PHOENICS NEWS

Autumn 2012

Editorial

In January Professor Spalding will be 90 so it is proposed to dedicate the Winter Edition of the PHOENICS Newsletter to his scientific interests particularly CHAM, pre-PHOENICS software and, of course, PHOENICS.

It would be much appreciated if you, our PHOENICS Users, and CHAM Agents, would search your files and the archives of your memories and send me (cik@cham.co.uk) information including, but not limited to:

- Brief articles recalling your first experience of meeting Brian and / or of using PHOENICS;
- Problems solved using the code.
- Experiences of attending PHOENICS Conferences (photographs please).
- Extracts from publications based on PHOENICS giving the date and including figures exemplifying the work done.
- Any other materials and / or memories you have and would like to share; for example:

Do you remember using:

ESTER: Electrolytic Smelter?

STELLA: Steam Generator Elliptic Analyser?

TACT: Thermal Analysis of Cooling Towers?

CORA3: Combustion and Radiation Analyser, 3 Dimensional?

CONNIE: Condenser Numerical Integrator?

PICALO: Piston in Cylinder Calculator?

There were others before PHOENICS which was 30 years old in 2011.

If you have used any of the above we would ask you to share your memories, photographs, calculations, publications based on the codes, etc by sending them to me (cik@cham.co.uk) *during November please.* Thank you and I much look forward to hearing from you.

Colleen I King
Editor

CHAM
PHOENICS- Your Gateway to Successful CFD

2) PHOENICS News

2.1 Branch and Agent News

2.1.1 Safe Solutions

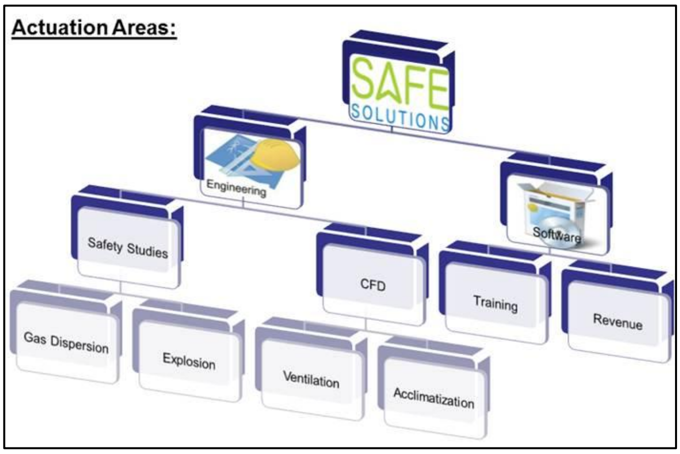
CHAM is pleased to announce the appointment of **Safe Solutions** as an additional Agent in Brazil. Safe Solutions is run by Fabio Fundo and Erick Soares de Souza (shown above) who have extensive experience of using, and marketing, PHOENICS from their time at Chemtech.

Safe Solutions say, of their new venture:

"Safe Solutions is a new company that will focus on Engineering projects (mainly in Safety Studies, such as Gas Dispersion & Explosion Analysis, and Ventilation & Acclimatization), and software Sales & Training. In Safety Studies projects we expect to simulate leakages, to evaluate if they represent risks to Industrial Units, and to recommend gas detectors or changes in process to reduce these risks. In Ventilation & Acclimatization, we expect to simulate buildings, car parks, stadium and industrial units to evaluate comfort indexes and assess whether the temperature is adequate to the situation.

Safe Solutions is very proud to represent PHOENICS in Brazil. We have large experience in Brazilian market, so we expect to grow the sales and dissemination of the software. We are confident that this partnership will be a great success."

Contact: Safe Solutions, Rua Agostinho Menezes 453, Anndarai, 20540 150 Rio de Janiero – RJ, Brazil
Web: www.safesolutions.com.br,
e-mail: fabio.fundo@safesolutions.com.br
tel: +55 (21) 7307 4440



2.1.2 ACFDA

Customized one-on-one PHOENICS training courses are provided by ACFDA over the internet on a cost-effective basis (no travel is required).

A typical training course program is available in www.acfda.org/docs/Program2012_3days.pdf . The course is divided into 2-hour sessions offered on a flexible schedule proposed by a client. Inquiries can be sent to info@acfda.org.

Collaborative research is being undertaken by ACFDA and Department of Ecology of National Research Tomsk Polytechnic University (Russia) to develop PHOENICS-based modeling tools for training students to analyze behavior of forest fires, fires in buildings and dispersion of pollutants. An example of research work is available on: www.wildlandfirecanada.ca/Presentations/Posters/P29.pdf.

2.2 PHOENICS Activities

Dates	Activity
November 12 - 13	***Champion, Taiwan**: Advanced Training (CFD in Semi Conductors & Opteoelectronic Processing Equipment) Contac:t sales@c-h-a-m-p-i-o-n.com.tw*
November 13 - 15	***PHOENICS/ FLAIR Training Course** This is one of CHAM's regular courses and comprises a three-day introductory course. Attendees are welcome to come for all, or part, of the time. Email sales@cham.co.uk to register for this course or to obtain further information. Courses can also be run at customer sites by prior arrangement.*
November 16 – 17	***Champion, Taiwan**: Demonstration & Presentation at the National Conference of Theoretical and Applied Mechanics, R.O.C. Contact sales@c-h-a-m-p-i-o-n.com.tw*

2.3 CHAM News

2.3.1 BSO12 Conference: CHAM Sponsorship
by Rama devi Pathakota, CHAM Limited

Ms Rama devi Pathakota of CHAM, Dr Malcolm Cook of Louthborough University, Prize Winner John Mardaljevic of de Montfort University, and others at the Presentation for the Best PhD Paper at BSO12

CHAM sponsored the "Best PhD Paper" at the BSO12 Conference. The above photograph shows the prize being presented by Ms Rama devi Pathakota of CHAM to John Mardaljevic of de Montfort University, Institute of Energy and Sustainable Development, Leicester, for his paper entitled: ***"Daylight Metrics: Is there a Relation between Useful Daylight Illuminance and Daylight Glare Probability***."

2.3.2 BSO12 Conference Report
by Rama devi Pathakota, CHAM Limited

The Building Simulation and Optimization conference 2012 (BSO12) was held at Loughborough University September 10 – 11 2012. This conference was attended mainly by academic researchers and industrial groups including IES, Buro Happold, Design Builders, IDA, etc who are mainly consultants and producers of building performance simulation software tools.

The main theme of the conference was how to make effective use of improved building simulation tools to design economic buildings that have reduced fuel bills which in turn reduces carbon emission and its contribution to global warming. Accordingly the conference covered a wide range of topics including: optimum design and control of buildings using evolutionary algorithms; the architecture of low energy buildings; natural and mixed-mode ventilation modelling; and visualizing building performance.

Some of the papers are briefly described below:

Case study on the international pier building at Birmingham Airport by James Parker, Michael Oates, Paul Cropper & Li Shao, Institute of Energy and Sustainable Development, De Montfort University, Leicester, UK

For the international pier building two different calculation methodologies were used to calculate the amount of energy consumed. The pier building achieved an EPC rating of 'B' but an operational DEC rating of 'F', which was much lower than anticipated. Dynamic thermal simulation (DTS) was performed to identify the critical pieces of information that caused such a discrepancy. It was found that the fact that equipment loading was not included in the calculation of the EPC rating led to such a large difference.

Simulation Experiments with Birmingham Zero Carbon House and Optimisation in the Context of Climate Change by Ljubomir Jankovic and Halla Huws, Birmingham School of Architecture (BIAD), Birmingham City University, Birmingham

The Birmingham Zero Carbon House is a Victorian house that has achieved a carbon-negative performance after a retrofit. This paper concentrated on the performance simulation of the building. A dynamic simulation model of the house was calibrated using measured performance data. The performance of the house was subsequently studied through dynamic simulation in current and future weather years. The main features of the Zero Carbon House that led to efficient energy usage were, 1. A high level of thermal insulation (which reduced heat transfer between the inside and outside) and 2. A high amount of thermal mass (smoothes out temperature fluctuations). The results of the paper show that overheating arising from climate change can be effectively but not fully mitigated using relatively simple measures, such as shading and free cooling. The need to prepare homes gradually for adaptation to climate change was emphasised.

Modelling Buoyant Thermal Plumes in Naturally Ventilated Buildings by Faisal Durrani, Malcolm J Cook and James J McGuirk, School of Civil & Building Engineering & Department of Aeronautical and Automotive Engineering, Loughborough University, Loughborough, Leicestershire.

RANS and LES were used to investigate buoyancy-driven natural ventilation resulting from two coalescing plumes. It was observed that the interface height separating the upper warm layer from the lower ambient air was predicted more correctly by LES than RANS. It was also revealed that the interface height remains unsteady throughout the flow process rather than being fixed as suggested by theory. LES provided a greater insight than RANS into the turbulent processes that underpin buoyancy-driven natural ventilation.

Solar Assisted Ground Coupling for Naturally Ventilated School Buildings by Malcolm Orme and Agniesszka Isanska-Cwick, AECOM, Birmingham, UK

A new design method was used for natural ventilation in a school building by supplying air through culverts buried under the ground. Simulations were performed to investigate whether this method would be helpful in reducing heating and cooling requirements. The method showed good potential as a zero energy cooling solution which could significantly reduce overheating without requiring mechanical ventilation or cooling.

2.3.3 WESO12 Conference Report
by Paul Emmerson, CHAM Limited

WES-2012 Attendees: ***Conference Dinner at Chilworth Manor***

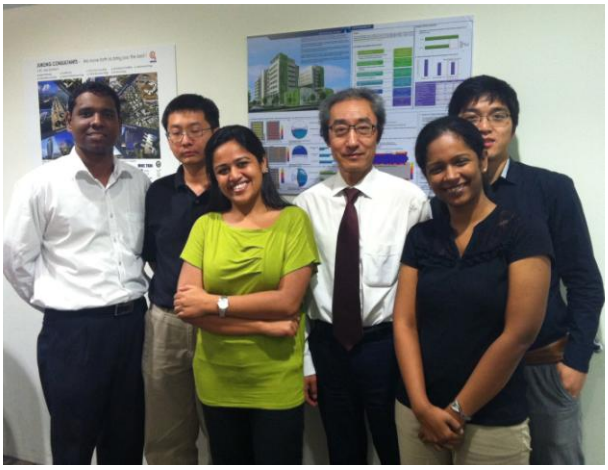
Paul Emmerson attended the 10th UK conference on Wind Engineering (WES-2012) held at the University of Southampton, UK, between 10th and 12th September 2012. CHAM has corporate membership of the Wind Engineering Society (WES), and this was the first conference at which a representative had attended.

These conferences are biennial, and this year had a full programme of selected papers covering a broad range of wind engineering topics including measurements and simulations of the urban environment, interactions with buildings, bridges, vehicles, and other structures, dispersion, structural loads, and wind energy. There were four keynote lectures, 34 oral presentations, and six poster presentations, with international participation and delegates from over a dozen countries. Also, there was a well attended conference dinner at Chilworth Manor and a tour of Southampton University's experimental wind tunnels.

Papers of particular interest were:

- A keynote lecture by Professor Kareem, University of Notre Dame, USA on the modelling of transient winds and their load effects on structures. This explored gusts, downbursts and the consequences of urban aerodynamics during transient events.
- A paper by COWI, Denmark giving examples of CFD projects simulating the urban wind environment and considering the practical applications.
- An impressive presentation and paper from SL-Rasch GmbH, Germany, showing results from simulations of large folding umbrella structures used to provide shade in Saudi Arabian Piazzas. The numerical wind flow simulations included fluid-structure coupling, to analyse the dynamic wind loads and investigate scenarios where the umbrellas were partially folded.
- A keynote lecture by Ender Ozkan, ARUP, UK, on the future of wind engineering from an industry perspective. Current practices, future trends and possible actions were considered.
- A keynote lecture by Professor Porte-Agel, EPFL, Switzerland, describing Large-eddy simulations of atmospheric boundary layer flow through wind farms. In particular it considered the interference effects between wind turbines, looking at staggered and aligned arrays.

2.3.4 Jurong Training Course given by
Jeremy Wu for CHAM Limited



Dr Jeremy Wu of CHAM with Leo Hindarto and colleagues from Jurong, Singapore

Dr Jeremy Wu gave a course for CHAM at Jurong, Singapore which covered the use of PHOENICS/FLAIR for Air Ventilation Assessment (AVA) applications and a number of related topics of interest to Jurong Consultants, including the new Heat Island module.

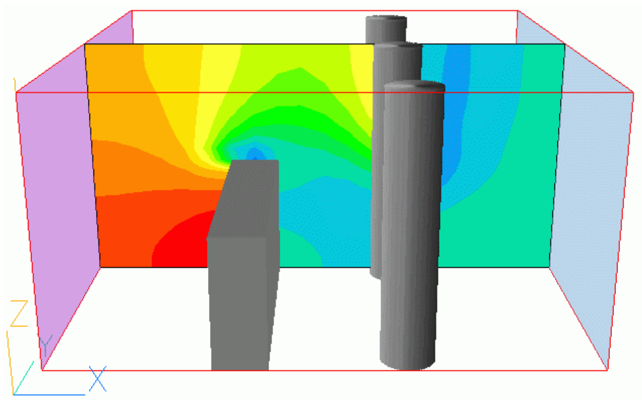
During the same visit, several personnel from the Singapore Statutory Board (JTC) received a 1-day overview of PHOENICS/FLAIR plus copies of PHOENICS/FLAIR for evaluation on behalf of the Singapore Building Construction Authority (BCA).

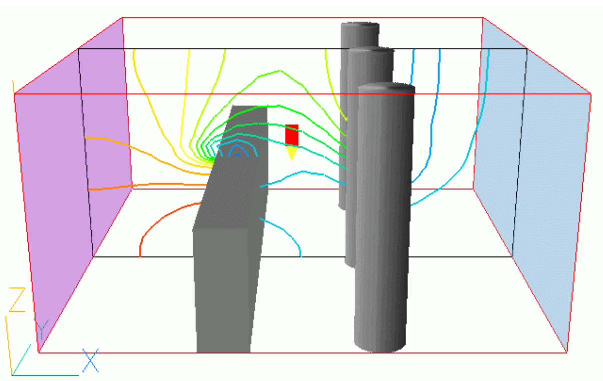
3) PHOENICS Applications

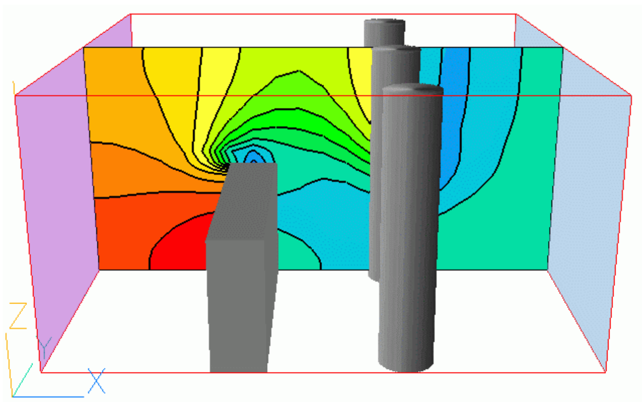
3.1 Improved Line Contouring in VR Viewer

by Steve Mortimore, CHAM Limited

The PHOENICS post processor has had an update in the way that line contours are drawn in the VR Viewer. This has enabled the lines to also be drawn over the fill contours to enable a clear delineation between the contour bands. The pictures below show how the contours will appear on a simple tutorial case. The first image shows the standard filled contour, the second shaded lines and then finally monochrome lines over the filled contours.





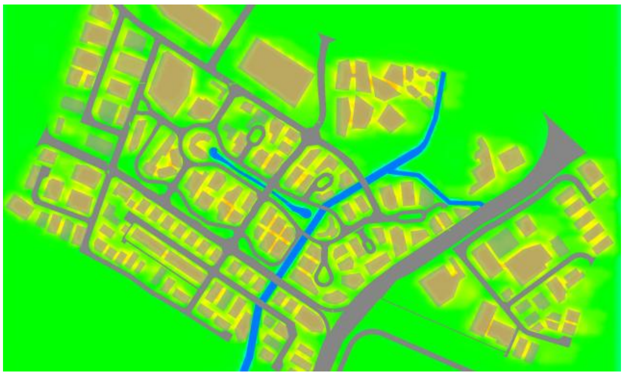


When the contour lines are drawn by themselves, they may appear using the same colours as the contour bands or as a single user-selectable colour. When displayed on top of the filled contour bands, the lines will appear always with a single colour.

Work is continuing to enable the contour lines to also be applied to user generated plotting surface objects.

3.2 FLAIR Update: Upgrade to Solar Heating model – SUN object by John Ludwig, CHAM Limited

When a SUN object is active, the amount of incident solar radiation absorbed by each object in the scene can now be set by the user. The dialogs for BLOCKAGE and PLATE objects have an extra 'Solar absorption' input box which allows the absorption factor for that object to be set. For most substances the absorption will be 0.5 or greater. Bricks, weathered steel or marble can be up to 0.9. Polished metal surfaces can be 0.1 – 0.2.



The user no longer has to ensure that objects are facetted in order for them to be picked up by the illumination algorithm.

The illumination algorithm will detect PLATE objects as well as BLOCKAGEs

Upgrade to the WIND object

When a weather file is in use for a transient case, the external pressure and temperature are updated at each time step from the weather file. This was done by updating the external pressure at outflow boundaries. In practise, it turned out that changing the external pressure can have unexpected consequences, for example creating inflows when the external pressure rises.

This has been addressed by keeping the external pressure at zero relative to the reference pressure, PRESS0, and updating PRESS0 each time step. In addition, the reference density for buoyancy, BUOYD, is also updated each time step to match the new external pressure and temperature. The transient behaviour is much improved by these two measures.

When a SUN object is active, the 'Solar absorption' factor of the WIND ground plane can also be set.

Further information on improvements to the SUN and WIND objects used for the special-purpose HeatIsle application of PHOENICS/FLAIR can be found on http://www.cham.co.uk/casestudies/CCS_HeatIsland_Application.pdf

3.3 Displaying PHOENICS Results in CAD
by Geoff Michel, CHAM Limited

Recently a number of enquiries have been received about using PHOENICS data in a CAD package. We have implemented a method of creating flow visualisations and displaying them in Rhino, allowing the CFD results to be displayed next to the CAD data. The CAD environment is often more familiar to the client so this display can make the results more accessible.

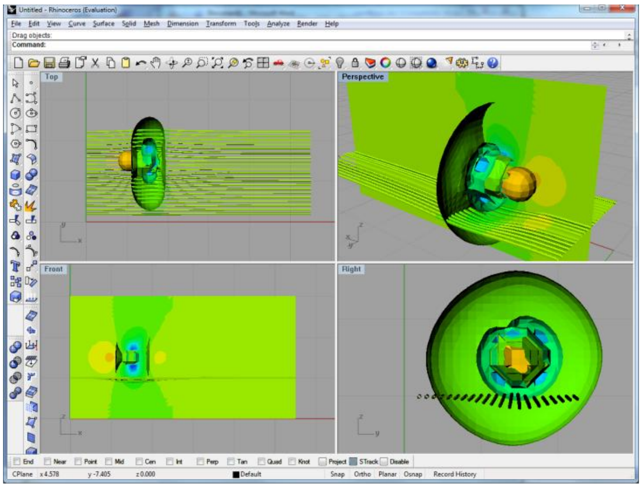


Fig 1: Example displaying contour plane, streamlines and pressure isosurfaces in Rhino.

All the facilities of Rhino are available; indeed geometry created in Rhino (or imported into Rhino) can be exported as an STL or 3DS file for use in PHOENICS, then after the CFD is complete the flow field can be visualised and the visualisations imported into Rhino. We are using 3DS format to generate the visualisation (exported from PRELUDE) but in future a direct interface to display results in CAD packages (starting with Rhino) is planned.

A student is also developing a Rhino plugin where PHOENICS can be run directly from the Rhino interface; as the solution can now be shown in the CAD package the complete PHOENICS calculation can be run and displayed in a single interface environment without the learning curve for use of the Satellite interface. This development will be aimed at non-specialists, avoiding the complexities of setting up a full PHOENICS case by use of a 'gateway' defining the basic flow solution with limited editing facilities.

The ability to redistribute the result visualisation files to customers is a further benefit – the results cannot be modified by the customer but can be viewed (including rotation or zooming) or used in presentations at any time.

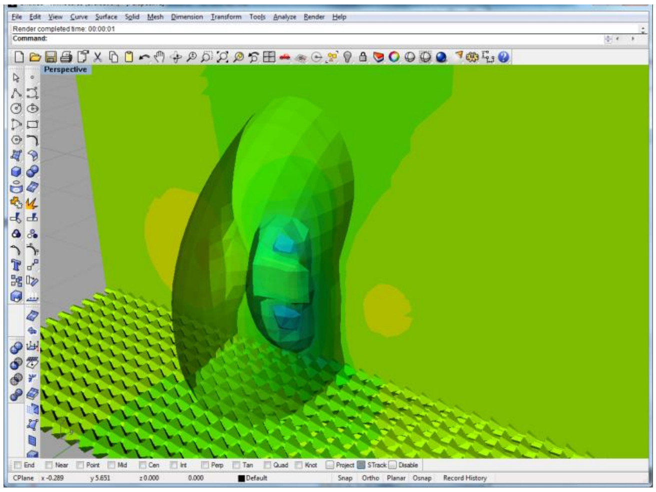


Fig 2: As figure 1 showing only the 3D view window.

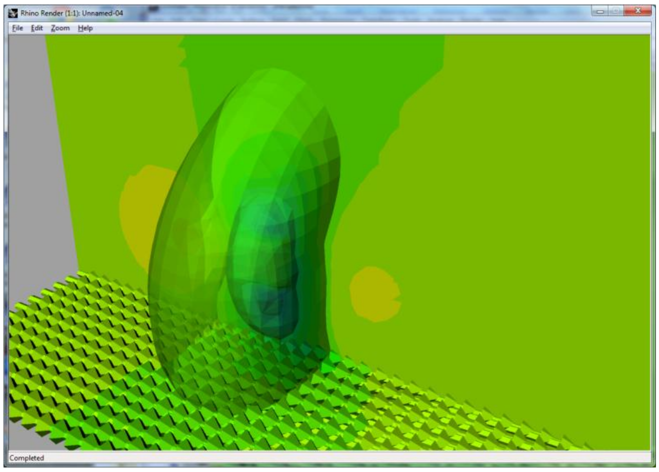


Fig 3: Ray traced rendering can improve the transparent appearance (particularly the isosurfaces inside other isosurfaces).

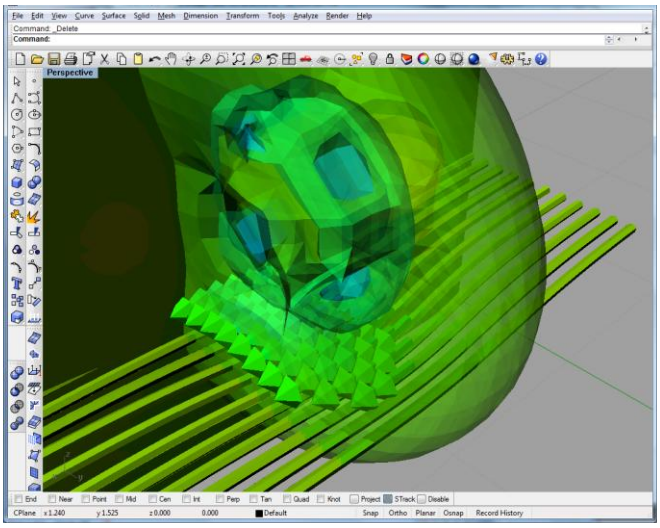


Fig 4 Detail of the isosurface view showing streamlines.

3.4 Fire and Smoke Investigation of Airport Fire Control Measures

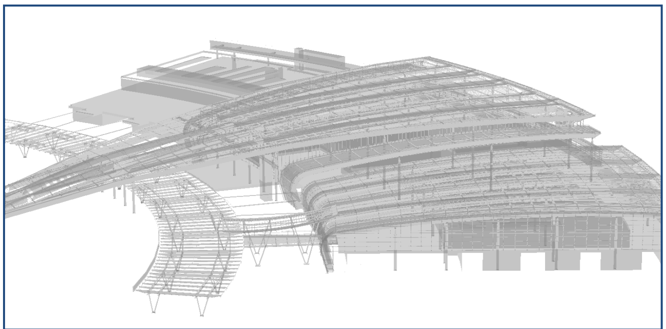
by the CHAM Consultancy Team, CHAM Limited

The Sir Seewoosagur Ramgoolam International Airport is the primary airport in Mauritius. It has been re-designed to cope with greatly increased traffic experienced over recent years and anticipated for the future. As part of the design processes, CHAM limited was contracted by engineering company, Gustave Maurel & Fils, to undertake a simulation of the fire control measures operating within its main and baggage halls.

The project involved importing a 3D model of the new terminal building for the SSR airport and incorporating its major structures, heat sources and ventilation system. The purpose was to investigate the heat and smoke dispersion from a hypothetical car fire located in the exhibition area of the airport departure hall on its first floor; and, secondly, a luggage fire located in the passport control area on the second floor.

Mauritius Airport: Picture Courtesy of Amitexo

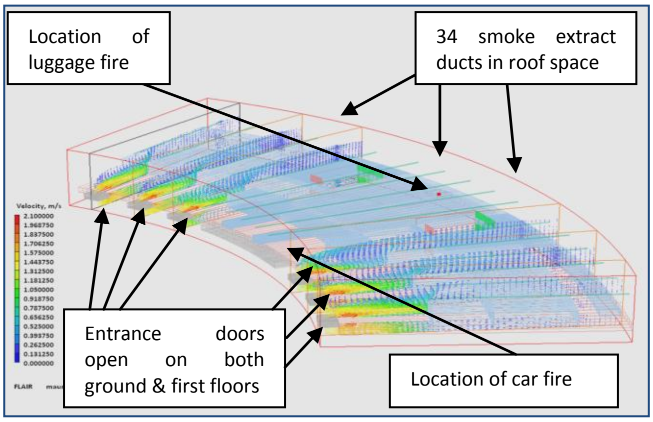
Upon discovery of a fire, the normal ventilation system is de-activated and the airport's twelve primary external access doors located on the ground and first floors are opened fully to permit public egress whilst providing a source of fresh air. Simultaneously, the 34 emergency smoke extraction systems are switched on.



CAD file Imported into PHOENICS

The CFD model was constructed using a polar coordinate meshing system which lent itself to the particular curved layout of the airport's design. The work included construction of a CFD model to take into consideration the primary architectural features and, in particular, its rows of smoke grilles located in the roof structure. The extraction rates for these grilles were based upon their operational specification.

Results of steady-state runs provided an indication of the total flow regime reflecting a "worst-case" scenario of a continuous fire with constant heat and smoke releases. Further transient runs were made to investigate the effectiveness of the smoke-extraction units over time.



Terminal Building in Polar Coordinate Mesh (Roof Structure not shown).

These demonstrated the accumulation and dissipation of smoke product, its layering and the expected visibility throughout the progression of the two fires simulated. As before, the CFD model incorporated operation of the smoke extraction system whilst assuming that the normal ventilation system is inactive, but now with the addition of a representative fire curve over time. The heat and product output of both luggage and car fires were in accordance with CIBSE guidelines. The luggage fire was set to grow and dissipate over 10 minutes, and the car fire over a 20-minute period

For the car fire the smoke production was based on a heat of combustion of $2.5x10^7$ J/kg, and a particulate smoke yield of 0.157kg_smoke/kg fuel; for the luggage fire the corresponding figures were $5.7x10^6$ J/kg and 0.16kg_smoke/kg fuel. These values are typical for polystyrene and PVC respectively. It was also assumed that the stoichiometric ratio was 1.908kg_O2/kg fuel for the car fire and 0.435kg_O2/kg fuel for the luggage fire.

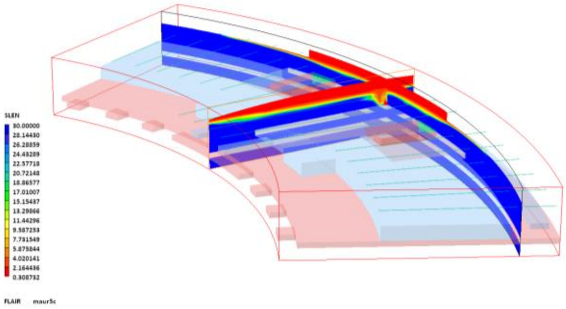
The variable "sight length" or "visibility" (SLEN) is been used in this report to display the variations of smoke concentration. This a measure of how far one can see through the smoke, being inversely proportional to the smoke particulate density (and proportional to the brightness of the object being looked at). Following CIBSE Guide E this quantity is defined as follows.

$$SLEN = \min (D_{max}, A/(K_m * C_{s,p}))$$

where Km is the mass-specific extinction coefficient in m2/kg-particulate-smoke, $C_{s,p}$ is the particulate smoke concentration in kg/m^3 of mixture, and A is an empirical coefficient with the value A=3 for light-reflecting objects. The CIBSE Guide E suggests that for the purposes of escape, visibility should be at least 8m.

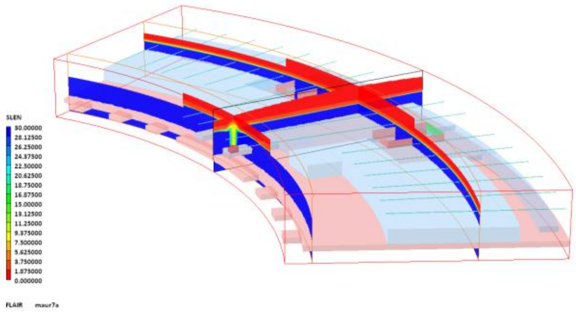
Results:

Luggage Fire Results – level 2



Sight Length after 20 minutes: Blue / Green / Yellow Acceptable Orange / Red Unacceptable

Car Fire Results – level 1



Sight Length after 20 Minutes: Blue / Green / Yellow Acceptable Orange / red Unacceptable

The results showed that the fires generated both heat and smoke product in the form of a plume that rose towards the smoke extraction grilles. Any smoke that passed the extract grilles accumulated in the roof structure but did not impede visibility at lower levels. With the exception of the immediate vicinity of the fires, the visibility (sight length) at 2m above floor level remained good throughout the airport and above the 8m minimum suggested by CIBSE. The extended article can be seen on *http://www.cham.co.uk/casestudies/CCS_AirportFireSimulation.pdf*

4) User Applications

4.1 Numerical Simulation of Temperature Distribution in a Stratified Heat Storage Tank by

Giedrė Streckienė, Department of Building Energetics, giedre.streckiene@vgtu.lt

Petras Vaitiekūnas, Department of Environmental Protection, vaitiek@vgtu.lt

ABSTRACT

The principle of operation of stratified heat storage tanks is based on the natural process of stratification, and hence the fluid flow within these tanks involves both forced and natural convection. In this paper, numerical analysis has been carried out to describe the temperature fields inside an actual heat storage tank that is installed in a CHP plant. This plant offers electricity production on the spot market. The installed storage tank makes production planning more flexible as production units can be stopped during the night or weekends if sufficient storage capacity is. Charging and discharging processes of the stratified heat storage tank are modeled using PHOENICS – multipurpose computation fluid dynamics (CFD) software. Two dimensional and three-dimensional transient models were solved. Three domain grids were tested. Influence of the maximum number of iterative sweeps and false-time step relaxation was analyzed. The theoretical possibility of thermocline formation was investigated. The special attention is given to the validation of the solution using actual data and results of *Zachar et al.* study.

Editors Note: Both Authors are at the Vilnius Gediminas Technical University, Saulėtekio ave. 11, LT-10223, Vilnius, Lithuania. Please contact them at the emails given above for a complete copy of the paper; or contact cik@cham.co.uk. The diagram below was extracted to indicate comparative results.

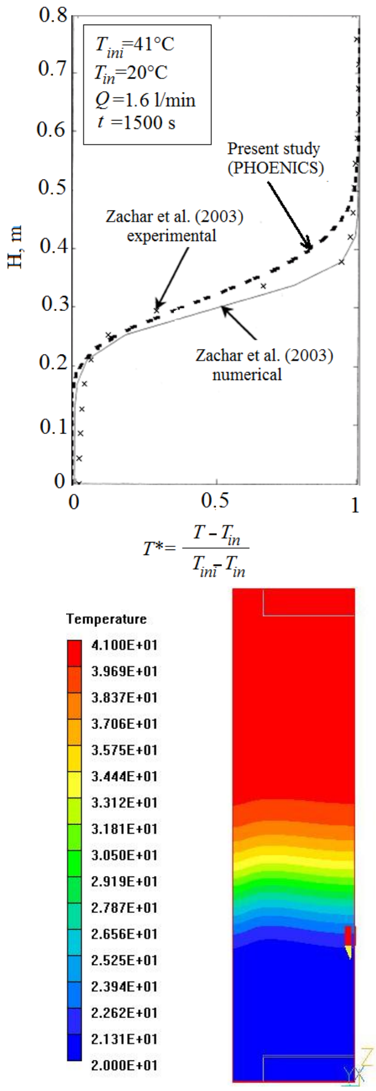


Fig. 12. Application of model to Zachar et al. (2003) research: comparison of temperature distributions (top) and view of temperatures in PHOENICS (bottom) Where T – temperature of the water inside the tank, T_{in} – inlet temperature, T_{ini} – initial temperature of the water.