been implemented and has been used this year by about 10% of the membership. There were no other matters arising other than items on the Agenda.

3. **Secretary's Report**

Membership 2001:

The British Section has 187 members whereas membership at end of year 2000 was 199.

The breakdown is as follows:

12 students	(6 %)
88 academics	(46 %)
67 industrialists or other	(35 %)
30 retired (9 academics, 21 industrialists)	(16 %)

The Section gained 27 new members this year (6 students, 11 academics, 10 industrialists). 41 members did not renew their membership from 1999 to 2000 of which 5 were students and 18 were academics.

A colour mail advertisement was posted to all members for circulating, resulting in at least 14 new members. The mail-out also resulted in many members from 1999 rejoining for 2001. It was proposed that this advertisement be sent with appropriate short course information from Leeds to try and attract new industrial members.

Meetings

The Spring one-day meeting 2001 on *Turbulent Flames: Modelling and Measurement* was held at Imperial College London on the 26th April. The meeting was very well received with over 70 attendees and 7 speakers including international contributions (Rob Barlow, Sandia Labs,

Thierry Poinot, Cerfacs). It was agreed by the committee that invited international speakers enhanced its success.

The Autumn meeting 2001 on *The Incineration of Waste Materials* was held at Cambridge University on Thurs. 13th September 2001 and was attended by over 60 participants. A report on this meeting will appear in the next *Newsletter*.

The Federation of European Sections in Brussels has proposed a spring meeting for 2002 with a proposed date of April 15th-17th 2002 in Louvain-La-Neuve in Belgium. European funding was sought for the meeting but the Chairman reported that funding had not been successful. The proposed subject topics were lean combustion, high temperature combustion, hydrogen as a fuel and biofuels. It is unclear at present whether the meeting will take place on the proposed dates.

A Spring 2002 British Section meeting may not be necessary if the European meeting was to take place.

Following invitation to members to comment on the format of future British Section meetings a response was received suggesting a longer annual meeting with more short presentations and published extended abstracts. Poster sessions with rapporteurs and associated discussion sessions were also suggested. The committee is pursuing a change in format for the Autumn 2002 meeting.

Prizes.

The committee recently agreed to fund a separate prize for the best UK paper in the International Symposium of £250. It was also agreed that prizes should be offered for the best poster at appropriate British Section meetings to encourage young researchers to take part in meetings. Professor Gray commented that perhaps the prize should only be offered for original poster contributions rather than for posters that had been presented at other meetings previously. This item will be discussed by the British Section committee.

The Sugden Prize for 2000 was awarded to G M Abu-Orf and R S Cant for their paper 'A Turbulent Reaction Rate Model for Premixed Turbulent Combustion in Spark-Ignition Engines', *Combustion & Flame*, **122**:233-252 (2000). Congratulations were offered to the authors by the meeting.

4. Chairman's report

The Chairman reported on continuing discussions with the EPSRC regarding the funding of combustion projects in the UK. A small delegation had visited Swindon in March and had been shown a list of the referees used to review combustion proposals. Since many of these were not recognised as combustion researchers, at EPSRC's suggestion, a more comprehensive list is being compiled by the Committee.

The Chairman also mentioned discussions that have taken place in Committee regarding the promotion of combustion within the UK, particularly to potential research students. A Prestige Lecture or a Roadshow has been suggested.

5. Honorary Treasurer's report

The Secretary presented a statement of accounts for 2000/2001 on behalf of the Treasurer. Current assets are £1,630 in the current account and £50,366 in the COIF Deposit Fund (all the savings were consolidated in this account because it gives very good interest - 5.9%, minimises risk and provides flexibility).

Once the accounts of Edinburgh 2000 are settled, the British Section should receive the money that is owed - around £28,000 - and a share of any surplus from the Symposium. The assets of the British Section will then be over £80,000. Thus the accumulated funds continue to grow.

Membership numbers and income are on a gentle downward trend. In 2000 this income was £3092. The other regular main source of income is the interest on savings.

Normal expenses (committee, secretarial, newsletter, Sugden Prize of £250) have not changed much over the past four years and average around £2,900 per year.

Travel grants worth £6800 (10@£500 and 6@£300) were made to enable members to attend Edinburgh 2000.

The accounts were adopted by the meeting and thanks were expressed to Dr M Davies and Dr J Sykes for auditing the accounts this year. The meeting agreed to invite them as auditors for a further year.

Professor Williams commented that if the accumulated funds continue to grow that the Section may be in danger of losing Charitable status. The meeting agreed that this issue should be further investigated by the committee. Professor Lawn suggested that one way of utilizing accumulated funds would be to offer support for members attending meetings other than International Symposia. The European Sections meeting would be one such example if it was to take place next year.

Dr Dave Smith presented a report regarding the resolution of problems related to the Symposium finances. A meeting with Clansman Monarch has taken place with legal representation present on behalf of the Combustion Institute. Clansman Monarch have agreed to pay the remaining surplus owed to the British Section so that outstanding bills can be settled. The remaining profit will be split 50:50 between the British Section and the Pittsburgh office with approximately £13,000 due to the British Section.

The meeting thanked Dr David Smith and Dr Chris Morley for their continued efforts in bringing the 28th Symposium accounts to fruition under very difficult circumstances.

6. Election of Committee members.

Chris Priddin came to the end of his first 3 year term as a committee member in September 2001. However, due an oversight by the committee, nominations for new members were not able to be invited in sufficient time before the AGM to hold a ballot. The meeting therefore agreed to elect Chris Priddin for a further year with the potential for him to be re-elected in 2002 for a further 2-year term. 5 members will come to the end of their terms next year and a ballot will be held.

7. Any other business

There was no other business and the meeting closed at 2.35 pm

AST (25/9/01)
(slightly edited by ARB)

BRITISH SECTION MEETINGS

Can they be improved? How?

If you are like me then you will probably have come away from one of our single-day meetings thinking that the papers were generally interesting and well-presented, the company was good and the lunch was excellent, but from a technical point of view, would I have spent the day better in the Library, focusing on my special interests? This of course is to neglect the possibility of serendipity and the benefits of generally broadening one's interests. Moreover, I do believe our meetings provide an almost unique opportunity to hear some of the leaders in their field speaking in a relatively informal atmosphere. But where is the discussion, the cut-and-thrust of scientific debate? Seldom present, for many reasons that we could all enumerate.

Your Committee are addressing the issue of how we can make our meetings more interactive, involve more of our younger researchers, and allow real opportunities for 'work-in-progress' to be discussed. In the past, we have tried calling for 'ten-minute' presentations, with some success, and we feel that poster sessions on the lines of those in the International Symposia could be attractive. Certainly, there was a lively buzz, and sometimes gross over-crowding, around some of the posters in Edinburgh.

We should like to hear the views of the membership on this. If you have ideas about what would constitute a 'good' meeting, either generically or with a specific topic in mind, please air them with me or another member of the Committee. Over a period in which 'new technology' has completely changed our modes of daily working, and certainly improved the visual quality of presentations, one thing at least has remained constant ... the format of our meetings! It does not have to be so.

Chris Lawn



PROPOSED EURO-CONFERENCE ON CLEAN COMBUSTION

At the beginning of the year, Dr Iskender Gokalp, the Chair of the French Section and also of the informal Federation of European Sections of the Combustion Institute, coordinated a proposal to the EC for support for a meeting on Clean Combustion under the High-Level Scientific Conferences Programme. The proposal was for restricted participation by nominated personnel from the 12 Sections, with the major themes of 'lean combustion', 'high temperature combustion', 'challenges of hydrogen as a fuel', and 'challenges of biofuels'. The Conference was to be in Louvain-La-Neuve in April 2002.

Dr Gokalp has now informed us that the proposal has been turned down by the EC, but he is canvassing the possibility of proceeding with a conference in any case. The British Section Committee is supportive of a European meeting, preferably with much wider participation, notwithstanding the proximity of the 29th International Symposium in Japan, so we are encouraging the idea and discussing how to promote it. However, it seems likely that it will be too late to arrange the conference for April 2002.

Chris Lawn

EPSRC SUPPORT FOR COMBUSTION RESEARCH

A report to the Combustion Institute (British Section) and Combustion Physics Group on a Meeting with EPSRC Personnel held in Swindon on 5 March 2001

Present :

Peter Hedges (ex PM for EPSRC, General Engineering)

Liz Foord (PM for EPSRC, General Engineering)

Larry Attwood (ex APM for EPSRC, Combustion in Engineering)

Dave Holtum (APM for EPSRC, Combustion in Engineering)

Allan Jones (Coal Research Forum)

Mike Fairweather (Combustion Physics Group)

Chris Lawn (Combustion Institute)

The purpose of the meeting was to maintain the profile of Combustion Research, and to voice some concerns about the current situation, in particular the decline in the quantity being supported in the UK. The main points were as follows:

- 1) EPSRC listed 100 projects totaling £14.7M under Combustion at that time, with 37 of these (£4.8M) being under General Engineering, and 6 under ESR21. However, about 15 of these were not on combustion per se, but to do with combustion equipment (eg 'turbine blade cooling'). A success rate of nearly 40% for all combustion applications in 2000 was quoted. There were three combustion-related Platform Grants.
- 2) For the future, EPSRC cited opportunities for combustion beyond responsive mode in the programmes on Distributed Generation, Renewables, and Sustainability of Electricity Supply. There was to be a 'future priorities' meeting for engineering as a whole on June 29th, and there was an open invitation to attend.
- 3) In response to our concerns about peer review, we were invited to submit a list of people with the expertise to undertake such reviews for combustion proposals. [Members of the CI and Combustion Physics Committees are currently making nominations of suitable referees and it is proposed to submit an amalgamated list.] EPSRC Allocation Panels are being focused to some extent: Panel A will tend to be Thermo-Fluids orientated.
- 4) EPSRC are keen to promote international collaboration and cited their support for a recent visit to the US by a number of Chemical Engineers. A similar proposal for a team of mid-career researchers in combustion to go to the US, or perhaps France and Germany, would probably be favourably received, although subject to responsive mode assessment.

C J Lawn, M J Fairweather and A R Jones

TURBULENT FLAMES: MODELLING AND MEASUREMENTS

A report on the Spring Meeting of the Combustion Institute (British Section) held at Imperial College London on 26 April 2001

Imperial College in London were the hosts for the British Section's Spring 2001 meeting. Entitled 'Turbulent Flames: Modelling and Measurements' the seminar was organised by Professor Bill Jones of the Department of Mechanical Engineering at Imperial, who had assembled a strong international array of speakers. Happily the strength of the speakers was reflected in the attendance, with over 70 delegates present.

The meeting was opened with a presentation from Dr Robert Barlow of the Combustion Research Facility at Sandia National Laboratories in the USA, talking on 'Multi-Scalar Measurements for Combustion Model Validation'. This presentation set the theme of the meeting since Dr. Barlow has been involved for a number of years in taking high-quality measurements which are being employed for development and validation of prediction methods. He began by discussing some of the test cases and results obtained during the international Turbulent Nonpremixed Flame (TNF) workshops held in the last years. These are a forum for collaboration between computational and experimental researchers investigating fundamental issues especially turbulence-chemistry interaction. So far five TNF workshops have been held, the most recent being in Delft in 2000 [1]. The 6th TNF is to be announced, and will be held in conjunction with the 29th International Symposium on Combustion, in Sapporo or Kobe [1]. It will bring together researchers from around the world participating in measurements and comparisons of modelling approaches for the target flame test cases. New target flames are being added to the TNF database, including new swirl-stabilised flames of CH₄/H₂, CH₄/air (from Asaad Masri in Sydney), the Tecflam swirl burner and partially premixed flames. The flames have been investigated using a Raman/Rayleigh single point technique for temperature and major species, and LIF (laser induced fluorescence) for OH, NO and CO. These measurements have demonstrated that sources of interference in the Raman signals obtained in CH₄ flames should be carefully considered. Calculations of the Sandia piloted flames show that some disagreement exists in predictions of fuel-rich mixtures obtained using different models, and some possible reasons for this were discussed by Dr Barlow. Interestingly, the comparison of measured conditional means with laminar flame calculations for Flame D also shows that differential diffusion effects appear to play a less relevant role as the Reynolds number increases. The assumption of unity Lewis number has been seen to yield better results than full transport in the far field while the reverse occurs in the near-nozzle region where the Reynolds number is lower.

Dr Barlow then described his current work, involving investigation of a low strain partially premixed CH₄ flame in the Tsuji porous cylinder geometry. He is considering NO mechanisms referring to calculations by J -Y Chen using CHEMKIN. The GRI-Mech 2.11 and GRI-Mech 3.0 mechanisms have been compared along with mechanisms by Jim Miller and Peter Lindstedt and results for peak and fuel-lean NO show that GRI 2.11 is performing better than GRI 3.0 for this flame. Dr Barlow closed his presentation with a description of the new combustion laboratory being built at Sandia, which will allow multi-scalar measurements and velocity measurements to be taken in two mirrored facility on the same test rig.

The second presentation by Professor Thierry Poinso of CERFACS in France dealt with Large Eddy Simulation of combustion instabilities in gas turbines. Professor Poinso pointed out that most research into LES of reacting flows concentrates on subgrid combustion modelling in one of the two extreme cases of perfectly premixed or diffusion flames, whereas both regimes are likely to occur in practical combustors. He described calculations for lean premixed prevaporised (LPP) combustion devices with swirl, such as are found in low-emissions power-generation gas turbines. In these flames combustion is partially premixed and reactions are

dominated by slow kinetics. Clearly, the assumption of infinitely fast chemistry cannot be invoked, nor can flamelet models be employed, although PDF transport methods would probably give a more realistic description of the mixing process. The flame structure corresponds to a triple-layer flame but differs from what is generally described as a triple flame: here the edge flame is anchored on burnt gas. This constitutes the stabilisation mechanism which must be captured by the predictive method. Professor Poinsoot also discussed the methods employed in his AVBP code, which features a thickened flame model to allow the reaction zone to be captured on the computational grid. He then showed some flow visualisations obtained from axisymmetric calculations of a LPP combustor, where large scale instabilities which seriously disrupt the flow patterns were clearly visible. This shows a way forward for predicting acoustic waves within the combustion chamber although the computational cost will remain high and some concerns remain on a number of numerical issues related to corruption of the wave prediction.

Professor Peter Lindstedt from Imperial College discussed prediction of kinetically-influenced phenomena in turbulent flames. Professor Lindstedt described a modelling methodology including comprehensive chemistry for premixed, partially premixed and diffusion combustion based on a scalar transported PDF approach coupled with a second-moment turbulence closure for the velocity field. This methodology employs systematically reduced chemistry. Professor Lindstedt remarked upon that the current targets of what constitutes a 'reasonable' level of complexity for chemistry has shifted from a few scalars to order 10 scalar variables. It remains to be proven whether this is practical for large three-dimensional calculations. Professor Lindstedt then described calculations of Sandia Flame D carried out within his research group [2] using the methods described earlier in his talk. These show a good level of agreement with the Sandia data especially when a variable Prandtl number was considered. It is possible that the predictions could be improved by accounting for radiative losses, while the effects of differential diffusion seem small which is consistent with the results discussed earlier in the morning.

After lunch the meeting resumed with a talk on Large Eddy Simulation of turbulent diffusion flames by Professor Johannes Janicka of the Technical University Darmstadt. Professor Janicka began by asserting that RANS (Reynolds averaged) calculations are still useful in an industrial context, especially for the day-to-day production calculations. However RANS is not suitable for combustion instability calculations, with unsteady RANS not able to treat frequencies in the range of interest (ie higher than 100-200 Hz). He also remarked that PDF transport methods are suitable for describing turbulence-chemistry interaction, but also that the applicability of the velocity-composition PDF in three dimensions has not been proven, a view supported in [3]. Since for many combustion problems the most important processes generally occur far from walls then the details of the wall modelling are less critical which is advantageous for LES. Professor Janicka then described the Darmstadt LES codes and the combustion model which they feature, based on a flamelet assumption and presumed PDF subgrid scale turbulence-chemistry interaction closure. He showed results for some diffusion flame calculations which demonstrated good agreement with experimental measurements. This presentation, along with Professor Poinsoot's earlier talk, provided a snapshot of how LES development is progressing towards practical tools for predictions of reacting flows.

The emphasis returned to advanced diagnostic techniques with the presentation by Dr James Kelman of Cranfield University on simultaneous laser imaging of scalars in turbulent flames. Dr Kelman presented results from measurements on some of the flames investigated at the University of Sydney during the time he spent there working with Asaad Masri. These results demonstrated how the planar laser imaging technique could reveal flame structure by investigation of scalar fields. While more work needs to be done on this method it does provide interesting results which give more insight into the flame behaviour.

The last two presentations, after the tea break, returned to modelling issues. Dr Nondas Mastorakos of Cambridge University discussed the Conditional Moment Closure for non-premixed combustion and auto-ignition, considering the basic formulation of the CMC method and its applications. The method assumes that all reactive scalars can be related to the mixture fraction; the problem becomes one of determining the functional relationships representing the conditional averages. The method has been applied to bluff-body flames, soot production and as a submodel in LES [4]. Dr Mastorakos illustrated the governing equations for CMC, and showed how the resulting 5-dimensional problem is made more tractable by assuming that the conditional averages vary slowly in space. The approach in its current formulation is slow (especially when detailed chemistry is accounted for) but can be improved. Dr Mastorakos then described how CMC can be interfaced with CFD codes before presenting some results from auto-ignition calculations. These show considerable promise and may prove to be a means of including more detailed chemistry in practical turbulent reacting flow calculations without the complexity of PDF transport methods.

The final presentation of the day was given by Professor Phil Gaskell of the University of Leeds on 'Turbulent Combustion Modelling: a Flamelet Approach'. Professor Gaskell presented a methodology for both premixed and non-premixed flame calculations based on Favre averaging, Reynolds Stress closure of the turbulence field and a flamelet description of combustion. For premixed flames the methodology described employs a description of the mean volumetric heat release rate which is written in terms of the probability of a flame being sustained, the integral of the heat release at zero strain, and a probability density function. This model shows that in weak mixtures the heat release rate reduces as strain increases, while for rich mixtures the heat release rate increases with increasing strain. For non-premixed flames the system is assumed to behave like an array of premixed laminar flames with a modified heat release rate expression and no combustion outside of the flammability limits.

This was a highly enjoyable and productive meeting. The presentations were varied and informative, giving a good cross-section of current research topics in both modelling and measurements. It was particularly encouraging to see such a large and interested audience, ranging from students to professionals with long experience in the combustion field, giving ample opportunity for interesting technical discussions. This was clearly helped by the strong international list of speakers and an easily accessible location. All of us who attended the meeting owe Professor Bill Jones thanks for persuading the speakers to appear, and also thanks to the other staff at Imperial College who were involved in the organisation of the day.

[1] The TNF web page at <http://www.ca.sandia.gov/tdf/Workshop.html>

[2] R P Lindstedt, S Louludi and T Vaos, 'Joint scalar pdf modelling of pollutant formation in piloted turbulent jet diffusion flames with comprehensive chemistry', proceedings of the 28th Symposium (International) on Combustion, The Combustion Institute, 2001

[3] K R Menzies, 'Turbulence Modelling for Industrial Reacting Flows: Current Best Practice and Future Prospects', Proceedings of ECCOMAS CFD 2001, Swansea, September 2001

[4] W K Bushe and H Steiner, 'Conditional moment closure for large eddy simulation of nonpremixed turbulent reacting flows', Physics of Fluids, 1999, vol. 11, n. 7, pp. 1896-1906

Francesca di Mare (IC London) & Kevin Menzies (Rolls-Royce plc, Bristol)

THE INCINERATION OF WASTE MATERIALS

A report on the Autumn Meeting of The Combustion Institute (British Section)
co-sponsored by The Institute of Energy, held in the Department of Chemical
Engineering, University of Cambridge on Thursday 13 September 2001

Programme

"Combustion of Agricultural Wastes"

Professor Joachim Werther, Technical University of Hamburg-Harburg, Germany

"Characterisation of Municipal Wastes"

Adrian Gibbs, University of Wales at Cardiff

"Combustion of R.D.F. and Waste Paper in a Bubbling Fluidised Bed"

R Cooke, M Goodson & A N Hayhurst, Department of Chemical Engineering, Cambridge

"The Role of Co-firing Wastes and Coal in Incineration"

P G Costen & F C Lockwood, Dept of Mechanical Engineering, Imperial College London

"Release of Heavy Metals during the Combustion of Wastes"

Paul Williams, Department of Fuel & Energy, Leeds University

"Downdraft Gasification of Sewage Sludge"

Abdulla Malik, Waste to Energy Ltd.

"Biomass-fired Turbines"

Tom Fraser & Nick Syred, University of Wales at Cardiff

"Dioxins from Incineration"

Rue Goh, Department of Chemical Engineering, Sheffield University"

"Novel Thermal processes for Municipal Solid Waste"

Bill Livingston, Mitsui Babcock

"NO_x from the Incineration of Paper and Plastic Waste"

Alan Williams et al, Department of Fuel & Energy, Leeds University

"An Overview of the day's topics and Modelling of Incinerators"

Jim Swithenbank, Department of Chemical Engineering, Sheffield University,



The Autumn meeting of the British Section of the Combustion Institute was held at the Department of Chemical Engineering, University of Cambridge. There were many interesting talks, showing that combustion scientists will have a go at burning just about anything that they can get their hands on, from coconut husks through cows to coal, and will throw even more things into their rigs, big or small, to see if they burn, help things to burn, stop things burning, or help to give a better understanding of things burning.

One thing I took away from the day was that, regardless of how low the emissions and how high the quality of control surrounding incineration of waste, until the perceptions of the general

public are changed it will still be difficult to utilise fully this method of waste disposal in this country.

Some figures quoted during the day stood out to me; the fact that this country produces thirty million tonnes of municipal waste a year, ten times as much as the amount of fossil fuels used, the fact that we simply send the vast majority of it to landfill, where its energy value is lost - truly a "waste".

There were a number of presentations on recovery of energy from municipal waste, with approaches varying from the most high tech (unsurprisingly Japanese) to men in overalls and wellies clambering over rubbish dumps in Wales to classify the waste arriving - important work; rather than me.

We were fortunate enough to start the day with a talk by Professor Joachim Werther, who talked about the combustion of agricultural wastes. His talk was very thorough, and gave us a great introduction to an important subject for the future. Next was Adrian Gibbs, who presented his work on the characterisation of municipal wastes, this was the man in the wellies on the rubbish dump. The work he presented was very hands on - sometimes actually sorting the municipal rubbish by hand. It was interesting to note the differences in the results of the characterisation between his approach and the commonly used approach of surveying households.

Professor Hayhurst then gave a short talk on the combustion of refuse-derived fuel and waste paper in a bubbling fluidised bed, utilising the bed to give information on the different stages of the combustion of these fuels. Dr Costen and Professor Lockwood gave an informative talk on the role of co-firing wastes and coal in incineration, showing why it is often necessary or advantageous to burn coal as well as waste. Dr Paul Williams gave a talk on the release of heavy metals during the combustion of wastes, showing some excellent slides detailing the deposition of the heavy metals. In the last talk before lunch Dr Malik gave a talk concerning the downdraft gasification of sewage sludge, a method which appeared to offer some advantages over the conventional method.

Lunch followed, with maybe the odd glass of wine, and a visit to some of the posters presented. Posters were on display all day from coffee at 10 am to tea after the meeting. Lunch was preceded by presentation of the Sugden Award for 2000 and followed by the AGM of the British Section (see minutes of the meeting elsewhere in the Newsletter).

Replete, we started the afternoon session with a talk by Tom Fraser and Nick Syred on biomass fired turbines, they concentrated mainly on the biomass elements, and showed that this could be an important technology for the future. Dr Goh then talked about dioxins from incineration, showing that modern combustion technology can produce almost immeasurably low concentrations of these important pollutants. Bill Livingston gave a talk on novel thermal processes for municipal solid waste, showing that the Japanese have some very high tech processes at a commercial scale for low emission, very low ash incineration.

Professor Williams gave a talk on NO_x from the incineration of paper and plastic waste, before Professor Swithenbank rounded off the afternoon with a few thoughts on equilibrium, and an overview of the day's topics, including some ideas on how incinerator operators might hope to change public perception of having an incinerator in their area.

I thoroughly enjoyed the day, and look forward to the next meeting.

Paul Fennell
(University of Cambridge)

COMBUSTION CHEMISTRY: ELEMENTARY REACTIONS TO MACROSCOPIC PROCESSES.

A report on the Faraday Discussion number 119 held in the School of Chemistry, University of Leeds on 9 to 11 July 2001

There is an unusual and highly successful format to the Faraday Discussions. Authors are allocated a 30-minute slot in the refereed paper programme, but are rigorously restricted to a five-minute verbal summary. These are usually presented in pairs or as a trio where there is a common theme. The remaining time from the session is then devoted to discussion. Verbatim records are not made but delegates are encouraged to submit written comments / questions and authors are expected to respond. These records constitute a very important part of the published proceedings. To facilitate discussion, registrants receive a set of preprints some weeks in advance of the meeting, and many arrive already primed with questions or comments – and are permitted (encouraged even) to introduce results from their own work. The immediate benefit is a lively and rewarding debate that takes place “on the floor”. The legacy is a unique record of exchanges of scientific ideas.

The 119th Faraday Discussion attracted over 80 scientists from around the world, and certainly lived up to the expectation of it. The meeting opened with a highly appropriate Introductory Lecture by Jürgen Wolfrum, entitled “Advanced Laser Spectroscopy in Combustion Chemistry: From Elementary Steps to Practical Devices”. At least he was accorded 55 minutes!

In reviewing the subsequent programme one would be bound to note that the balance of content lay towards elementary reactions rather than macroscopic process but, given the single session format with no simultaneous counter attractions, the dialogue between “pure kinetics” and the “combustion systems” people was able to fully develop. The breadth of elementary reaction contributions covered all facets relevant in combustion today, from the low temperature hydrocarbon oxidation end (eg alkyl + O₂), through reactions important in pollutant formation to the behaviour of small species in flames, such as CH₂. There was much to learn from them, during this meeting, about energy states of species, potential energy surfaces and the quantitative interpretation of competitive reaction channels. Much of this knowledge is gained from a combination of very sophisticated experimental methods to select or probe the states of molecules and highly developed *ab initio* calculations. To complement this type of work were contributions related to modelling of combustion in homogeneous and heterogeneous systems and also the development and application of diagnostic methods to flames and other combustion systems.

One evening of the meeting was devoted to a poster session, which covered a somewhat similar spectrum of interests as the main programme. This forum provided the usual, valuable opportunity for one-to-one discussion. The convivial atmosphere and provisions of Devonshire Hall, which was the residential centre for the conference, enhanced that side of the proceedings! The Royal Society of Chemistry prides itself on rapid publication of the Faraday Discussions. So members of the Section are recommended to look out for these before the end of 2001.

Further information about the programme of the meeting and the proceedings can be accessed electronically on www.rsc.org/lap/confs/faradischeme.htm

John Griffiths

SYMPOSIUM ON COMBUSTION THEORY

A report on a meeting organised by the London Mathematical Society in Durham on 4-13 July 2001

An important grouping of theoreticians and experimentalists in Combustion took place in July in the well appointed grounds of Durham University. This is the first time that the London Mathematical Society has sponsored an applied mathematical conference. They originally approached Professor John Brindley to have a conference on Combustion as part of their regular series of Durham Symposia in Mathematics.

About 60 delegates were invited from all over the world, and each day there was a theme with lead talks followed by a workshop. The themes were:-

Blow up
Flames
Condensed phase combustion
Detonations
Bifurcation and Instability.

One of the great benefits of the conference was the opportunity, in afternoon sessions, to speak at length in smaller groups concerning ongoing collaborative research in a very relaxed atmosphere. The aim of the conference was to look at new problems and challenges, and with this in mind, it was significant that a number of younger researchers were actively involved, both taking part in the discussions, and participating with short talks which were held in the evening. Some of the discussions that took place were much more in depth than could have been had in a larger setting.

The main morning talks were masterful - ranging from Heterogeneous combustion (John Buckmaster) to a tour de force through Flame theory (Guy Joulin). Leaders in their fields covered Catalytic combustion (Alastair Spence), Onset of detonation (Elaine Oran), Bifurcation in explosion theory (Graeme Wake), Ignition of a collection of solids (Brian Gray), Blow up in nonlinear hyperbolic systems (Pohozhaev), Solid high temperature synthesis (Bernie Matkowsky), Lifted diffusion flame structure (Amable Linan), Hot spot ignition in a reactive gas (Dave Kasso), Spinning Detonations (Scott Stewart), Gas Dynamics and combustion (John Clarke), Cellular detonations (Paul Clavin), Thermal explosions in heterogeneous combustion (Vladimir Goldshtein), and Mathematical analysis of blow up (Viktor Galaktinov).

There is a great need to consider generic problems in combustion with careful models established for their analysis. Hence the need to have interaction between experimentalists and mathematical modellers is one of the great requirements for the combustion community. Judging by the intense conversations taking place, this has been very much achieved. The organisers are grateful to LMS and EPSRC for their sponsorship of what has proved to be a very valuable symposium.

John Brindley, John Dold, Viktor Galaktinov and Andy McIntosh

TWELFTH SYMPOSIUM ON PROBLEMS CONNECTED WITH THE STABILITY OF EXPLOSIVES

A report of the meeting held in Karlsborg Fästning, Sweden on 13 to 17 May 2001

Fifty-three delegates from twenty-one countries attended the Twelfth Symposium organised by the Swedish Section for Detonics and Combustion (affiliated to the Combustion Institute) in the attractive, historic, and entirely appropriate setting of Karlsborg Fästning. The Göta canal, which was planned by Thomas Telford in 1808, links Gothenburg to the East coast of Sweden. Karlsborg Fästning is located where the canal enters Lake Vättern. This city is designated as "the reserve capital of Sweden" because, 200 years ago, a fortress was established there, in which the Swedish government could take refuge in the event of invasion from Eastern Europe. In fact, the scale of the construction is such that it took 90 years to complete and it has never been used for its original purpose. Nevertheless, it is alleged that gold reserves and national treasures were housed there in more recent times of conflict. The fortress remains today as an active garrison and training centre for the Swedish armed forces, but it is also open to visitors, so it was possible throughout the conference for advantage to be taken of the auditorium and social facilities.

The main purpose of this series of international meetings is to bring together workers who are involved in the surveillance of propellants for safe storage and preservation of their performance. The topics discussed and papers presented deal with the fundamentals of chemistry of degradation, experimental procedures, development of stability test methods and other aspects of surveillance, the results of tests on propellants in storage or in service, and the analysis of accidents. One new message that has emerged from the Twelfth Symposium is that "lifetime" has to be assessed against a background of abnormal conditions or climatic change. Two recent accidents are attributed to less than adequate protection against sustained periods of unusually high ambient temperatures and a third to a lightning strike. Also there is recognition that munitions are being moved around the world to different locations, to a greater extent than might have formerly been the case. The latter has promoted a UK initiative to develop environmental monitoring devices for attachment to or insertion in propellants.

Most propellants are still based on nitrocellulose or on its combination with nitroglycerine. These systems are inherently unstable because NO_2 is readily released and it promotes exothermic oxidation. Hydrolysis is known also to contribute as a result of water formation during the reaction. Stability is brought about by the incorporation of small quantities of substances that can react with the NO_2 to form stable products. The most common additives are diphenylamine ($\text{C}_6\text{H}_5\text{NH}$), 2-nitro-diphenylamine, Centralite ($\text{C}_6\text{H}_4\text{NH-CO-NH-C}_6\text{H}_4$) or Acardite ($\text{C}_6\text{H}_4\text{N-CO-NH}_2$). So there is a very strong chemical bias in discussions about stability tests and surveillance. One might guess also the types of surveillance procedures that are adopted, such as "the brown fume test", heat flow calorimetry, or HPLC analysis of the stabiliser degradation products. An implication of long-term stability is that accelerated ageing tests have to be performed by raising the temperature of a specimen, typically into the range 65 - 80 C. The test duration may be many months even so. A prediction of the stability of stored propellants has then to be made from the data obtained. There are also many other types of propellants in use, so a wide range of subjects was discussed at the conference. The topics are summarised below, and full papers will be published in the proceedings (contact Ola Listh, listh@foi.se). With typical Swedish hospitality there was also a delightful social programme integral to the meeting.

Papers presented:

Critical temperatures for the thermal explosion of chemicals.

Chemistry and kinetics of nitro-cellulose thermal decomposition.

Pyrolysis mechanism of rdx in inert solvents.

Nitric acid formation from nitrate esters through the corresponding nitrites.

Understanding the true driving force in the auto-ignition of propellants using microcalorimetry.

Study of the reactions of ethyl centralite with nitrogen dioxide at ambient temperature.

Computer simulation of the interaction of nitramines with gap and guanidine.

Influence of atmospheric conditions on the ageing of single and double base propellants.

Influence of humidity and oxygen on htpb and ctpb propellants: microcalorimetric studies.

Accelerating rate calorimetry studies on experimental hybrid propellant compositions.

Thermal and hazard properties of hnf/htpb-based propellants.

The advantages of environmental monitoring for prediction of the life of energetic materials.

Overview of propellant stability testing for the United States military.

Compatibility and service life predictions of propulsion/ ammunition systems.

Stability analyses of spherical propellants in dependence of their stabilizer and ngl content.

Surveillance testing: a modified hplc-method, also analysing anions.

Comparison of test methods for stability research of propellants in the Netherlands and Poland.

The application of gel permeation chromatography to the investigation of the ageing processes of nitro-cellulose.

Near infrared testing of propellant for stability.

Crystal purity of a-hmx by near infrared spectroscopy.

Analysis of copper azide in ammunition using ftir.

Small scale cook-off studies on explosives.

High pressure, subcritical water degradation of tnt, hmx and rdx in contaminated soil.

Studies of ageing in pyrotechnic mixtures of magnesium and sodium nitrate.

Decomposition of hydrazinium nitroformate (hnf) between 40 °C and 80 °C.

Explosion of 7.7 tons of smokeless powders in Japan 1 August 2000.

Ammunition depot accident July 1999 in Finland.

John Griffiths

$$V = h(a^2 + ab + b^2)/3$$

Lots of people read their newspapers by starting at the last page and working forwards, much to the annoyance of journalists and sub-editors, who have carefully arranged what they think are the most newsworthy bits at the front of the paper. The readers are of course being entirely logical. After casting an eye over the weather forecast, and estimating whether the day's crossword is easy or tricky, they then immediately discover whether the cash they have lost on the horse racing has been recouped on the stock market, or *vice versa*. Readers of the

January, 2001, *Newsletter* who started at the back in order to read the previous article in this series sooner rather than later will have immediately noted that in January, 2002, the Second Mediterranean Combustion Symposium will take place at Sharm el Sheikh, Egypt. Visions of hot sandy beaches, long cool drinks, scuba diving, sun bathing..... push considerations of the turbulent combustion of propane to the back of the mind.

But there is more to Egypt than sand, sun, and combustion. On the flight from Heathrow to Cairo a window seat on, say, the *left-hand* side of the plane has been secured. Shortly before landing the message comes from the flight deck that passengers on the *right-hand* side of the plane now have an excellent view of the Pyramids at Giza. Never mind, there is always the return flight. But then the message is that because of poor visibility and low cloud we cannot see the Pyramids today. Also because of fog at Heathrow we shall be diverting to Manchester where it is raining; coaches will be provided to take passengers on to London, where estimated time of arrival will be five hours later than scheduled. Please be sure to claim your baggage at Manchester before boarding the coaches.

So to ensure savouring the Pyramids at Giza it is necessary to break the journey and go there on purpose. But do they have any connection with combustion, to provide a valid excuse? The group is dominated by the so-called Great Pyramid built by the Pharaoh Cheops (Hellenised version of Khufu) and 100,000 other people over about 20 years, as his personal memorial. The Pyramid consists of an estimated 2,300,000 separate blocks of limestone and granite, each of average mass 2.5 tonnes. A design of structure for which a very low premium is negotiable with fire insurance companies. Most of the stone was quarried on the eastern side of the river Nile, and ferried across to the Pyramid site on the western side. All done 4500 years ago without wheeled transport.

Let it not be thought that the Great Pyramid grew by trial and error. The square base was very accurately laid out and positioned. The sides are 230.4 ± 0.1 metres long; the east and west sides are well within 0.1° of true North-South, which is more accurate than using Polaris (the Pole Star) and much more accurate than magnetic North, which anyway the Egyptians did not then know about.

The orientations of the north and south sides are of similar accuracy (working out how they did it is an exercise left to the student, as the textbooks used to say). They would of course have checked that the base was a square, and not a rhombus, by measuring the diagonals. The rock on which the Pyramid was based was made flat by building a low wall around it, filling with water, and using a depth gauge to check uniformity. The completed structure was originally 146 metres high, and the slope of the sides is 51.7° to the horizontal.

Not all earlier, smaller, Pyramids contain a burial chamber but most did, and it was sited at or below ground level. Originally the Great Pyramid was designed to this pattern, but during construction changes were made and the chamber for the Pharaoh's sarcophagus, the so-called King's Chamber, is in the Pyramid itself. To reach it the entry to the Pyramid is a corridor from the North face, about 17 metres above ground level and just over 1 metre square, descending at 26° to ground level. It then ascends at the same angle for 39 metres. At this point it expands into what is called the Grand Gallery, which carries on the ascent at the same angle, and is 47 metres long and 8.5 metres high. At the far end of the Gallery is the King's Chamber, which is built entirely of granite. The Chamber is 10.5 metres east to west, 5.2 metres north to south, and 5.8 metres high. The total volume is about 317 m^3 . The overall design thus has the shape of a backwards tilted L, with access at the base of the L leading to the Chamber at the top.

Although some dressing of the granite could be done before the stone was put into place, the detailed finishing to the appropriate high standard would be done by masons within the

Chamber itself. The total area of exposed granite is about 290 m². The granite is too hard for the copper tools then available, so the masons would use hard stone hand hammers about the size of tennis balls to smooth the granite: a time-consuming process.

What about the atmosphere inside the Chamber as work progressed? Some crude calculations, on the back of an old papyrus, help out. Imagine two masons in there, each on a 10-hour shift per day. Each would require about 300 ml of air every 5 seconds for respiration. The total requirement for the daily shifts is 4.3 m³. Air contains 21% oxygen, and exhaled breath about 16%, plus 4% carbon dioxide. But how could they see what they were doing? They needed oil lamps or wax tapers, with diffusion flames burning on wicks; this is where combustion comes in. If each mason had two lamps, in order to see to work or re-light if one lamp extinguished, the total daily fuel requirement could be of order 1 kg. This would require 14.5 m³ of air for complete combustion. But diffusion flames burning on wicks extinguish, as do masons, if the oxygen concentration drops by one third to 14%; so the air requirement rises to 43.5 m³. Including respiration the air requirement is about 48 m³ per day. The air supply originally inside the Chamber would last for about 1 week; not enough. Air replenishment was essential. External air would be hot in the daytime, and cold at night; air inside the structure would be warm.

The earlier Pyramids, with ground-level burial chambers, also had the entrance through the face of the Pyramid, and above ground level. Thus at night cold external air would be denser than that inside, and the workings would be purged by buoyancy. But in the Great Pyramid, with the tilted L design only the base of the entry would be purged. During the daytime the air in the entry corridor would be more dense than that outside, and buoyancy would not operate. To solve the problem the King's Chamber was provided with two rectangular shafts. One penetrated to the Northern face of the Pyramid, at an angle of 31° to the horizontal, and the other to the Southern face at an angle of 45°. Why provide two shafts? The heat release from the masons' lamps is unlikely to have provided sufficient energy to operate a single shaft as a flue; the ventilation would be mainly provided by the wind operating a pressure differential on opposite faces of the Pyramid. Current archaeological opinion favours an astrological explanation for the shafts. The North shaft enabled the spirit of the Pharaoh to visit Polaris, maybe to arrange for its more accurate positioning of true North, and the South shaft enabled visits to prominent constellations. Be that as it may, the shafts seem to have a ventilation function. The clever part is that the need for the shafts was foreseen in advance, so that the limestone blocks could be cut to the required shape before inclusion in the structure.

When completed the Great Pyramid was covered with limestone facings which hid the shaft exits and the entry corridor. But tomb robbers found a way in and removed all traces of Cheops and his personal possessions. So was all the effort in vain? He would have commended to his successors the words of the poet [1]: "Look on my works, ye mighty, and despair!" (The cry to the Examiners of the struggling PhD student, through the ages). Although the contents of the Great Pyramid have gone, the original achievements of Cheops and his teams will live on in human memory, so he has achieved his immortality.

Were they engineers, scientists, or architects? They had no algebra, but had geometry and knew how to calculate the volume of a pyramid in order to be able to quarry the necessary amount of stone. The title of this article is the equation for the volume of a truncated pyramid, where a and b are the lengths of the horizontals and h is their vertical separation, and they knew how to calculate that too. It told them how much stone they still needed to finish the job. Perhaps they knew more about combustion than we realise, and they were certainly experts in fire resistant structures and in avoiding asphyxiation. They would now only acquire Chartered or Professional status with difficulty, because none of them had a university qualification. Nowadays, with our committee-ridden management processes, could a project such as building

the Great Pyramid ever be completed satisfactorily? Something to think about on the journey to Sharm el Sheikh in January, 2002.

Reference

1. Shelley, P B, Ozymandias.

Ken Palmer

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A LETTER FROM STIG JOHANSSON

Secretary of the Swedish Section for Detonics and Combustion (affiliated to The Combustion Institute)

It was a pleasure for me as Editor of the Newsletter to find that someone not only reads each edition, but that they write to me about them! Let's have more comments and contributions, from UK members as well as from other Sections. As this was written in February I have edited out some date-sensitive parts.

Tony Burgess

Dear Professor Burgess,

Thank you for sending me your Newsletters - as editor of the Swedish ones I cannot do without them. In your calendar section I always find events that otherwise would have escaped me. Moreover, it happened once that we stole from you: We reproduced Ken Palmer's Ghost Story in our issue No. 1, 1999. We thought it too good not to be read by our 200 odd members. Could you, please, forgive us and prescribe the crime? And continue sending us copies?

As to your January issue, starting with your editorial: The Millennium question is interesting from a pedagogical point of view. It is a well-defined and simple problem, but, nevertheless, almost the whole world got it wrong a year ago, and is still wrong. And the few who knew better were as a rule not very clear in their teaching: "*.. since A.D. zero does not exist*". This "explanation" is even given in the famous Encyclopedia Britannica. It *is* no explanation, it is a consequence of the calendar being out of phase with the time axis (sorting out cause and effect relations is a not so easy an epistemological task). For my part I changed my mind - in the nick of time - when I realized (= someone told me) that 1 July 2000 is not, as I then maintained, equal to 2000.5, but to 1999.5 on the time scale. In all its simplicity, this is a noteworthy example of how important it is to view things in good way, or to "select and group", as your clear-minded Edinburgh philosopher W A Sinclair put it in 1945 in his "*An Introduction to Philosophy*". If we cannot get the millennia right, what kind of mess are we maintaining in other fields? Sinclair writes: "*If all men were pure intellect without feelings and wishes, all our assumptions should no doubt be clear to us. But we are no pure intellect, and in many cases our assumptions are such that we should experience a very unpleasant shock if we became aware of them*".

Having arrived at the same conclusion as Sinclair the hard way; chemistry teaching - it all began when I wrote "The special case of the electron in chemistry" in 1965, followed by a combustion definition proposal in 1971, etc. -, and indeed having experienced his "unpleasant shock", I became impressed by his insight, "just" a philosopher as he appears to be. By the

way, 100 years ago Norway and Sweden were united; Norway celebrated the millennium shift correctly, Sweden wrongly! What about England, Scotland, and Wales?

It was a pleasure to read John Griffiths' article about our disposal conference in November 2000. Thank you for publishing it*.

Again, Ken Palmer's contribution was interesting. (Could you, please, advise me how to order Emsley's book?). In my "On the history of fire tools and matches" (*Proc. Pyroteknikdagen*, 1983(1985)1-104) I, too, refer to Brand and his discovery of white phosphorus, and learnt that the year 1669 appears to be wrong. It was more likely 1674 or 1675, according to Gmelins *Handbuch der anorganischen Chemie*, Teil "Phosphor", 1965.

For foreign mistreaters of the English language, like me, Palmer's reminder of guidelines was welcome. But as far as commas are concerned, be sure you remove the unnecessary ones only! Often they appear to be too few, in my opinion. And what about the plural disease, ie, to put uncountables and collective nouns in plural: "At high temperatures", "enthalpies of combustion", "melting points of salts", etc. Since, eg, a fuel can have *one* "enthalpy" only, the plural is not only grammatically wrong but also illogical; I think. But "temperatures" is difficult. Personally I use it only as a short form for "temperature values", never when it is a clear uncountable. Do you have a Samuel Johnson about for ignorant foreigners to consult? Finally, how come that people write "devolatilisation" ("s" or "z"?) when they mean "volatilisation" (cf. "militarization" and "demilitarization")?

If you could bear with me down to here, I am,

Yours sincerely,

Stig Johansson

*Editor's note: see John Griffiths' article about the latest (the 12th) Symposium in this *Newsletter*.

COMBUSTION CALENDAR

2001

OCTOBER 2001

8-9 OCTOBER

Liège, Belgium. POWER GENERATION AND SUSTAINABLE DEVELOPMENT. Details: Chantal Lacrosse-Pirotte, AIM – Association des Ingénieurs diplômés de l'Institute Montefiore, 31 rue Saint Gilles, B-4000 Liège, Belgium. Tel: + 32 4 222 2946, Fax: +32 4 222 2388, e-mail: ch.lacrosse@congress.skynet.be

10 OCTOBER

Utrecht, The Netherlands. COMBURA - COMBUSTION RESEARCH AND APPLICATION. Details: http://www.ifrf.net/ifrf_net/meetings.html

14-18 OCTOBER

Haifa, Israel. 6th INTERNATIONAL SYMPOSIUM ON SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS. Details: I Gotman, Technion-Israel Institute of Technology, Department of Materials Engineering, Technion, Haifa, Israel 32000, Tel: +972 4 829 2112, Fax: +972 4 832 1978, e-mail: gotman@techunix.technion.ac.il, web: <http://www.technion.ac.il/technion/materials/conferences.html>

14-19 OCTOBER

Antalya, Turkey. INTERNATIONAL SYMPOSIUM ON VISUALIZATION AND IMAGING IN TRANSPORT. (VIM'01). Details: F Arinc, Secretary-General, ICHMT, Mechanical Engineering Department, Middle East Technical University, 06531 Ankara, Turkey, Tel: +90 312 210 1429, Fax: +90 312 210 1331, E-mail: arinc@metu.edu.tr, web: <http://ichmt.me.metu.edu.tr>

21-25 OCTOBER

Buenos Aires, Argentina. 18TH WORLD ENERGY CONGRESS. Details: World Energy Council, Del Carmen 766-4^o Piso, 1019 Buenos Aires, Argentina. Tel: +54 11 4 813 2219, Fax: +54 11 4 814 3664, web: www.18th-wec.com.ar

NOVEMBER 2001

5-8 NOVEMBER

Amsterdam, The Netherlands. 2001 INTERNATIONAL GAS RESEARCH CONFERENCE. Details: D Dolenc, Tel: +1 773 399 8226, Fax: +1 773 399 4605, e-mail: igrc@gri.org, web: <http://www.gri.org/IGRC2001>

6-9 NOVEMBER

Leeds, England. EXPLOSION PREDICTION AND MITIGATION. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511 e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

11-16 NOVEMBER

New York, NY, USA. COMPUTATIONAL MODELING OF INDUSTRIAL COMBUSTION SYSTEMS. 2001 ASME INTERNATIONAL MECHANICAL ENGINEERING CONGRESS AND EXPOSITION. Sessions on Pool Fire Measurements and Simulations and an Open Forum on Fire and Combustion. Details: Meetings Department, American Society for Mechanical

Engineers, 345 E. 47th Street, New York, NY 10017, USA. Tel: +1 212 705 7037, Fax: +1 212 705 7143, web: <http://www.asme.org>

12-15 NOVEMBER

San Francisco, CA, USA. FINITE VOLUME METHODS FOR FREE-SURFACE SHALLOW FLOWS WITH APPLICATIONS TO ENVIRONMENTAL PROBLEMS. A short course organised by Numeritek Limited, UK. Details: e-mail: courses@numeritek.com, web: <http://www.numeritek.com>

18-20 NOVEMBER

San Diego, CA., USA. DIVISION OF FLUID DYNAMICS MEETING OF THE AMERICAN PHYSICAL SOCIETY. Details: American Physical Society, Meetings Department, One Physics Ellipse, College Park, MD 20740, USA. Tel: +1 301 209 3280, Fax: +1 301 209 0867, web: <http://www.aps.org>

19-22 NOVEMBER

San Francisco, CA, USA. FINITE VOLUME METHODS FOR COMPRESSIBLE FLOW. A short course organised by Numeritek Limited, UK. Details: e-mail: courses@numeritek.com, web: <http://www.numeritek.com>

26-30 NOVEMBER

Rome, Italy. FOURTH INTERNATIONAL SYMPOSIUM ON HIGH TEMPERATURE AIR COMBUSTION AND GASIFICATION. Details: Guiseppe Giraldi, Via Angullarese 301, 00060 S M di Gafera (RM), Italy. Tel: +39 06 3048 3364, Fax: +39 06 3048 4990 or 4811, e-mail: htacg4@caraccia.enea.it

26-30 NOVEMBER

Leeds, England. SPARK-IGNITION ENGINE EMISSIONS. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511 e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

28-30 NOVEMBER

Pisa, Italy. 2001 SAE SMALL ENGINE TECHNOLOGY CONFERENCE AND EXPOSITION. Details: Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096, USA. Tel: +1 724 776 4841, Fax: +1 724 776 5760, e-mail: meetings@sae.org, <http://www.sae.org>

DECEMBER 2001

3-6 DECEMBER

Callaghan, NSW, Australia. FIFTH ASIA-OCEANIA SYMPOSIUM ON FIRE SCIENCE AND TECHNOLOGY. Details: B Z Dlugogorski, Department of Chemical Engineering, The University of Newcastle, Callaghan, NSW 2308 Australia. Tel: +61 2 4921 6176, Fax: +61 2 4921 6920, e-mail: cgbzd@alinga.newcastle.edu.au

3-7 DECEMBER

Newcastle, New South Wales, Australia. 18TH INTERNATIONAL PITTSBURGH COAL CONFERENCE, COAL'S INTERNATIONAL FUTURE: THE TECHNICAL CHALLENGE. Details: Conference Secretary, Pittsburgh Coal Conference, University of Pittsburgh, 1130 Benedum Hall, Pittsburgh PA 15261, USA. Tel: +1 412 624 7440, Fax: +1 412 624 1480, e-mail: pcc@engrng.pitt.edu, web: <http://www.engrng.pitt.edu/~pccwww/>

3-7 DECEMBER

Mulhouse, France. MATTER PROCESSING THROUGHOUT GALACTIC AND STELLAR UNIVERSE. One of a series of conferences which will include combustion science topics such as "soot and fullerenes formation in flames, combustion of soot, combustion of metallic particles, reactions at particle's surface, optical properties, atmospheric dispersion and combustion experiments under zero gravity". Details: J P J Lafon, DASGAL, F92195 Meudon CEDEX, France. e-mail euro.conf@obspm.fr, or Lucien Delfosse, Université de Haute Alsace, Laboratoire de Gestion des Risques et Environnement, 25, rue de Chemnitz, 68200 Mulhouse, France. Tel: +33 03 89 32 76 57, Fax : +33 03 89 32 76 61, e-mail: delfosse@orion.UHA.fr, web: <http://www.obspm.fr/euroconference2001>

9-14 DECEMBER

Adelaide, Australia. 14th AUSTRALASIAN FLUID MECHANICS CONFERENCE. Details: 14th Australasian Fluid Mechanics Conference, Department of Mechanical Engineering, The University of Adelaide, SA 5005, Australia. Tel: +61 8 8303 5397, Fax: +61 8 8303 4367, e-mail: afmc@mecheng.adelaide.edu.au, web:<http://www.mecheng.adelaide.edu.au/14afmc/14afmc.htm>

16-18 DECEMBER

Indore, MP, India. INTERNATIONAL CONGRESS OF CHEMISTRY AND ENVIRONMENT. Details: S L Gargh, e-mail: chemjyot@sancharnet.in

18 DECEMBER

Uxbridge, England. ENGINE DIAGNOSTICS AND INSTRUMENTATION. A UnICEG meeting. Details: Colin Garner, Department of Mechanical Engineering, Loughborough University, Loughborough LE11 3TU. Tel: 0150 922 3249, Fax: 0150 922 3934, e-mail: C.P.Garner@Lboro.ac.uk

2002

JANUARY 2002

3-5 JANUARY

Calcutta, India. 5th ISHMT/ASME HEAT AND MASS TRANSFER CONFERENCE. Details: Meetings Department, American Society for Mechanical Engineers, 345 E. 47th Street, New York, NY 10017, USA. Tel: +1 212 591 7072, Fax: +1 212 705 7143, web: <http://www.asme.org>

6-11 JANUARY

Sharm El-Sheikh, Egypt. SECOND MEDITERRANEAN COMBUSTION SYMPOSIUM. Topics will include Flame Dynamics and Turbulence, Sprays and Gas Combustion Systems, Internal Combustion Engines, Solid Fuels Combustion, Diagnostics and Measurements, Fire and Explosions, Pollutants and Kinetics. Details: M S Mansour, Mechanical Engineering Dept, The American University in Cairo, Cairo, Egypt. Fax: +20 2 795 7565; e-mail: mansourm@aucegypt.edu, web: <http://ichmt.me.metu.edu.tr/upcoming-meetings/Mcs-02/announce.html>

14-18 JANUARY

Leeds, England. ULTRA LOW NO_x GAS TURBINE COMBUSTION. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511 e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

21-25 JANUARY

Leeds, England. FIRE DYNAMICS & MODELLING. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

FEBRUARY 2002

7-8 FEBRUARY

Venue not known. 2002 AUSTRALIAN SYMPOSIUM ON COMBUSTION and THE SEVENTH AUSTRALIAN FLAME DAYS. A biennial meeting of The Australian/New Zealand Sections of the Combustion Institute and the Australian Flame Research Committee. Details: http://www.ifrf.net/ifrf_net/meetings.html

MARCH 2002

18-22 MARCH

New Orleans, LA, USA. PITTCON 2002: THE PITTSBURGH CONFERENCE. Details: The Pittsburgh Conference, 300 Penn Center Blvd., Suite 332, Pittsburgh, PA 15235, USA. Tel: +1 412 825 3220, Fax: +1 412 825 3224, e-mail: pittconinfo@pittcon.org, web: <http://www.pitcon.org/>

APRIL 2002

2-5 APRIL

Estoril, Portugal. SIXTH EUROPEAN CONFERENCE ON INDUSTRIAL FURNACES AND BOILERS. Details: INFUB % Alvaro Reis, Rua Gago Coutinho, 185-187, 4435-034 Rio Tinto, Portugal. Tel: +351 22 973 4624 or 973 0747, Fax: +351 22 973 0746, e-mail: conference@infub.pt, web: <http://www.infub.pt>

7-10 APRIL

Sorrento, Italy. NINTH INTERNATIONAL CONFERENCE ON NUMERICAL COMBUSTION. A joint meeting of SIAM (Society for Industrial and Applied Mathematics) and The Combustion Institute (Italian Section). Details: Gaetano Continillo, Chair, Local Organising Committee. e-mail: continillo@unisannio.it, or icnc2002@unisannio.it, web: <http://www.ing.unisannio.it/icnc2002>

7-12 APRIL

Orlando, FL., USA. 223rd NATIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. Topics in the Division of Fuel Chemistry include CO₂ Capture and Sequestration, Hydrogen Production and Utilization, Production and Utilization of Renewable Fuels, Trends in Carbon Products and Utilization of Greenhouse Gases. Details: R P Warzinski, Federal Energy Technology Center, US Department of Energy, PO Box 10940, Pittsburgh, PA 15236, USA. Tel: +1 412 386 5863, Fax: +1 412 386 4152, e-mail: warzinski@fetc.doe.gov, or Meetings Department, American Chemical Society, 1155 16th Street, NW, Washington, DC 20036, USA. Tel: +1 202 872 4396, Fax: +1 202 872 6128, e-mail: natlmrgs@acs.org

8-12 APRIL

Leeds, England. FIRE SAFETY DESIGN. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

9-10 APRIL

Leeds, England. COMBINED HEAT AND POWER IN INDUSTRY AND COMMERCE. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials

Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

14-17 APRIL

Rockford, IL., USA. ASME/INTERNAL COMBUSTION ENGINE DIVISION SPRING TECHNICAL CONFERENCE. Details: Meetings Department, American Society for Mechanical Engineers, 345 E. 47th Street, New York, NY 10017, USA. Tel: +1 212 591 7054, Fax (212) 705-7143, web: <http://www.asme.org>

15-19 APRIL

Leeds, England. DIESEL PARTICULATES AND NO_x EMISSIONS. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511 e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

16 APRIL

Cambridge, England. CONDENSED-PHASE EXPLOSIONS. A UKELG meeting. Details: Martin Braithwaite, RMCS Cranfield University, Shrivenham, Swindon SN6 8LA. Tel: 01793 785220, Fax: 01793 785772, e-mail: m.braithwaite@rmcs.cranfield.ac.uk

22-25 APRIL

Leeds, England. THE ECONOMICS OF FIRE PROTECTION. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

29 APRIL-1 MAY

Seoul, Korea. 5th INTERNATIONAL WORKSHOP ON CATALYTIC COMBUSTION. Topics will include: Kinetics and Transport Processes in Catalytic Combustion, Development of High Temperature Materials for Catalytic Combustion, Application of Catalytic Combustion in Industrial Commercial and Residential Burners and Commercialization of Low Emission Gas Turbine Catalytic Combustors. Details: Sung June Cho, Secretary, 5 IWCC, Korea Institute of Energy Research, 71-2, Jang-dong, Yusung-gu, Taejon 305-343, Korea. Tel: +82 42 860 3613, Fax: +82 42 860 3133, e-mail: sjcho@kier.re.kr

MAY 2002

5-8 MAY

Niagara Falls, Canada. 7th CIRCULATING FLUIDIZED BED CONFERENCE. Details: AICUL Consulting. e-mail: aicul-con@home.com

13-14 MAY

Leeds, England. FIRE FLAMMABILITY AND EXPLOSIONS. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

15-17 MAY

Leeds, England. CHARACTERISTICS OF GAS & DUST EXPLOSIONS & VENT DESIGN.

A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

JUNE 2002

10-13 JUNE

Minneapolis, MN., USA. ASME SUMMER ANNUAL MEETING. Details: Meetings Department, American Society for Mechanical Engineers, 345 E. 47th Street, New York, NY 10017, USA. Tel: +1 212 591 7795, Fax: +1 212 705 7143, web: <http://www.asme.org>

17-21 JUNE

Leeds, England. FIRE & SAFETY LAW. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

23-27 JUNE

Baltimore, MD., USA. AIR AND WASTE MANAGEMENT ASSOCIATION ANNUAL CONFERENCE. Details: Air and Waste Management Association, Member Services, One Gateway Center, Third Floor, Pittsburgh, PA 15222, USA. Tel: +1 800 270 3444 or +1 412 232 3444, Fax: +1 412 232 3450, web: <http://www.awma.org>

24-28 JUNE

Leeds, England. ENGINE EMISSIONS MEASUREMENT. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511 e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

JULY 2002

9-12 JULY

Leeds, England. FIRE SAFETY MANAGEMENT AND RISK ASSESSMENT. A short course. Details: Alison Whiteley, CPD Unit, School of Process, Environmental and Materials Engineering, University of Leeds, Leeds LS2 9JT. Tel: 0113 233 2494, Fax: 0113 233 2511, e-mail: cpd.speme@leeds.ac.uk, web: <http://www.leeds.ac.uk/fuel/shortc/sc.htm>

21-26 JULY

Sapporo, Japan. TWENTY-NINTH INTERNATIONAL SYMPOSIUM ON COMBUSTION. Details: Sue Terpack, The Combustion Institute, 5001 Baum Boulevard, Suite 635, Pittsburgh, PA 15213, USA. Tel: +1 412 687 1366, Fax: +1 412 687 0340, e-mail: office@combustioninstitute.org, web: <http://www.ec-inc.co.jp/combustion2002/>

28 JULY-2 AUGUST

Location not known. 17th IUPAC CONFERENCE ON CHEMICAL THERMODYNAMICS. Details: A Heintz, Universitat Rostock, FB Chemie, Hermannstr. 14, 180512 Rostock, Germany. Tel: +49 381 498 1852, Fax: +49 381 498 1854, e-mail: andreas.heintz@chemie.uni-rostock.de, web: <http://www.iupac.org/symposia/>

AUGUST 2002

4-9 AUGUST

Sapporo, Japan. 14th INTERNATIONAL CONFERENCE ON PHOTOCHEMICAL CONVERSION AND STORAGE OF SOLAR ENERGY. Details: The Secretariat IPS-14, EC Inc., President Building 5F, Minami-1, Nishi-5, Chuo-ku, Sapporo, 060-0061, Japan. Tel: +81 11 231 2289, Fax: +81 11 221 0496, e-mail: ips14@ec-inc.co.jp, web: <http://www.ec-inc.co.jp/ips14>

18-22 AUGUST

Boston, MA., USA. 224th NATIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. Details: Meetings Department, American Chemical Society, 1155, 16th Street, NW, Washington, DC 20036, USA. Tel: +1 202 872 4396, Fax: +1 202 872 6128, e-mail: natlmtgs@acs.org

SEPTEMBER 2002

1-5 SEPTEMBER

Rio de Janeiro, Brazil. THE PETROLEUM INDUSTRY: EXCELLENCE AND RESPONSIBILITY IN SERVING SOCIETY. The 17th World Petroleum Congress. Details: web: www.world-petroleum.org

8-13 SEPTEMBER

Taipei, Taiwan. 6th INTERNATIONAL AEROSOL CONFERENCE. Details: CAART, C-J Tsai, Institute of Environmental Engineering, National Chiao Tung University, Hsin Chu, Taiwan. Tel: +886 3 573 1880, Fax +886 3 577 27835, e-mail: cjtai@green.ev.nctu.edu.tw, web: <http://jeff.che.nthu.edu.tw.caart/>

2003

MARCH 2003

23-27 MARCH

New Orleans, LA., USA. 225th NATIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. Details: Meetings Department, American Chemical Society, 1155, 16th Street, NW, Washington, DC 20036, USA. Tel: +1 202 872 4396, Fax: +1 202 872 6128, e-mail: natlmtgs@acs.org

JUNE 2003

22-26 JUNE

San Diego, CA., USA. AIR AND WASTE MANAGEMENT ANNUAL CONFERENCE. Details: Air and Waste Management Association, Member Services, One Gateway Center, Third Floor, Pittsburgh, PA 15222, USA. Tel +1 800 270 3444 or +1 412 232 3444, Fax: +1 412 232 3450, web: <http://www.awma.org>