MINUTES OF MEETING

FLACS USER GROUP (FLUG)



Venue: Bergen, Norway, hosted by GexCon
Meeting: 6-7 May 2009
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List of Participants:

Name	Organization	Nationality
Chris Savvides	BP	UK
Vincent Tam	BP	UK
Asmund Huser	DNV	Norway
Noela Vasquez	GDF SUEZ	France
Hans-Christen Salvesen	GexCon	Norway
Idar Storvik	GexCon	Norway
Jens Melheim	GexCon	Norway
Kees van Wingerden	GexCon	Norway
Mathieu Ichard	GexCon	Norway
Ole Jacob Taraldset	GexCon	Norway
Prankul Middha	GexCon	Norway
Lars Rogstadkjernet	GexCon	Norway
Trygve Skjold	GexCon	Norway
Ellen Østerbø	GexCon	Norway
Are Bratteteig	GexCon	Norway
Laetitia Brodie of Brodie	GexCon	Norway
Jan Roar Bakke	GexCon	Norway
Arnt-Lennard Fuglestad	GexCon	Norway
Norunn T. Stene	GexCon	Norway
Ingvild Lid	GexCon	Norway
Kjetil F. Larsen	GexCon	Norway
Tommy Lea	GexCon	Norway
Erik Aadland	GexCon	Norway
Jerome Hocquet	IRSN	France
Jennifer Wen	Kingston University	UK
Erik Månsson	Lilleaker consulting	Norway
Jan Terje Birkeland	Lilleaker consulting	Norway
Robert English	MMI	UK
Marco Pontiggia	Politecnico di Milano	Italy
Hanne Gøril Thomassen	Safetec	Norway
Kari Frederichsen	Safetec	Norway
Jan Pappas	Scandpower	Norway
Øystein Spangelo	Scandpower	Norway
Tina Almhjell	Scandpower	Norway
Clément Lapierre	Total	Norway
Bjørn Arntzen	UIB / GexCon	Norway
Valentina de Cesare	Universita' di Roma "Sapienza"	Italy
Djurre Siccama	Vectra Group	UK/Netherlands
Francesco Chille	ZC Studio	Italy

FLUG meeting 6-7 May 2009

FLUG Chairman: Chris Savvides (BP)

Day 1: 6 May 2009

Welcome to Bergen and GexCon
Erik Aadland welcomed the participants to Bergen on behalf of GexCon (host).

Welcome to FLUG and agenda for the meeting
The Chairman welcomed the participants to the meeting. The proposed agenda was adopted by the participants.

Minutes from the previous FLUG meeting
Topics related to the minutes from the previous meeting in Trondheim 6-7 November 2008:

- The new FLACS manual is now available online.
- A question was raised on how the FLACS user can see which release of FLACS that is installed on his/her computer. The text in the log file from the simulation shows the version of the core flacs simulator. Information concerning the version of the installed FLACS program package is available from the "Help" menu, submenu "About FLACS RunManager" in the FLACS RunManager. GexCon will make it easier for the user to see which version of the FLACS program package that is installed, and also look into making it easier to get an overview of installed versions of CASD, Flowvis, core simulator of FLACS, Porcalc, etc. Chris Savvides, BP, commented that the version of porcalc being employed in general matters for the simulation results, and information about the version of porcalc used in the flacs simulation considered should be made more visible. The version of the FLACS core simulator is in general most important, deciding the simulation modelling.
- Idar Storvik, GexCon, commented that the BugZilla system for tracking bugs, suggested improvements, etc. is used in the development work for FLACS. GexCon will establish and maintain a list of FLUG wishes keeping track of what is done so far.

Update GexCon Software & UK/US offices.
Prankul Middha, GexCon, gave a presentation concerning GexCon Software & UK/US offices. A list of new FLACS user companies/institutions in 2009 was presented. FLACS activities in China were described. Plans for a more advanced FLACS course and web based course were mentioned. FLACS support is planned to be enhanced using the web-based tool Salesforce. The GexCon US office currently focuses on services related to accident investigations. A new web site is developed for the GexCon US office. Vincent Tam, BP, asked about any plans for development work being useful when estimating structural response in connection with FLACS. Kees van Wingerden, GexCon, commented that GexCon is considering going in this direction for future development work.

Overview: 'JIP 2009 – 2011 and beyond'.
Kees van Wingerden, GexCon, presented the prospective Joint Industry Project (JIP). Further FLACS development as part of the JIP is planned within the following areas:

- *Enhanced performance: parallelization, solvers for non-compressible flow, and embedded grid*
- *Dispersion modelling: improved source term modelling, and atmospheric boundary layer*
- *Explosion consolidation: validation work for other types of fuel than methane and hydrogen, evaluation of equivalent gas cloud methods used in connection with FLACS, evaluation of particular models in FLACS*

The kick-off meeting for the JIP was held in Paris on 24 March 2009. The first progress meeting is planned in November 2009 (in connection with next FLUG meeting). The JIP members will get a special version of FLACS including all the improvements and enhancements of the simulator as part of the project. The intention is that the results will be incorporated in the regular FLACS versions after the project. Chris Savvides, BP, asked about possible collaboration with universities in connection

with topics focused on in the JIP. Trygve Skjold, GexCon, commented that GexCon has an active cooperation with various universities.

FLACS – A tool for accident investigations?
Prankul Middha, GexCon, presented work from various accident investigations where FLACS has been used as part of the investigation.

Update from GexCon R&D – Introduction
Trygve Skjold, GexCon, summarized some of the focus areas for future R&D work at GexCon:
- *Atmospheric boundary layer*
- *Release and dispersion of toxic materials over large distances*
- *New or extended application areas; renewable energy, wind power, bio fuels, hydrogen, etc.*
- *Fire calculations*
- *Improved modelling of internal geometries*
- *Security, explosives, shock and blast waves, etc.*
- *Structural response: simple tools and export from FLACS to other software*

Vincent Tam, BP, asked whether FLACS work using the MEGGE Protocol (European Community protocol for gas explosion model evaluation) has been published from GexCon. It was commented that some work in this area using the MEGGE Protocol has been described in the confidential GSP (Gas Safety Program) reports. Jan Pappas, Scandpower, pointed out the benefit of large scale data to validate against. Chris Savvides, BP, commented that FLACS has a certain validation envelope, when the scale is beyond the envelope, the simulation results may still be OK, but then they are not fully validated.

Update from GexCon R&D – The latest FLACS release and plans for the next release.
Ole Jacob Taraldset, GexCon, presented an overview of the latest FLACS release and the plans for the next release:
- *CASD load filter: considers only a selected subset of the geometry*
- *Improved CASD object selection, including copy and paste functionality*
- *Plan drawings in CASD*
- *In the future: possible to save drawings in the CASD database*
- *Interactive drawing of object and 'snap' functionality*
- *Flowvis: future XML based presentation file format*
- *Flowvis: gradual development of a new plot engine*
- *geo2flacs: a few bug fixes included, planning future capability to handle version 8 dgn*

Øystein Spangelo, Scandpower, asked about the possibility of a filter for importing geometries from KFX into FLACS. Ole Jacob Taraldset, GexCon, commented that such a filter is something that GexCon may consider to develop. It was commented that in some cases geometrical elements seem to be better imported into KFX compared to FLACS, and knowledge in this area may be helpful when improving FLACS.

Update from GexCon R&D – Enhanced performance in FLACS
Idar Storvik, GexCon, presented prospects for enhanced performance in FLACS:
- *Utilize more computer power*
- *Reduce total number of active grid cells*
- *Reduce number of iterations.*
- *Reduce memory usage per grid cell*
- *Parallelization of FLACS*
- *Local grid refinement*
- *Slim down computational efforts (e.g. single precision rather than double precision)*
- *Improved algorithms*
- *Tracer-mode solver*
- *Optimize use of hardware architectures: multi-core processors, etc.*
- *Programming tools and software: OpenMP, etc.*
- *Compiler auto-parallelization*

- *LAVA batch queue system*

Some tools and strategies for speed-up/parallelization have been tested, but the actual implementation is expected to take place within the next 1-3 years.

Update from GexCon R&D – Ongoing work on dispersion modelling

Mathieu Ichard, GexCon, presented some ongoing work on dispersion modelling in FLACS:

- *Two phase flow and flashing jets*
- *A simple approach to handle two-phase jets in FLACS*
- *Validation work of existing models in FLACS*
- *Sensitivity of stability class when simulating dispersion of cloud*
- *Further validation against experiments*
- *Improve source term modelling of flashing*
- *Lagrange approach*

Update from GexCon R&D – Pool simulations

Jens Melheim, GexCon, presented the status on pool modelling in FLACS. The expression for friction force has been improved, and further work is planned to make it possible to apply a finer grid for pool spreading.

Update from GexCon R&D – NORCOWE and FLACS-Wind.

Trygve Skjold, GexCon, gave a presentation about NORCOWE (Norwegian Centre for Offshore Wind Energy) and FLACS-Wind. FLACS-Wind is primarily intended for optimizing the layout of wind parks.

Ongoing experimental research at GexCon

Kees van Wingerden, GexCon, presented resent experimental work:

- The influence of flame inhibitors and vegetation on flame propagation in vapour clouds
- Dust explosion tests in a full-scale roller mill (volume ca. 10 cubic meter).

Trygve Skjold, GexCon, presented resent work in collaboration with the University of Bergen on experiments in a 3.6 meter long flame acceleration tube. The experimental results are potentially valuable validation data for DESC.

Vincent Tam, GexCon, commented that he appreciates the openness to share the thoughts of GexCon with respect to ongoing work interesting for the FLUG members.

Discussion – FLACS and current R&D challenges

Djurre Siccama, Vectra Group, inquired about the possibility of using FLACS to simulate the opening or closing of a door. This may in principle be done by an EVENT-file in FLACS, where a certain value of a variable (e.g. pressure) in a specified monitor point triggers a specified action (e.g. the closing or opening of a panel, or a leak). GexCon will make sure that this feature is properly documented in the manual. Øystein Spangelo, Scandpower, expressed the wish that FLACS supports geometry import from as many CAD system formats as possible (e.g. KFX format, Microstation version 8).

GexCon pointed out that any feedback from the user regarding the FLACS manual is most welcome.

Oblique elements are to some extent possible to include in FLACS, but if more than a few hundred oblique elements are included in the same geometry model, porcalc (the porosity calculation program in FLACS) will work very slowly. It is in principle possibility to use two separate geometries, one for pure visualization and one for the actual flacs calculation. Idar Storvik, GexCon, pointed out the need for further validation work of FLACS when sloping elements are included in the geometrical model.

End of Day 1

The FLUG Chairman concluded the first day of the meeting by thanking the speakers, before the participants departed for the social event and dinner at Møvik.

Day 2: 7 May 2009

The use of FLACS in the Buncefield accident investigation
Jan Roar Bakke, GexCon, shared (with prior permission) some experiences from the use of FLACS in the Buncefield accident investigation.

Use of FLACS for turbo compressor building studies
Noela Vasquez, GDF Suez, gave a presentation on experiences when using FLACS for explosion modelling in turbo compressor building studies. Assumed worst case indicated overpressures that could potentially destroy the building, but also less severe scenarios were considered.

Capacity of FLACS to simulate oblique gas release
Clement Lapierre, Total, shared experiences from work on simulating oblique gas releases in FLACS (oblique relative the Cartesian grid, i.e. the jet axis of the release is not aligned along one of the 3 coordinate axis). The results indicate that FLACS is currently not adapted to model this properly. Idar Storvik, GexCon, commented that GexCon will look into this area in more detail, aiming at either improving the modelling of oblique jet releases (if possible), or at least provide improved guidelines for the FLACS users.

Numerical study of spontaneous ignition of direct release of pressurized hydrogen in air
Vincent Tam, BP, gave a presentation on the topic: spontaneous ignition of hydrogen releases. Experiments show that spontaneous ignition of hydrogen is possible under certain conditions, and this phenomenon has been studied numerically at Kingston University.

Discussion – FLUG wishes
It was commented that it is in general better using Linux (compared to Windows) for memory demanding cases with FLACS. Djurre Siccama, Vectra Group, asked about the possibility to extract a subset of the data stored in 3D output files. Idar Storvik, GexCon, commented that it is possible to consider extending the functionality of the 'r3file' utility tool or include an option to keep only the last time step 3D output data, limiting the size of the output file.

Øystein Spangelo, Scandpower, asked about the possibility to delete instances in Casd more efficiently. Ole Jacob Taraldset, GexCon, commented that GexCon has plans for improvements in this area to be included in future version of Casd.

Clement Lapierre, Total, asked about including undo/redo functionality in Casd. GexCon commented that this is in principle possible, but that it is very demanding to implement.

Djurre Siccama, Vectra Group, asked about including an auto backup feature in Casd. Ole Jacob Taraldset, GexCon, commented that this should be possible, but such an auto backup will typically take significant time for a large geometry, and that it usually would be more convenient for the user to manually save the geometry.

Øystein Spangelo, Scandpower, asked about the possibility to disable license wizard at client computer in cases where such a wizard is not needed since there is a network license server connected to the client computer. Idar Storvik, GexCon, commented that GexCon may look at some menus that can be masked out when they are not relevant. He also commented that GexCon soon will have new computers available and experiences with these computers can be shared with the FLUG members as a help to the members when they are considering buying new hardware.

Robert English, MMI, shared experience with problems when loading FLACS database. It was commented that when database files are copied from a CD/DVD it may happen that file access permissions are too restrictive (e.g. read only). Furthermore, whether the interpretation of the characters of a file name is case sensitive, depends on the operating system (Linux or Windows), and this may in some cases possibly lead to problems.

A CFD based approach to correlation of maximum explosion overpressure to process plants
Asmund Huser, DNV, presented a new spreadsheet tool, developed by DNV, intended for the first screening of potential explosion pressures during the concept phase of a project. The new tool would only provide maximum pressure, based on earlier experiences from a set of offshore modules. Vincent Tam, BP, commented that more information is needed to evaluate the new tool properly.

Geometry imports, experiences and challenges
Are Bratteteig, GexCon, shared some experiences in connection with geometry import in FLACS. Modern CAD models are significantly more detailed than they used to be, and some details are not relevant for explosion modelling in FLACS. It is recommended to check thoroughly both your geometry model in CASD and the original CAD model, and be cautious when using the utility tool 'cofile' (for extracting obstacle size distributions from co-files).

Probabilistic explosion risk analysis at large scale onshore plant: the Mongstad refinery
Ellen K. Østerbø, GexCon, shared some experiences from the work on a probabilistic explosion risk analysis for the Mongstad refinery in Norway. New features in FLACS are used to handle an unusually large and complex geometry. Some of the topics considered in the analysis include:

- *Dimensional explosion loads for the entire process plant*
- *Specific load for critical equipment*
- *Explosion loads for buildings*
- *ACH number of air changes per hour*
- *Gas detection optimization*

CFD evaluation of risk assessment related to dangerous products releases
Marco Pontiggia, Politecnico di Milano, shared his experiences on simulating dangerous products releases with both Fluent and FLACS. The advantages of using FLACS include the effective handling of geometry, ease when defining the grid, and relatively short CPU time per simulation. Marco expressed a wish that FLACS should include more flexible solutions for user-defined source-term modelling for research purposes, e.g. some kind of UDF implementation (User Defined Function).

Formal issues
Jerome Hocquet, IRSN, was elected the new Chairman for the FLUG meetings. IRSN will host the next FLUG meeting in Paris, France, on 2-3 November 2009.

AOB
None of the participants brought forward any additional issues.

End of meeting
The FLUG Chairman thanked the speakers and closed the meeting, before the remaining participants were invited to witness the first experimental dust explosion tests in the new 3.6-metre flame acceleration tube.