THE COMBUSTION INSTITUTE

(British Section)

NEWSLETTER

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EDITORIAL

As this is the first *Newsletter* of the year I should like to welcome new members and greet old ones. I don't think I can wish you a happy new year in June, but I hope that your happiness is doubled in the next half year!

John Griffiths, our Hon. Secretary tells me that there are still about 40 members from 1998 who have not renewed their membership for this year. If you are one of the few who have not yet renewed, please could you remedy this soon by contacting John, so that you continue to be informed about Combustion Institute affairs.....otherwise this will be the last *Newsletter* that you will receive! Membership of the British Section is a very inexpensive way of keeping in touch, not only with combustion news and people in Britain, but also in the rest of the world. Added to that, the opportunity to purchase *Combustion and Flame* at a ridiculously low price, and the reduced cost of attending our meetings as a member makes membership essential for all right-thinking combustion people. I would urge all members not only to keep up their subscription, but to encourage their colleagues to join.

Enclosed with this *Newsletter* is a letter to members about the AGM to be held in Cambridge during the "Combustion Theory" meeting on 14 September. Nominations for committee members to replace those retiring are solicited.

There are two reports in this edition of the *Newsletter* from perhaps slightly different perspectives on the very successful meeting in Nancy of the German, French and British Sections of the Combustion Institute. Another collaborative effort was the British-French Flame Days held in Guernsey last October. Nondas Mastorakos from the Greek Section attended the meeting and agreed to write a description for the *Newsletter*. A collection of abstracts describes the papers presented at our Spring 1999 meeting in Leeds on hazards, and there is a piece from Ken Palmer in a rather more serious vein than usual sparked off by his attendance at that meeting. Ken has promised a "special" for the Millenium Edition! Clifford Jones relates some spectacular hazard control methods, not to be tried at home, to complete the hazard collection. I am grateful to all our contributors, and would be very happy if other members volunteered articles for the *Newsletter.*

David Smith's article in the last *Newsletter* didn't provoke the correspondence we had hoped for. Arthur Lefebvre made up for this by his letter to David, part of which is reproduced in this edition. Let's have some more reaction!

We mustn't forget Edinburgh 2000, so Dave Smith has been searching for interesting things there and tells of some which he found.

I wonder how many people use the web version of the *Newsletter*. Let me know your reaction. The German Section used to reprint and distribute hard copies to all their members. They now only do this if a member cannot access the web easily. It has been suggested to me that the web version is in one continual file so all of it can be down-loaded and printed in one go, rather than in separate sections as at present. This edition will be treated that way thanks to Javier Molero who has been responsible for the web version since we first put it there.

Tony Burgess

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CONTROL OF FLAMES AND INDUSTRIAL PROCESSES

British-French Flame Days 1998, held in Guernsey 29-30 October 1998

This meeting was jointly organised by the International Flame Research Foundation (IFRF), the Combustion Institute, and the French and British Flame Research Committees and suitably took place in the beautiful island of Guernsey, culturally, historically and geographically between France and England. With about 50 participants from 10 European countries, it had a further international component, and hence formed the best setting for P Roberts of the IFRF to unveil the "IFRF-Net", a serious and very interesting effort by IFRF to disseminate information concerning combustion research through the Internet. We should all spend some time "surfing" the IFRF www site for more on this great idea.

The technical part of the meeting consisted of some 20 oral presentations and 15 posters of high standard in the fields of solid fuel combustion, control methodologies for boilers and furnaces, NOx formation, soot, and CFD predictions ranging from advanced models of simple premixed flames to full-scale modelling of cement kilns and power plants. The spirit of the presentations and the discussions was more on what can be done to reduce the emissions and to predict the behaviour of industrial-type flames and furnaces, rather than fundamental issues of combustion science. However, the latter were not absent, making the meeting a very useful forum for engineers and researchers alike. I expect that we will see in the future many of the papers and posters presented in Guernsey in the archival literature.

The first Session was on "Fundamentals of Solid Fuel Combustion", with two papers on experimental work with lab-scale coal furnaces and a paper on scale-up issues and useful correlations of NOx emissions from a wide range of furnaces. In the following Session on "Control Systems", two papers were presented on how measurements can be used to control boilers and the atomisation process, and in a very interesting paper, the combined use of CFD and neural networks was described. Models for carbon in ash and a review of various techniques for pollutant reduction from boilers, waste incinerators, fluidised beds and other combustors, including relevant emission limits, followed. A presentation on the design of an acoustic sensor for temperature and two more papers on boiler control models concluded the first day of the conference.

The second day began with a Session on fundamental aspects of soot formation and its control, which was followed by a presentation on waste incineration. The day continued with two Sessions concerned with modelling. On the fundamental side, there were two presentations on turbulent flame modelling and on a more practical side, CFD predictions of VOC emissions from power plants and of the behaviour of cement kilns (coal combustion, clinker formation, heat transfer) concluded the meeting.

Throughout the Meeting, there were lively discussions and a "family" atmosphere prevailed, which was transmitted even to people, like myself, who had not previously met most of the participants. Everybody felt relaxed and at ease and discussed substantial science. Perhaps this was the major reason for the success of the meeting and the organisers (John Smart and Sebastien Devroe) should be congratulated for their efforts in this direction and for their hospitality.

It should finally be mentioned that the venue, a four-star hotel with its own golf course, and the town of St Peter Port provided excellent facilities and opportunities for a relaxed time out. I would like to thank all the people involved for organising this meeting, which will not be forgotten easily by anyone of the participants.

Nondas Mastorakos (22/12/98)
Institute of Chemical Engineering and High Temperature Chemical Processes.
Foundation for Research and Technology - Hellas, Patras, Greece

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COMBUSTION THEORY

A One-day Meeting of the Combustion Institute (British Section), to include the AGM.

Selwyn College, Cambridge, Tuesday 14 September 1999

The purpose of the one-day meeting is to provide a focus for discussion on the mathematical theory of combustion, with a view to increasing the level of contact between mathematicians, chemists, physicists and engineers. Topics will include asymptotic analysis of flames, detonations and solid propellants together with a variety of combined approaches involving both theory and computation in areas such as gas turbines and reheat systems. There will be a small number of invited presentations, and short contributions (about 15 min maximum), especially of a theoretical nature, are welcome.

Further details may be obtained from John Griffiths or the principal organiser, Stewart Cant.

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INDUSTRIAL COMBUSTION HAZARDS

Joint meeting of The Combustion Institute (British Section) and UKELG
Leeds University, 14 April 1999

This meeting Attracted more than 50 registrants. The programme, and abstracts of each presentation provided by the speakers have been collected together by John Griffiths.

Programme

Chemical warehouse fires
Graham Atkinson, HSL, Buxton
Industrial fires and explosions - the view from the I Chem E accident database
Brian Tyler, S & T Consultants Ltd
Towards quantifying liquid two-phase combustion hazards
Phil Bowen, University of Wales, Cardiff
Burning velocity enhancement in quiescent aerosol flames
Malcolm Lawes, University of Leeds
Ignition by laser - irradiated surfaces
Fred Carlton, Imperial College, London
Explosion hazards in vent collection systems
Tony Ennis, ICI Runcorn and Richard Bambrey, University of Wales, Aberystwyth
Explosion development in pipeline systems and linked vessels
Roth Phylaktou, University of Leeds
Models for turbulent gas explosions: development and evaluation from experiments and case studies
Peter Lindstedt, Imperial College, London
The meeting was concluded with a discussion led by Peter Fearnley, HSE, on
Standards for offshore fire and explosion safety systems

Chemical Warehouse Fires

One of the responsibilities of the U.K. Health and Safety Executive (HSE) is the assessment of risks from warehouse fires that may involve the toxic materials listed in the Control of Industrial Major Accident Hazard (CIMAH II) regulations. This is for the purpose of giving advice on land use planning. HSE also has a duty under CIMAH II to assess the adequacy of the information set down in safety reports. The assessment includes predicting the potential consequences to people and the environment after a fire.

The control of risks at major hazard sites is to be revised shortly through the introduction of COMAH regulations. These will place new duties on industry to consider the potential risk from release of materials that arise from unplanned chemical reactions; this may be taken to include storage fires. Thus the effects of harmful combustion products may have to be considered where these pose significant additional risks to the transport of uncombusted toxic material. Since the early 1990s HSE has undertaken a programme of development of its methods of assessment in the area of chemical warehouse fires. The first strand of this process has been the development of a computer model (FIREPEST). This software allows rapid, accurate and consistent assessments based on existing information on fire growth, combustion chemistry, building response and dispersion.

The second strand of HSE's development programme has involved the sponsoring of basic research in some of the key areas of uncertainty. Examples of such areas have included :

Fire growth in chemical commodities
Dispersion of buoyant releases from warehouse buildings
Aerosol physics
Building response in fire
Special risks (eg ammonium nitrate)
Mitigation of chemical fires
Combustion chemistry and plume seeding

This talk will review experimental and modelling work under some of these categories.

G Atkinson

Industrial Fires and Explosions – a View From the IChemE Accident Database

The Institution of Chemical Engineers has developed, and is maintaining, as a commercial project, a large database of known accidents, incidents and near misses of relevance to the process industries. The records come from both published sources and, increasingly, from previously confidential in-company reports. The latter are extracted in a form that does not reveal the company or location. The 1998 version of the database contains over 9,000 records and the second version, just issued, has 11,400. The database is supplied on a CD for use on a PC. It can be searched using a set of pre-defined terms (activity, equipment, causes, consequences, substances) each of which has multiple sub-sets. These terms can be used singly or in combination. Searching is also possible using free text keywords and with restricted date ranges. Searching is fast – a few seconds using pre-defined terms and a few tens of seconds when the whole database is searched using a free text keyword.

The individual records give some background – source of data and the date, location and number of injuries and deaths in the incident. There is then a description of the incident ranging from 20 to perhaps 400 words. Whenever available, the lessons from the incident are given – 40% of the reports have this feature in version 2. The results from a search can be selected and sorted by the user and printed out in full or in brief.

The database has been used here to search for records relating to fire and explosion, to some subsets within these fields, and to the subject areas of the papers in this meeting. Only a general overview will be given, as there are very large numbers of relevant incidents – 3784 involving fire, 2844 mentioning explosion. Even for specialist aspects there can be many – 31 reporting a BLEVE and 13 with ethyl acetate as an involved substance.

General areas examined include detonation, BLEVE and vapour cloud incidents. Of particular relevance to this meeting the database has been searched for incidents involving warehousing and vent and flare systems. The general picture from these searches will be presented. Not surprisingly, the lessons will be of most interest to those with responsibility for active process systems, including production, storage, transport, maintenance and training. Obviously fire and explosion have been, and remain, major potential hazards in the industry. Whilst bulk hydrocarbons feature in many big incidents, the substance list from the database is very extensive, with some chemicals involved not being obvious candidates. Ignition sources, although not always identifiable, never seem

in short supply, even on occasion coming from hot work being done to improve safety. Maintenance work is a common factor in many incidents. It is depressing to see a great similarity between records that are years apart, showing that the lessons are not learnt, or are quickly forgotten.

B J Tyler

Further information about the Accident Database can be obtained from:
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Towards Quantifying Liquid Two-phase Combustion Hazards

Liquid fuel is widely used as a source of power generation in many diverse industries, including aviation, automotive and stationary power generator systems. However, understanding and quantifying the mechanisms by which power is efficiently generated from dispersed liquid fuel whilst minimising environmental pollutants, is a very challenging prospect compared with gaseous systems.

The author encountered the intricacies of quantifying aerosol combustion characteristics whilst trying to quantify accidental condensate explosions, particularly in offshore structures, on behalf of Shell during the early 1990s. This work identified weaknesses in current understanding, and a particular dearth of experimental benchmark data in this area. This presentation outlines recent progress, at Cardiff University, to address some of these issues.

The particular problems in experimentally investigating aerosol combustion phenomena are well documented. Here, a recent review paper is summarised, which proposes a medium-term strategy for quantification of aerosol flammability / combustion hazards using a phenomenological approach (*Hydrocarbon / Aerosol Explosion Hazards, P.J. Bowen and L.R.J. Cameron, Trans. I Chem. E., vol 77 part B, 1999*). Recent, unpublished results in the particular areas concerned with controlled generation of aerosol clouds for combustion studies, and the generation of flammable mist from high-flashpoint fuels are presented. Legislative changes in the latter area have invoked further interest.

Results show that mono-disperse aerosol clouds can be produced within the so-called aerosol 'transition' range of particle sizes (5-15 mm), where burning rate is presumed to be fastest, and which traverses the range from 'vapour' to 'droplet' burning mode. A purpose-built cloud chamber has been designed and built, incorporating the required optical access and minimising laser-diagnostic error. The particle size is shown to be dependent upon the expansion ratio, initial temperature and expansion rate, and an empirically based methodology for generating these characteristic clouds has been established. However, a fully predictive model for droplet size as a function of these control parameters is not yet available.

A dimensional-analysis approach is presented for assessing the aerosol flammability hazard posed by impingement of low-pressure, high-flashpoint fuel on surfaces. Guidance on critical angle of impingment and impingement distance are postulated, and are currently being appraised using PDA. We have built a system for generating and characterising aerosols within the particle size range of interest for combustion hazards, and are about to start ignition studies. The ability to generate satisfactory droplet sizes is a very big part of the problem, and so a report on progress of this aspect will be given. The project is complementary to the studies that are in progress at Leeds. Thus

presentations on both of these studies at this meeting give an ideal opportunity to share experiences and to give a broad perspective to delegates.

Recent modelling studies have shown that droplet-induced flame-wrinkling could not account for any significant enhanced burning effects. Hence, any significant enhancement has to come back to chemistry/thermodynamic effects. We have appraised the potential of generating these clouds of dangerous particle-size from a modelling perspective. New results will be presented.

Finally, we have some recent data from direct injection engines showing that particle sizes generated in our study are precisely those of interest in new DI gasoline engines. This emphasises a breadth of the subject beyond the application to explosion hazards.

P J Bowen

Burning Velocity Enhancement in Quiescent Aerosol Flames

The combustion of clouds of fuel droplets is of great importance in many industrial applications, such as gasoline and diesel engines, gas turbines and furnaces. Here, efficient combustion has to be combined with minimum noxious emissions. Aerosols can also produce a particularly hazardous explosion risk. To optimise their performance a fundamental understanding of the complex processes in aerosol combustion systems is necessary. In order to quantify the parameters of importance, a novel aerosol combustion apparatus was developed. It offers a well controlled environment with respect to aerosol properties, temperature, pressure and turbulence.

Aerosols were generated using the Wilson cloud chamber principle of expansion cooling, which produces a homogeneously distributed, near monodisperse droplet cloud. Drop sizes of 10 to 30 mm, pressures between 100 and 360 kPa and temperatures of 263 to 292 K were used. A considerable burning velocity enhancement of up to 420% with respect to that in an equivalent, homogeneous gaseous mixture was observed. This enhancement was shown to be a function of drop size and liquid fraction. From the present study, it was concluded that burning velocity enhancement probably is caused by the increase in surface area due to wrinkling, caused by the development of instabilities. At low temperature ($T < 275$ K) the formation and destruction of wrinkles and cells was random. At higher temperatures ($T > 290$ K) cell formation and division was progressive and traceable, like that observed in gaseous flames. Cellular acceleration at these temperatures was similar to that of gaseous flames. Stretch appeared to have a damping effect on the instabilities caused by the aerosol. Inert glass particles in a gaseous fuel-air mixture had no effect on flame speed or structure. However, water aerosols caused significant burning velocity enhancement (50%).

These findings contradict the hypotheses that fuel-rich pockets, flame propagation through "easy-to-burn" regions or a "grid-effect" may trigger instabilities in aerosols. Comparison with a linear stability analysis of heat loss from the flame yielded good qualitative agreement with the data of the present work.

F C Atzler and M Lawes

Ignition by Laser - irradiated Surfaces

The criteria under which laser irradiation of inert targets leads to the ignition of a surrounding flammable gas mixture are studied in relation to the hazard associated with the use of optical fibres in explosive atmospheres. Results for stoichiometric mixtures in air of eleven diverse fuels are presented in the form of the minimum igniting irradiance,

distributed uniformly over an area large by comparison with quenching dimensions, as a function of the time to ignition. Thermal histories during radiant heating and cooling of the target in an inert atmosphere are used to establish its thermal characteristics.

The variation of minimum igniting irradiance with ignition lag is universal such that the igniting energy density varies linearly with time - a relationship which is accounted for theoretically. The intercept gives the limit of minimum igniting energy surface density as time tends to zero, whilst the slope provides an accurate value of the minimum igniting irradiance at infinite time, from which the surface ignition temperature can be deduced.

These temperatures are comparable to autoignition temperatures for rapidly reacting mixtures, but greatly in excess of them when autoignition temperatures are low. This is accounted for theoretically in terms of the effect of natural convection, and empirical correlations are proposed which allow surface ignition temperatures, and hence minimum igniting irradiances, to be estimated in terms of known combustion parameters. Conversely, these relationships may be applied to deduce unknown autoignition temperatures from our irradiance measurements, and this is applied to calculating autoignition temperatures for mixtures of fuels, with some interesting results.

J Adler, F B Carleton and F J Weinberg

Explosion Hazards in Vent Collection Systems

In the rush to meet new environmentally emissions standards for volatile organic compounds (VOCs) a large number of vent gas incineration systems have been or are being installed (so-called "end of pipe treatment"). It is not widely appreciated that there may be considerable operational difficulties and explosion hazards attached to the installation of such systems often arising from the complex interactions within the plant(s) being served. The application of environmental improvement schemes can lead to an increase in the risk of explosion.

Ignition of a flammable mixture in a long pipeline can run up from deflagration to detonation. The risk can actually be worse in lines containing mixtures with low flame speeds due to the effect of pressure piling. A methodology has been developed to assess the hazards in lines transporting potentially flammable gas mixtures which can be used to develop a valid basis of safety. The effects of deflagration and detonation on pipelines are discussed.

Flame arresters are often used in these lines to prevent transmission of flames from ignition sources into pipelines. Flame arresters are generally tested in straight lines with standard gases. The effect of different gas mixtures and the influence of plant geometry on the run up to detonation and performance of crimped metal flame arresters, is not well understood. A number of tests have been made on a crimped metal flame arrester in a typical plant configuration with a non-standard gas. Data on run up to detonation and flame arrester performance has been recorded in full scale plant with several gases and will be presented. These data have been used for safety design of the process.

A Ennis and R Bambrey

Explosion Development in Pipeline Systems and Linked Vessels

The networked vessel configuration is common in industrial installations where process vessels are linked by pipelines, in connected segments of tankers and aircraft, in adjacent (connected) buildings, in mine shafts etc. Generally such systems are designed to exclude air or to operate outside the flammability limits. However, during plant start-up or shut-down, or malfunction, air can enter the system and an explosion may result. An accidental explosion in one part of the system will be transmitted through the linking geometry into the other parts. Accidental explosions in such systems are not rare, and a particular feature of these events is the violence of destruction in the linked vessels rather than in the originating one. In addition, the current trends and regulations of collecting waste, toxic gases and fumes (even in emergency relief situations) in order to prevent atmospheric pollution, have greatly increased the range of systems in which this hazard is relevant. These gas recovery systems usually consist of pipe networks, typically with multiple points of extraction connecting the process to a collection vessel or an incinerator. The material conveyed in these systems is often already within the explosive range and considering that it is extremely difficult/impractical to eliminate all sources of ignition. It is often the case that these systems are (and should be) designed with the prospect of an explosion in mind.

The explosion hazard in these systems goes beyond the present understanding of explosions; it can lead to much more severe overpressures than expected due to high flame speeds, pressure piling and possibly detonation. The consequences of such incidents could combine severe plant damage with strong environmental impact. At present such designs are based primarily on information from explosions in isolated vessels. Limited information, mainly from small scale lab experiments and from actual incidents, indicates that such an approach is unsatisfactory.

In a linked vessel geometry an initially laminar explosion in one vessel sets up a pressure differential between the linked vessels which creates a flow away from the ignition vessel through the linking pipe. The flow contraction (from the large vessel to the pipe) results in high velocities and turbulence in the pipe. When the flame enters the pipe, combustion becomes turbulent and the flame is accelerated to high speeds creating an even higher (than before) unburnt gas flow through the pipe (ahead of the flame) which expands into the linked vessels creating conditions of extreme turbulence. Ignition in these vessels occurs in the form of strong jetted flame emerging from the pipe, resulting in very severe explosion.

In previous work we have reported very high flame speeds in the linking pipe between two vessels (of the order of 370 m/s for a stoichiometric methane/air mixture, while even for a near flammability limit mixture the flame speeds reached a maximum value of 200 m/s). The explosion in the second vessel was about 17 times more violent than expected if this vessel was considered in isolation. In a partially filled 3-vessel system where the volume of the mixture was significantly smaller than the volume of the system, we reported overpressures significantly higher than the expected adiabatic values.

The linking pipe networks invariably include bends, junctions and changes in flow area. These will have an additional contribution to the severity of an explosion. In this presentation experimental data on the effects of 90^{o} bends in pipe explosions are also reviewed, showing that a smooth bend accelerated the explosion by a factor of 6 while a sharp bend caused an enhancement factor of 13. The effects of these commonplace flow devices in a linked system are not known.

In conclusion this review demonstrates that significantly more research effort has to be directed at this type of problem in order to be able to incorporate (with confidence) appropriate design features in practical process flow networks.

H N Phylaktou

Models for Turbulent Gas Explosions: Development and Evaluation from Experiments and Case Studies

It is apparent that not enough progress has been made over the years in developing a culture that (i) promotes the inclusion of appropriate physics in practical models or that (ii) ensures that formulated models are applied correctly. This has become evident from the personal experience of having worked for many years in the Model Evaluation area on behalf of the CEC. Lately, these impressions have been confirmed by participation in an HSE advisory committee.

One purpose of the current presentation is thus to show how a unique detailed characterisation (in terms of velocities and turbulence quantities) of flow fields for turbulent gaseous explosions can be used to highlight both satisfactory and weak aspects of current modelling practice in this area. Data are drawn from the work by Lindstedt and Sakthitharan (*Combust. Flame 114:469-483 1998*).

The overall lessons from the work are (i) that a proper model development cycle should be performed in a manner which permits the validation and verification of the physics, and (ii) that suitable data are almost impossible to procure outside well instrumented laboratories. This is particularly relevant in the area of combustion hazards.

However, it is argued that it is equally important that derived models be applied (though not "fitted") to large scale scenarios and that the application to such geometries will require the use of advanced CFD techniques and suitable validation data (cf Joint Industry Project in the case of gas explosions).

The intention is to look at the topic from a positive perspective and to illustrate how experiments and model development should be performed "hand-in-hand" with work on practical geometries.

R P Lindstedt

TWO TRAGEDIES

After attending the Leeds meeting described earlier, Ken Palmer, in a serious mood, reflects on the responsibilities of engineers

The British Section meeting in collaboration with UKELG, on industrial combustion hazards, reminds us that engineers and scientists have a wide ethical duty of care and foresight in the application of their work, as well as legal obligations. Combustion is inescapably linked to the release of energy, and if this release escapes from control expensive misfortune may result. So the British Section and UKELG have an important function in focussing attention on the possibilities. But it is not only combustion engineers who need to be on alert. Two other engineering calamities have recently been dealt with by scientific investigation: one on the high seas and one in Britain. Combustion engineers should note and learn.

In 1980 the M.V.Derbyshire was lost in a typhoon about 800 km from the coast of Japan. The ship was a bulk ore carrier and at 166,000 tonnes was the largest British ship ever to have been lost at sea. All 44 persons aboard died; no SOS was sent, or at least picked up. Why?

Derbyshire was only 4 years old and was one of a batch of six bulk carriers built in the UK. Each ship comprised a bow section, followed by nine main cargo holds the sternmost of which was separated by a bulkhead (number 65) from the remainder of the ship, with bridge above. The accommodation was towards the stern. All five sister ships developed severe cracking in the vicinity of bulkhead 65; three were strenghtened and a fourth, in 1986, had to be abandoned and subsequently broke up in Bantry Bay, Ireland.

The official inquiry into the loss of the Derbyshire concluded that she had been overcome by the force of the typhoon. Relatives of those lost were not satisfied because of the problems with the sister ships, and pressed successfully for further investigations. The wreck was subsequently located, in 1994, at a depth of 4,200 metres. In 1997 a detailed survey was made, using an American submersible, and is published as a Summary Report [1]; a full version with visual aids is also available. (Note: the Summary is most quickly obtained direct from the publishers, see References). The Summary contains a small selection of excellent photos from more than 100,000 images recorded. No physical samples were retrieved from the wreck; the sequence of the loss had to be derived by detective work using computers, based on the pattern of wreckage on the ocean floor. The technical expertise involved is impressive.

The likely circumstances of the sinking of the Derbyshire are described, and in short are:

1. As the typhoon approached the Master turned the ship in the prescribed manner, keeping the seas just off the bow.

2. The seas broke over the bow with increasing power, and a stores hatch cover was carried away.

3. The stores filled with sea water in probably less than one hour.

4. Because the hatch was hidden from direct view from the bridge, by a mast and other fittings, the Master could not see this happening and that the bow had lost freeboard.

5. In the darkness the mast floodlights could not be switched on during the storm , because the switches were forward and not on the bridge.

6. As the storm increased The Master hove the ship to, matching as far as possible the force of the waves with his main engine.

7. By being 2.5 metres down at the bow the ship would be more sluggish to rise to the waves, which were probably 25 metres high. There would be 4-5 wave encounters per minute.

8. A wave crashed over the bow and destroyed the hatch covers to No. 1 hold, driving them into the hold. A 25 m wave would generate a hydrostatic pressure of 2.5 bar. The hatch covers were much weaker than the decking.

9. In less than one minute No 1 hold would be filled up with 10 000 tonnes of sea water. All bow freeboard would be lost, and the waves could roll up the deck as if up a beach.

10. The hatch covers to No 2 would collapse into the hold, and the ship would be foundering. As the Derbyshire slipped below the seas the remaining hatch covers were driven inwards by wave pressures which become increasingly violent as the angle increased when the bow went down.

11. Other enclosed volumes in the ship imploded, which broke up and some parts capsized.

12. From the failure of the No 1 hatch covers to the sinking of the stern, probably only a few minutes would have passed; there was no time to send a distress signal.

13. The wreckage indicated that failure at bulkhead 65 was not the cause of the loss.

The official inquiry into the loss of the Derbyshire has been re-opened, to consider the extra evidence now available, and no doubt a final full report will eventually be published. But the inability of the Master, on the bridge, to see the bow of his ship or to be able to switch on the floodlights ought to have been spotted at the design stage. The hatch covers were relatively weak, but their integrity in a storm is vital. So why were they not stronger? What was the next weakest vital component of the ship: should that have been strengthened, and so on?

Engineers do not come well out of this tragedy. Those who earn a living on dry land owe safety to mariners who traverse the oceans. Several hundred lives are lost annually from bulk carriers worldwide.

The other tragedy, at Ramsgate, Kent, involved both land and sea and was the subject of a Thomas Lowe Gray lecture [2]. Ramsgate has a roll-on/roll-off ferry facility, which originally had a steel bridge structure to link the stern of the ferry to the shore. The seaward support was provided by a floating pontoon. The moored ferry lowered its ramp on to the pontoon, to allow vehicles to pass. Increased traffic led to a requirement for a second bridge, with loading and unloading at two levels, one above the other. It was decided to have a separate passenger walkway at the upper level.

The walkway was in three sections. The central length was fixed on to supports on the pontoon. The seaward length was a lifting section which connected to the ferry. The landward length connected the passenger terminal to the fixed central length on the pontoon; it was 33 metres long and rose to 10 metres above the pontoon. After only 4 months use it collapsed, the seaward end falling on to the pontoon. Six people were killed and seven seriously injured.

The design acknowledged that the collapsed section had six degrees of freedom of motion: three of translation and three of rotation, resulting from movement of the pontoon on the sea. But during construction and initial operation ominous signs appeared. The walkway was 0.75 m too short and remedial work was needed (the vehicle bridge was 0.75 m too long). The sliding mechanism in the terminal building, which accommodated translational movement along the axis of the walkway, was not smooth and had to be modified. The walkway was of lattice construction and was too rigid to flex with torsional movement along the axis. One foot of the walkway at the landward end was seen to lift from its support, indicating that the structure was improperly carried. In the worst case the whole load would be carried on only two of the four feet. Ultimately the seaward end of the walkway became detached, and as no abutment had been provided underneath, it fell 10 m to the pontoon.

After the collapse of the walkway, forensic examinations were made to ascertain what aspects of the design, construction and operation led to the failure. Serious faults were found in each. But the primary cause was the failure by all parties to manage the project effectively, using good communication and quality control.

Legal proceedings were brought by the Health & Safety Executive against the principal parties concerned in the design, construction and use of the walkway. Fines totalling £1.7 million, plus costs of £723,000 were imposed.

The outcome reinforces case law relating to the extent of duty on a client to effectively manage the activity of contractors. Engineers have a key role in such a situation. Their legal obligations have been further emphasised by the Construction (Design and Management) Regulations 1994. These Regulations are concerned with the management of health and safety, and require the appropriate parties to work together as a team.

The Regulations are of wide application. They can include not only buildings and structures, but also large-scale plant items, for instance, in the power generation and process industries. Construction, modification and dismantling can all be caught. Combustion engineers need to be aware.

References

1. Torchio, R., Williams, R.A. M.V. Derbyshire Surveys. UK/EC Assessors' Report. A Summary. Department of Environment, Transport and the Regions. London, 1998. ISBN 1-85112-075-0. (Obtainable direct from DETR Publication Sales Centre, Unit 21, Goldthorpe Industrial Estate, Rotherham, S Yorks, S63 9BL. Price £10 including postage in UK. Telephone enquiries: 01709 891 318)

2. Crossland, Sir Bernard., Joel,S., Norton, G., Underwood, J. Port Ramsgate Walkway Collapse Disaster. 71st. Thomas Lowe Gray Lecture. Institution of Mechanical Engineers. London. 1999.

Ken Palmer (April 1999)

INSIGHTS FROM THE DISTANT PAST INTO UNDERGROUND METHANE EXPLOSIONS

On a recent holiday in Poland I visited the famous salt mine in Wieliczka, near Kracow. During the 700 year history of the mine there have been cases of methane discharge as a result of excavation. Nowadays any hazards resulting from such discharge would be overcome by monitoring the methane concentration by instrumentation and removal as necessary to ensure that it never built up to an explosive proportion. The artisans of several centuries ago did not have these benefits, and in the official guide [1] it is described how methane leaks were dealt with in those days. It is interesting that two important facts were discovered and, indeed, acted upon in an empirical way centuries before they were the subject of formal scientific investigation.

The approach taken to reducing the methane hazard was to have systematic periodic burning of methane in, it was hoped, a controlled way. This was done by a group of men called gas firers, also nicknamed ‘penitents’ or ‘creepies’, who went about their task when the mine was otherwise unoccupied by persons. The gas firers wore protective clothing by way of a cloak with a hood to protect the face. Although they were presumably unaware of Avogadro’s Law and the respective densities of air and methane, they *were* aware that methane rises and accumulates adjacent to the ceiling of the mine chamber in which there has been leakage. This enabled the gas firers to use a flame on a long pole to ignite the methane from the relative safety of the floor of the chamber.

Even more interesting is the fact that the gas firers anticipated a point about which we currently hear a great deal in the context of leaked hydrocarbons and damage therefrom. They moved about the chamber on all fours so as to create, in the words of the guide book [1], ‘as little commotion as possible’. This is entirely analogous to what we now know that buildings, plant and the like which raise the turbulence of a hydrocarbon-air mixture will increase the destructive potential of the resulting combustion wave if there is ignition. This is an area of ongoing research by organisations including TNO in Holland, and was known in Polish mining practice several centuries ago.

We are also told in the guide that the gas firers were held in ‘great respect’ by the community, a fact from which their modern counterparts in the fire protection profession will perhaps take heart!

References.

[1] Majka J. *Guide Book,* Wieliczka Salt Mine (English Translation), Wieliczka Salt Mine Co. Ltd (1998).

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Reprinted from the Journal of Fire Sciences, Vol. 17, March/April 1999

JOINT MEETING OF FRENCH, GERMAN AND BRITISH SECTIONS OF THE COMBUSTION INSTITUTE

Nancy, 18 to 21 May 1999

Two linked articles describe this very successful joint meeting.

From the second circular members will be aware of the programme and content of the Joint Meeting that was organised by the French Section of The Combustion Institute, and hosted by the Département de Chimie, Physique des Reactions, ENSIC / CNRS in Nancy. The meeting was held in the Palais des Congrès in the heart of Nancy, which was a most comfortable and convenient venue to accommodate the 200 or so registrants. There are immeasurable scientific and social benefits to be gained from the opportunity for all delegates to take coffee breaks and lunch at the same time and in the same place, and the facilities were well suited to these requirements.

The framework of the meeting, with plenary lectures followed by two parallel sessions or a poster session, separated on each day by a leisurely two-hour lunch break, proved to be a very satisfactory arrangement - which was easily sustainable until the last day. This must reflect also to a considerable extent on the excellent science and on the very high quality of the presentations. Amongst those presenting in the oral sessions, and in the poster sessions for that matter, were a goodly number of young research workers. This was very pleasing indeed, and their contributions were especially commendable. I wonder if others share my impression that there tends to be a rather more relaxed approach to presentation of work at a meeting of this style and size. I sensed a marked contrast to the often frenetic atmosphere of the International Combustion Symposia, where deliveries can appear to be driven more by the desire to impress than to inform.

The spectrum of topics for the plenary lectures, which addressed turbulent, premixed flames (Michel Champion, Poitiers), smoke and thermal radiation in fires (Barry Moss, Cranfield), aromatic and PAH formation in flames (Bill Pitz, LLNL), autoignition of fuel droplets (Christian Eigenbrod, Bremen), low temperature kinetics of hydrocarbon oxidation (Ray Walker, Hull), automatic generation of models for the same (Gerard Sacchi, Nancy), and pressure and temperature dependences of elementary reactions in combustion (Horst Hippler, Karlsruhe), gives a measure of the breadth of coverage that was achieved. “Optical diagnostics” were also addressed both in their own right, as well as “tools of the trade” for the study of practical combustion systems. Four of the plenary titles included one or other of the words “modelling” or “numerical” - and a fifth was wholly devoted to these issues, but did not need to say so (i.e Bill Pitz’ talk). Thus one might have presumed that discussions throughout the week would be dominated by computational work. Not so! Of course, numerical studies as predictive and interpretative tools are central to progress in combustion research, but there was a very healthy representation of experimental work on both simple and complex combustion systems, using both simple and complex techniques. We each will have a perspective of what constitutes a “simple” system. However, Ray Walker will have left no-one in doubt as to the degree of simplicity that is essential if unambiguous kinetic data are to be obtained!

The coincidence of the meeting with the centenary celebrations of the contributions of "l'ecole de Nancy" to the "art nouveau" movement added a special pleasure to the social programme, and delegates were also given a cordial welcome to the city at the very fine Hotel de Ville, located in the magnificent Place Stanislaus. The French Section and the local organising Committee, especially Drs Francois Baronnet and Frederique Battin-

Leclerc in particular, are to be congratulated and thanked for their efforts to promote such an enjoyable and rewarding meeting.

John Griffiths

In the usual style of these joint meetings of the Combustion Institute, an excellent technical and social agenda had been carefully constructed with a wide variety of interesting and topical technical presentations in addition to a cultural and historical introduction to the town of Nancy. The atrocious weather conditions throughout the week could not detract from the somewhat surprisingly beautiful surroundings of the town of Nancy, in particular the impressive architecture of the Stanislas Place. A highly cultural, technically rewarding meeting ensued, from Art Nouveau to the Dome glass collections. The packed social agenda was extremely enjoyable and educational, not to mention gastronomically rewarding! In true French style, the food and wine were of outstanding quality (and quantity) throughout the week, including the sampled selection of small but extremely popular restaurants in the old town offering a very reasonably priced authentic French menu. However, the French chefs still refuse to accept that red meat can be eaten without blood dripping from within. Regardless of the emphasised, 'tres,tres bien cuit', in true Brit style, the obviously dedicated chef could not force himself to cook a steak thoroughly and was undoubtedly hugely offended by its return to be burnt and no doubt in his opinion, ruined!

Aside from the already daunting task of presenting technical work to a large audience which includes several prominent experts in the combustion field, I have enormous admiration for the presenters from France and Germany who very considerately presented in a second language, English. Although English is the international business and technical language, we should still be extremely appreciative of the presenters consideration for those of us who are more linguistically challenged!

The relevance and interest of the technical sessions of the week to the gas turbine industry was evident from the agenda, and held enormous promise with regard to generating new ideas, bench-marking our own current practice within Rolls-Royce Combustion Engineering, and making useful and fruitful contacts within the field. The technical sessions did not disappoint. On the first day alone, the presentations on Turbulent combustion modelling and soot formation (in particular the plenary by Barry Moss the following day), reflected some of the main areas of interest and concern in the combustion modelling community within Rolls-Royce. In addition, the use of relatively new CFD modelling techniques will allow an improved description of the chemistry of kerosene combustion in our future CFD modelling approach, an additional area of current research reflected in the significant contributions in the area of chemical kinetics, automatic mechanism generation and mechanism reduction by the relatively new but powerful technique of Intrinsic Low-Dimensional Manifolds (H Niemann).

However, although the content of such a wide-ranging technical schedule tends to be of enormous general interest with respect to the fundamentals of combustion and the underlying science and mathematics, several presentations tend to be of limited practical usefulness in terms of the application of combustion theory to practical problems at practical conditions, such as in the high pressure operation of a gas turbine combustor. The extrapolation of phenomena such as soot formation and weak extinction of systems at low pressures, for simple gaseous fuels such as methane to high pressure (up to 40 bar), kerosene (a complex multi-component fuel) combustion, remains a risk in terms of the validity of these extrapolations.

One of my own particular favourites of the week was the plenary lecture by Christian Eigenbrod from Bremen University on the autoignition of fuel droplets. This outlined sophisticated experimental and numerical methods which they have used to investigate the autoignition of a model kerosene fuel droplets. The direct relevance of this work to understanding the occurrence of autoignition of droplets of kerosene in the Lean Prevaporised Premixed mixing duct of the future generation Low NOx emissions combustors for gas turbines was emphasised, implying that the liquid phase autoignition could compete successfully with the gas phase process to result in the occurrence of autoignition at high pressures and temperatures (40 bar, 900 K) given a sufficiently long residence time.

The overall attendance was a healthy figure of ~200 and the entire organisation and presentation and poster facilities were of a high standard throughout the week. Despite the strict timing of presentations and discussions, there is always the risk with parallel sessions of not being 100% certain that one is seated in the right room at the right time! The overall representation by British Section members was somewhat disappointing and, even more so, the representation by British Industry. In my opinion the academic institutes are becoming increasingly sensitive and responsive to the needs and interests of industry and thus would encourage improved representation at such meetings. Perhaps stronger powers of persuasion need to be imparted on the industrial members where future meetings are concerned.

It's always an excellent way to make new friends in addition to reaffirming old friendships. In particular the poster sessions tend to be very good conversation starters and several new and useful ideas can be generated from the less formal discussions which follow. The discussion within and outside the formal presentations tends to encourage an open-minded approach to the problems and challenges which we face in the design and development of practical combustion systems and is therefore an invaluable process and provides more than sufficient justification for attendance at the meeting.

Caroline Mohamed
Rolls-Royce plc

"I'M NOT CONTENT WITH THE LEVEL OF DISCUSSION AT COMBUSTION SYMPOSIA"

In response to his article in the last Newsletter, David Smith received a letter from Arthur Lefebvre. The following is a slightly edited version. Further discussion by readers is encouraged.

I was relieved to learn from the earlier article (December 1998 Newsletter) that The Combustion Institute has failed in its various attempts to achieve parity between Combustion Symposia papers and those published in recognised journals such as Combustion & Flame. It would have been damaging to the combustion community if its arguments had prevailed.

Papers submitted to C&F undergo a rigorous review process and it is quite an achievement to have a paper accepted in this prestigious journal. On the other hand, acceptance of a Symposium paper seems to lie more in the lap of the gods and can be independent of the quality of the paper. A number of us can relate incidents of papers rejected by the Symposium but then accepted by a prestigious journal. Some of these experiences are now historical and steps have been made to remove some of the worst excesses of the Symposium selection process. It now serves well in weeding out really bad papers but the final choice of papers for presentation still seems fairly arbitrary with a large element of chance. This can lead to various misconceptions, such as the one mentioned in the earlier article, whereby authors of rejected papers tend to assume that their papers have failed to meet exceptionally high acceptance standards, seemingly higher than those for C&F. The comment in the earlier article that "perhaps the refereeing process is different" is most apposite.

On the wider point of discussion at Combustion Symposia, I believe that one cannot divorce paper selection from paper discussion. Although I have not attended a Combustion Symposium for a long time now, I was a regular attender for around 20 years. My experience was that, while discussion was not frowned upon, neither was it especially encouraged. Comments from the floor were usually confined to the trite and uncritical. Partly because of this, I finally gave up attending the meetings and waited instead for the published proceedings (incidentally always good value for money).

Too often, in my view, discussion is regarded merely as an appendage to what is perceived as the main purpose of a conference, namely the presentation of papers. This is not confined to Combustion Symposia. Many conference organisers feel that the only reason for allocating discussion time after each presentation is to provide an opportunity for members of the audience to ask questions of the author. Some chairs, anticipating few questions, allow the presenter extra time, in order to avoid an embarrassing gap in the proceedings. Too few people seem to recognise that discussion has an important role to play in its own right.

I firmly believe that lively discussions are vital to the success of a meeting. In fact, they are the main reason for holding a meeting. Discussion of a paper is not only a compliment to the author but is much appreciated by the audience. What can be more entertaining than listening to a bunch of "experts" arguing (I mean debating) with each other? On such occasions, people are drawn into expressing views verbally that they would never dream of committing to paper. Thus a good discussion can be highly informative to the audience and can help to make the cost of conference attendance worthwhile.

It is important to remember that a high level of discussion rarely occurs by accident. It requires careful planning. I like the way it is handled by the Combustion and Fuels Committee of the International Gas Turbine Institute, a subdivision of ASME. Essentially, the process of ensuring lively discussion starts with the selection of papers. Papers are chosen for presentation only or for presentation *and* publication. Of the papers selected,

roughly one-third then go forward for publication (in this case in the Transactions of ASME).

This has two advantages. First, it ensures that only papers of the highest quality attain the status of a refereed journal publication. Second, and equally important, it facilitates the presentation of papers which may have little or no long-term significance but which contain material of topical interest, or have the potential for provoking interesting debate, or both.

Another question raised in the earlier article is how to deal with topics such as reaction kinetics, which, as pointed out there, tend to attract papers which generate little discussion, because the relevant techniques are now well established and data acquisition often seems largely routine. The answer is simple: remove such topics from future symposia until such time as new developments justify their re-inclusion. One of the main criteria for including any subject in a Symposium programme should be: will it generate lively and interesting discussion? If a subject fails this test, then it has no place in a forum that purports to portray the latest in combustion science.

New areas of combustion are opening up all the time. To accommodate these new topics, some more traditional ones, where the pace of development has slowed down, should be omitted until they deserve re-instatement. Increasing the number of technical sessions or resorting to multi-volume proceedings have been advocated as means of introducing new topics without sacrificing the old ones. Such easy options are hardly the hallmark of a dynamic organisation.

A further issue raised in the earlier article is the role of the session chairman. No-one has a more vital part to play in ensuring a successful conference. A good chairman is one who, prior to the meeting, examines the papers in his session and prepares one or two questions on each that can be used to initiate discussion or to inject new life into the discussion should it start to flag. In addition, chairmen will be well acquainted with many of the delegates in attendance and, before the start of proceedings, can call upon a few of them to solicit their active involvement in the subsequent discussion. All this may seem contrived, but a high level of discussion is too important to be left to chance. Of course, different chairmen may employ different techniques but in all cases the objective should be the same - to create an atmosphere which is conducive to active audience participation and debate. We must dispel the notion that the Chairman's primary role is that of timekeeper.

Finally, I hope that the original article and this response will provoke other readers into offering their own suggestions for raising the status of conference discussion. From the various critical comments one sometimes hears, it does seem that the present format is not working perfectly and that improvements are in order.

Arthur Lefebvre

Please write to the editor or David Smith if you would like to comment on David's article or Arthur Lefebvre's response. Please indicate whether you would be happy for your comments to be published in the Newsletter.

EDINBURGH .....

When I first drafted this article (quite a few weeks ago), I remarked that if you read the Guardian on Saturdays, you may be familiar with Matthew Engel's column in which he concocts a list of something or other. Lists make interesting reading, so I made one of my

own. As soon as I had my words on paper, Mr. Engel stopped doing his (spooky or what!) But I decided to carry on....

While in Edinburgh recently (in connection with planning next year's Combustion Symposium), I took a stroll round town. Untypically for this spring, the weather was fine and warm and Edinburgh looked wonderful. While in the Royal Mile, I 'did an Engel' and complied a list of some the things one can buy there. In alphabetical order:

- Armoured figures, metal, 1 ft tall
- Crystal vases
- Eagle comics
- Flintlock pistols
- Fridge magnets
- Fudge
- Golf bags
- Kilts
- Maps
- Murder mystery tours
- Organs (musical variety)
- Pizzas
- Playing cards
- St. Andrew's golf course T-shirts
- Swords and "other pointy things"
- Tam o'shanters
- Tarot cards
- Tattoos
- Tours of Edinburgh
- Whisky

I'm sure one can buy other things, possibly even more useful, but twenty makes a good list. Meanwhile, arrangements for the Symposium are progressing nicely. If the weather is kind to us (fingers crossed), I believe Edinburgh will be a memorable Symposium venue. You will have received the early details in the First Announcement. In addition, we have an (as yet, fairly rudimentary) web site and, as this evolves, it will give more information on Edinburgh and the Symposium. The address is:

http://www.efm.leeds.ac.uk/edin2000/

It is being looked after by Phil Gaskell and a colleague, Andy Sleigh, who are both based in Leeds - hence the Leeds address.

Chris Lawn (overseeing arrangements for the technical program) has agreed with the Program co-chairs (Jim Driscoll and Sebastien Candel) the overall structure of the program. It will be as at Naples and Boulder; that is: six parallel sessions plus a generous allocation of accepted papers presented as posters. In addition, there will be the usual Work-in-Progress posters.

The basic shape of the Social Programme has been decided, as set out in the First Announcement. Of course, venues and overall content is one thing (or rather two); we still have all the fine detail to arrange. But it is pleasing to note that, because Edinburgh is so richly provided for, we have been able to choose venues either in the city centre itself

(e.g. the Banquet is at the lower end of the Royal Mile) or within easy reach (e.g. the Wednesday outing is only about 20 minutes drive away).

Another significant task shortly to be done is the choice of Symposium hotels. Again, because it attracts so many visitors, Edinburgh is well catered for here. In addition to the hotels, we have already booked campus accommodation for 850. This is in Pollock Halls, overlooking Arthur's Seat. It is of higher quality than much campus accommodation and should prove an attractive option (certainly it's the one I'm going for!)

Finally, we are now liaising with Clansman Monarch on the Accompanying Guests programme. As noted several times already, Edinburgh and the Lothian region has much to offer and Clansman has considerable experience in organising such programmes. So, we should be well set there.

Clansman Monarch is the company of Professional Conference Organisers we have hired to assist us in planning and running the meeting, and they are involved in all its aspects. Their deep knowledge of conference organising in general complements our lack of experience of the detail but better understanding of the shape and feel of combustion symposia.

David Smith

TWENTY-EIGHTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION
30 JULY-4 AUGUST 2000

Papers to Sue Terpack by 15 December 1999 at:-
The Combustion Institute
5001 Baum Boulevard, Suite 635
Pittsburgh, PA 15213-1851
USA.
Tel: (412) 687 1366
Fax: (412) 687 0340
e-mail: combust@telerama.lm.com.

Work-in-Progress abstracts to John Griffiths by 14 April 2000.

See the Symposium website at **http://www.efm.leeds.ac.uk/edin2000/**

COMBUSTION CALENDAR

1999

JUNE 1999

19-23 JUNE
Anatalya, Turkey. MEDITERANEAN COMBUSTION SYMPOSIUM. A meeting of the Combustion Institute and the International Centre for Heat and Mass Transfer. Topics will include: *Stationary Sprays and Gas Combustion Systems, Combustion of Solid Fuels PF, FBC and Waste, Internal Combustion Engines, Optical Diagnostics and Radiative Transfer, Flame Dynamics and Turbulence, Pollutants, Fire and Explosions, Kinetics* .Details: F Arinc, Secretary General, ICHMT, Mechanical Engineering Department, Middle East Technical University, 06531 Ankara, Turkey. Tel: 312 210 1429, Fax 312 210 1331, e-mail: arinc@metu.edu.tr, web: http://ichmt.me.metu.edu.tr

20-22JUNE
Portland, OR, USA. 54th NORTHWEST REGIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. Details: T Dunne, 3203 Southeast Woodstock Boulevard, Portland, OR 97202, USA. Tel: (503) 777 7207, Fax: (503) 777 7769.

21-23JUNE
Columbus OH, USA. 31st CENTRAL REGIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. Details: J Parson, Chemistry Department, Ohio State University, 100 W. 18th Avenue, Columbus, OH 43210, USA. Tel: (614) 292 3267, Fax: (614) 292 1685, e-mail: parson2@osu.edu

21-26JUNE
Potsdam NY, USA. 28th NORTHEAST REGIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. Details: P Zuman, Department of Chemistry, Potsdam University, Potsdam, NY 13699, USA. Tel: (315) 268 2340.

27-30 JUNE
Karlsruhe, Germany. SIXTH INTERNATIONAL CONGRESS ON TOXIC COMBUSTION BYPRODUCTS. Details: pic99@ict.uni-karlsruhe.de
web: http://www.ict.uni-karlsruhe.de/pic99/.

27-30 JUNE
Monterey, CA, USA. PULSED POWER CONFERENCE. Details: C Stallings, Physics International, 2700 Merced Street, San Leandro, CA 94577, USA. e-mail: chstallings@corp.olin.com

28 JUNE-1 JULY
Manchester, England. 13th UMIST course on ATOMISER & SPRAY TECHNOLOGY. Details: Melinda Curtis, Department of Mechanical Engineering, UMIST, PO Box 88, Manchester M60 1QD, England. Tel:(0161) 200 3274, Fax: (0161) 200 3723
e-mail: melinda.curtis@umist.ac.uk

28 JUNE-2 JULY
Leeds, England. ENGINE EMISSIONS MEASUREMENT. A short course. Details: Jenny Bannister, Department of Fuel and Energy, University of Leeds, Leeds LS2 9JT England. Tel: (0113) 233 2494, Fax: (0113) 233 2511, e-mail: shortfuel@leeds.ac.uk

29 JUNE-1 JULY
Edinburgh, Scotland. INTERFLAM '99. 8th FIRE SCIENCE AND ENGINEERING CONFERENCE. Details: Carole Franks, Interscience Communications Ltd., West Yard House, Guil;ford Grove, Greenwich, London SE10 8JT, England. Tel: (0181) 692 5155

e-mail: intercomm@dial.pipex.com, web: http://dspace.dial.pipex.com/intercomm/

JULY 1999

4-6 JULY
Sheffield, England. 2nd INTERNATIONAL SYMPOSIUM ON INCINERATION AND FLUE GAS TREATMENT TECHNOLOGIES. Details: Jennie Black, Conference Department, IChemE, 165-189 Railway Terrace, Rugby CV21 3HQ, Warwickshire, England. Tel: (01788) 578214, Fax: (01788) 577182, e-mail: jblack@icheme.org.uk

5-7 JULY
Toulouse, France. 15th ANNUAL CONFERENCE ON LIQUID ATOMISATION AND SPRAY SYSTEMS (ILASS-Europe '99). Details: Secretariat ILASS-Europe '99, ONERA-Centre de Toulouse, 2 Av. Edourd Belin, BP 4025, 31055 TOULOUSE Cedex, France. Tel: (5) 62 25 25 82, Fax: (5) 62 25 25 83, e-mail: Gerard.Lavergne@onecent.fr

5-9 JULY
Poitiers, France. 6th INTERNATIONAL SYMPOSIUM ON FIRE SAFETY SCIENCE. Details: 6th IAFSS Symposium Organisers, LCD-ENSMA. Teleport 2, BP 109-86960 Futurescope Cedex, France. Tel:(05) 49 49 82 90, Fax: (05) 49 49 82 91, e-mail: iass6@lcd.ensma.fr

12-15 JULY
Lisbon, Portugal. CLEAN AIR V: FIFTH INTERNATIONAL CONFERENCE ON TECHNOLOGIES AND COMBUSTION FOR A CLEAN ENVIRONMENT. Details: Maria da Graça Carvalho, Mechanical Engineering Department, Instituto Superior Técnico, Av Rovisco Pais, 1096 Lisbon Codex, Portugal. Tel: (1) 841 7372 or 7186, Fax: (1) 847 5545 or (1) 726 2633, e-mail: cleanair@esoterica.pt

18-23 JULY
San Francisco, CA, USA. ASME/JSME FLUIDS ENGINEERING CONFERENCE. Topics include *Industrial Applications of Swirling Flows*, Details: M Padmanabhan, e-mail: Padu@aldenlab.com, *Numerical Developments in CFD,* M Dhaubhadel, e-mail: Mdhaubha@ford.com, *8th International Symposium on Gas/Particle Flows,* D Stock, e-mail: stock@mme.wsu.edu, *Turbulent Mixing and Diffusion,* J C Hill, Iowa State University, USA, and K Ghia, University of Cincinnati, USA, *Thermal Anemometry* J Foss, e-mail: Foss@msu.egr, **or** O F Turan, e-mail: Ofturan@dingo.vut.edu.au, *Experimental and Numerical Flow Visualization and Laser Anemometry,* B Kahlighi, e-mail: Bkhaligh@cmsa.grm.com, *Finite Element Applications in Fluid Mechanics,* M. Dhaubhadel, e-mail: Mdhaubha@ford.com *Shock Waves and Compressible Flows,* M Morris, Bradley University, O Baysal, Old Dominion University, and A Kuhl, Lawrence Livermore Laboratories, *Optical Methods and Image Processing in Fluid Mechanics,* R J Adrian, e-mail: r-adrian@uiuc.edu

25-30 JULY
Heidelberg, Germany. 17th INTERNATIONAL COLLOQUIUM ON THE DYNAMICS OF EXPLOSIONS AND REACTIVE SYSTEMS. Details: U Reidel, IWR, Universität, Heidelberg, Im Neuenheimer Feld 368, D-69120 Heidelberg, Germany. Tel: (6221) 54 8887, Fax: (6221) 54 8884, e-mail: icders99@iwr.uni-heidelberg.de
Web: http://reaflow.iwr.uni-heidelberg.de/icders99.html

AUGUST 1999

1-5 AUGUST
Kazimierz Dolny, Poland. 16th INTERNATIONAL SYMPOSIUM ON COMBUSTION PROCESSES. Details: A Kowalewicz, Radom Technical University, Institute of Maintenance of Vehicles and Machines, Al. Chobrego 45, 26-600 Radom, Poland. Fax: 48 440 74
e-mail: kowalka@kiux.man.radom.pl

1-6 AUGUST
London, England. 5 th WORLD CONGRESS OF THEORETICALLY-ORIENTED CHEMISTS. Details: Dr John Gibson, WATOC '99,The Royal Society of Chemistry, Burlington House, London W1V 0BN, England. Tel: (0171) 437 8656, Fax: (0171) 734 1227
e-mail: conferences@rsc.org

14-17 AUGUST
Albuquerque, NM, USA. ASME HEAT TRANSFER CONFERENCE. Details: Meetings Department, ASME, 345 E. 47th St., New York, NY 10017, USA. Tel: (212) 705 7037, Fax: (212) 705 7143.

16-19 AUGUST
Moscow, Russia. FIFTH INTERNATIONAL SYMPOSIUM ON SELF-PROPARGATING HIGH-TEMPERATURE SYNTHESIS (SHS-99). Details: Organising Committee, Institute of Structural Macrokinetics and Materials Science (ISMAN), Russian Academy of Sciences, Chernogolovka, Moscow 142432, Russia. Tel: (095) 962 8008, Fax: (095) 962 8040, e-mail: SHS99@ism.ac.ru or merzh@isman0.Unicon.msk.su, web: http://www.ism.ac.ru/SHS99.html

22-26 AUGUST
Dearborn, MI, USA. 14th OZONE WORLD CONGRESS. Details: M Istok, IOA/PAG Executive Director, 31 Strawberry Hill Avenue, Stamford, CT 06902, USA. Tel: (203) 348 3542, Fax: (203) 967 4845, e-mail: mistok@i-2000.com, **or** mistok@int-ozone-assoc.org

22-26 AUGUST
New Orleans, LA, USA. 218th NATIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. A variety of combustion-related topics. Details: *Tutorial on Advanced Analytical Methods for Fossil Fuels and Products,* R E Winans, e-mail: rewinans@anl.gov . *Molecular and Network Structures of Coal,* M Jino, E-mail: jino@icrs.tohoku.ac.jp **or** R E Winans, e-mail: rewinans@anl.gov . *Hydrogen Production, Storage, and Utilization,* C Gregoire-Padro, National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, CO, 80401, USA. Tel: (303) 275 2919.

SEPTEMBER 1999

5-8 SEPTEMBER
Edinburgh, Scotland. 14th FIRE SCIENCE AND FIRE INVESTIGATION COURSE. Details: Amy Middlemass, Edinburgh Research and Innovation Ltd., The University of Edinburgh, TTC, Kings Buildings, Mayfield Road, Edinburgh EH9 3JY, Scotland. Tel: (0131) 650 5782, Fax: (0131) 662 4678, e-mail: amy.middlemass@ed.ac.uk

8-10 SEPTEMBER

Greenwich, England. FIRE RETARDENT POLYMERS. Organised by the SCI Fire Chemistry Discussion Group. Details: SCI Conference Secretariat, 14-15 Belgrave Square, London SW1X 8PS, England. Tel: (0171) 235 3681, Fax: (0171) 235 7743
e-mail: conferences@chemind.demon.co.uk

12-17 SEPTEMBER
Taiyuan, Shanxi, PR China. TENTH INTERNATIONAL CONFERENCE ON COAL SCIENCES. Details: Lixin Zhou, 10th ICCS Secretariat, Institute of Coal Chemistry, Chinese Academy of Sciences, PO Box 165, Taiyuan, Shanxi 030001, PR China. Tel/Fax: (351) 4048967, E-mail: iccs99@ms.sxicc.ac.cn

13-16 SEPTEMBER
London, England. SIXTH GROVE FUEL CELL SYMPOSIUM: FUEL CELLS, THE COMPETITIVE OPTION FOR SUSTAINABLE ENERGY SUPPLY. Details: Phillipa Orme
e-mail: p.orme@dial.pipex.com, web: http://eee.elsevier.nl/locate/fuelcell99

14 SEPTEMBER
Cambridge, England. COMBUSTION THEORY. The Autumn meeting of the Combustion Institute (British Section) including the AGM and presentation of the Sugden Award for 1998. Details: John Griffiths, Department of Chemistry, University of Leeds, Leeds LS2 9JT, England. Tel: (0113) 233 6462, Fax: (0113) 233 6565
e-mail: j.f.griffiths@chem.leeds.ac.uk See also this *Newsletter*

14-15 SEPTEMBER
Dresden, Germany**.** 19th DEUTSCHER FLAMMENTAG : MEETING ON TECHNICAL COMBUSTION PROCESSES. Details: VDI-Gesellschaft Energietechnik, Postfach 101139, D-40002 Duesseldorf, Germany. Tel: (211) 6214329, e-mail: get@vdi.de **or** German Section of the Combustion Institute, Tammannstr. 6, D-37077 Goettingen, Germany. Tel: (551) 393112, Fax: (551) 393117, e-mail: jkupfer@gwdg.de
web: http://combinst.iwr.uni-heidelberg.de

15 SEPTEMBER
Loughborough, England. CURRENT RESEARCH IN COMBUSTION PHYSICS: A FORUM FOR RESEARCH STUDENTS AND YOUNG RESEARCHERS. A meeting organised by the Institute of Physics Combustion Physics Group. Details: Mike Fairweather, Department of Chemical Engineering, University of Leeds, Leeds LS2 9JT, England. Tel: (0113) 233 2419, Fax: (0113) 233 2405, e-mail: m.fairweather@leeds.ac.uk

20-21 SEPTEMBER
Leeds, England. The Twelfth Annual Short Course on INCINERATION OF MUNICIPAL WASTE WITH ENERGY RECOVERY. Details: Alison Whiteley, CPD Unit, SPEME, Houldsworth School, University of Leeds, Leeds LS2 9JT, England. Tel: (0113) 233 2494, Fax: (0113) 233 2511, e-mail: shortfuel@leeds.ac.uk
web: http://www.leeds.ac.uk/fuel/shortc/sc.htm

OCTOBER 1999

17-20 OCTOBER

Knoxville, TN, USA. 51st SOUTHEAST REGIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. Details: C Feigerle, University of Tennessee, Department of Chemistry, Knoxville, TN 37996, USA. Tel: (615) 974 2129, e-mail: reglmtgs@acs.org

18-20 OCTOBER
Lexington, Kentucky, USA. 1999 INTERNATIONAL ASH UTILISATION SYMPOSIUM. Details: Gretchen Tremoulet, University of Kentucky Center for Applied Research, 2540 Research Park Drive, Lexington, KY 40511-8410. Tel: (606) 257 0355, Fax: (606) 257 0360, e-mail: gtrmoulet@caer.uky.edu, web: http://www.flyash.org

NOVEMBER 1999

9-11 NOVEMBER
Birmingham, England. INTEGRATED POWERTRAIN SYSTEMS FOR A BETTER ENVIRONMENT at AUTOTECH '99. Details: Conferences and Events Dept., IMechE, 1 Birdcage Walk, London SW1H 9JJ, England, web: www.imeche.org.uk

10 NOVEMBER
Birmingham, England. EDUCATION IN AUTOMOTIVE ENGINEERING at AUTOTECH '99. Details: see above.

14-19 NOVEMBER
Nashville, TN, USA. ASME INTERNATIONAL MECHANICAL ENGINEERINGCONGRESS AND EXPOSITION. Including a Symposium on Fire and Combustion Systems. Details: P Pfund, Conference Chair, Babcock and Wilcox, 1562 Beeson Street, Alliance, OH 44601, USA. e-mail: phil.a.pfund@mcdermott.com

21-23 NOVEMBER
New Orleans, LA, USA. 52nd MEETING OF THE AMERICAN PHYSICAL SOCIETY, DIVISION OF FLUID DYNAMICS. Details: M Gad-el-Hak, Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN 46556, e-mail: mohamed.gad-el-hak.1@nd.edu

DECEMBER 1999

1-2 DECEMBER
London(?), England. FUEL INJECTION SYSTEMS. A meeting organised by the Combustion Engines Group of IMechE co-sponsored by the British Section of the Combustion Institute. Details: e-mail: m_powell@imeche.org.uk

2000

MARCH 2000

5-8 MARCH
Amelia Island, Florida, USA. EIGHTH INTERNATIONAL CONFERENCE ON NUMERICAL COMBUSTION. Details: www.siam.org/meetings/nc00

APRIL 2000

10-14 APRIL
Lake Windermere, UK. THIRD INTERNATIONAL SEMINAR IN FIRE AND EXPLOSION HAZARDS. Details: Georgy Makhviladze, Centre for Research in Fire and Explosion

Studies, University of Central Lancashire, Preston PR1 2HE, England. Tel : (01772) 893222, Fax : (01772) 892916, e-mail: g.makhviladze@uclan.ac.uk
web: http://www.uclan.ac.uk/commerc/fire.htm

11-14 APRIL
Porto, Portugal. 5th EUROPEAN CONFERENCE ON INDUSTRIAL FURNACES AND BOILERS Details: INFUB $^{c}/_{o}$ Albino Reis, Rua Gago Coutino, 185-187,4435 Rio Tinto, Portugal. Tel: (2) 9734624/9730747, Fax: (2) 9730746, e-mail: conference@infub.pt
web: http://www.infub.pt

JULY 2000

23-28 JULY
Las Vegas, NV, USA. ENERGEX 2000: 8th INTERNATIONAL ENERGY FORUM. Details: P Catania, Faculty of Engineering, University of Regina, Regina, SK S4S 0A2, Canada. Tel: (306) 585 4363, Fax: (306) 585 4855, e-mail: peter.catania@uregina.ca, web: http://www.energysource.com/ief/updates/

10-13 JULY
Lisbon, Portugal. TENTH INTERNATIONAL SYMPOSIUM ON APPLICATIONS OF LASER TECHNIQUES TO FLUID MECHANICS. Details: Prof. Manuel V. Heitor, Dept. of Mechanical Engineering, Instituto Superior Técnico, Ac. Rovisco Pais, 1049-001 Lisboa Codex, Portugal. Tel: 841 73 79 / 841 73 32, Fax: 849 61 56, e-mail: llaser@dem.ist.utl.pt

30 JULY-4 AUGUST
Edinburgh, Scotland. TWENTY-EIGHTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION. Its getting nearer! Papers to Sue Terpack, The Combustion Institute, 5001 Baum Boulevard, Suite 635, Pittsburgh, PA 15213-1851, USA. Tel: (412) 687 1366, Fax: (412) 687 0340, e-mail: combust@telerama.lm.com by 15 December 1999. Work-in-Progress abstracts to John Griffiths by 14 April 2000. See the Symposium website at http://www.efm.leeds.ac.uk/edin2000/ . See also this *Newsletter*