# MINUTES OF MEETING

## FLACS USER GROUP (FLUG)



**Venue:** Bergen, Norway, hosted by GexCon
**Meeting:** 15-16 May 2012
**Issued:** 16 August 2012
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**Distribution:** FLUG mailing list

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# FLUG meeting 15-16 May 2012

## FLUG Meeting – 15 May:

**FLUG Chairman:** Chris Savvides (BP).

**Welcome to FLUG**
Prankul Middha (GexCon) welcomed the participants to Bergen and the FLUG meeting on behalf of GexCon.

**Agenda and minutes from last meeting**
Chris Savvides (BP) welcomed as chairman. The provisional agenda was adopted. There were no special comments to the minutes from the last meeting.

**Overview of the new release: FLACS v10**
Djurre Siccama (GexCon) presented an overview of the new release; FLACS v10 (copy of presentation available at the FLUG web site). Specific questions about license pricing for FLACS v10 can be directed to Djurre Siccama (or other at GexCon); flacs@gexcon.com. Chris Savvides (BP) asked for how good tested and validated the new FLACS v10 will be when it is released. Remi Martini (GexCon) commented that the new FLACS solver has been tested for some time in the Consulting department of GexCon.

**GexCon R&D: Activities in 2012 and beyond**
Trygve Skjold (GexCon) presented an overview of the GexCon R&D activities in 2012 and beyond. Chris Savvides (BP) asked whether the validation results will be available for all FLACS users. Trygve Skjold (GexCon) answered that the plan is to prepare a validation report available for all FLACS. This validation report can include a summary of different sets of validation studies that have been performed. GexCon will also try to indicate the application range, including uncertainties on how large this range is, based on the range of experimental cases that have been validated. It was pointed out that the FLACS user should be careful to consider whether the planned use of FLACS results are inside the validated range.

**The new version of Geo2Flacs**
Ole Jacob Taraldset (GexCon) presented the new version of geo2flacs (the old version of geo2flacs will be an option for some period), where the final release is planned for the fall 2012. A question was raised about which AutoCAD format that is recommended together with FLACS. Ole Jacob Taraldset (GexCon) replied that AutoCAD is very surface-based (making it difficult to import), but hopefully an improved number of objects (including those employed in AutoCAD) will be recognized in the new geo2flacs.

**Live demo of new features in CASD7**
Ole Jacob Taraldset (GexCon) presented some of the new features in CASD7. A question was raised whether CASD4 will be delivered together with the new CASD7. GexCon answered that a functionality similar to CASD4 will be available as an option in CASD7. Another question was raised on which type of graphics card that is now recommended together with FLACS. GexCon answered that, as earlier, Nvidia graphics card is recommended when running CASD and Flowvis (other type of graphics card may cause problems).

Lars Pesch (GexCon) presented the new surface area leak functionality in FLACS, including a diffusive surface area leak. Suction for a surface area leak is also expected to work fine. A question was raised on how the length scale for a surface area leak is set. Idar Storvik (GexCon) answered that the value of the length scale must be given by the FLACS user. It is recommended to avoid setting the length scale larger than the Control Volume (CV) length of the numerical grid used in the FLACS simulation. A FLUG wish for more guidance (included in the FLACS manual/documentation) on how to best set the length scale, is noticed by GexCon.

Tommy Lea (GexCon) demonstrated some features of CASD7. A question was raised whether this version of CASD can import a cloud. GexCon answered that (at least one type of) FLUENT cloud can be imported. Another question was raised related to validation of FLACS for a fuel composition having mixture of different fuel species. Olav R. Hansen (GexCon) answered that quite reasonable results are seen for the validation cases studied so far comparing FLACS simulations (including mixture of different fuel species) with available experiments.

Helge Hestetræet (GexCon) gave a presentation on how to handle large geometries in CASD. One measure is to use the assembly feature for each of a set of different areas (combined covering the total area considered). In extreme cases, another measure is to have several databases and use the comerge utility program. For viewing, the clip plane functionality is useful.

**Enhanced performance version of FLACS**
Idar Storvik (GexCon) gave a presentation on the enhanced performance version of FLACS v10. An incompressible solver and parallel solver are included in this version. The parallel solver is based on OpenMP tested with up to 16 memory channels. The capacity of the memory channels is important for the performance of the parallel solver.

**Sub-grid turbulence modelling in FLACS**
Vagesh D. Narasimhamurthy (GexCon) gave a presentation on certain aspects of sub-grid turbulence modelling in FLACS. A new, proposed version for an improved sub-grid turbulence model was presented. The new model has been tested in about 1400 consultancy scenarios. Especially for simulation of hydrogen explosions, an improvement is seen when employing the new model.

**Modelling of vented gas explosions in FLACS**
Helene H. Pedersen (GexCon) gave a presentation on modelling of vented gas explosions in FLACS. Some effects are in general well represented by FLACS. Acoustic effects are not well represented. Explosions in empty enclosures, with small vent openings and front/central ignition are challenging to model.

**Modelling of flashing liquid releases Flowvis5: Technology preview**
Mathieu Ichard (GexCon) gave a presentation on modeling of flashing liquid releases. The Euler-Lagrange approach employed here, can in the future also be considered for e.g. (water) deluge, dust explosions, combustion of mists, and dispersion of flame inhibitors. The alternative Homogeneous Equilibrium Model (HEM) uses a simplified approach, but demands less computer resources compared to the model based on the Euler-Lagrange approach.

**Flowvis5: Technology preview**
Ove Lampe (CMR Computing) presented a technology preview for the new Flowvis 5. The main programming language of Flowvis 5 is Python. A question was raised whether it will be possible to easily store plot results in several folders. Ove Lampe (CMR Computing) answered that currently only one folder (at a time) is available to storing plot results. Another question was raised whether it is possible to have a different aspect ratio for a plot. Ove Lampe (CMR Computing) answered that currently this is not possible, but this could be changed in the future (so that aspect ratio different from 1.0 is possible).

**FLUG Meeting – 16 May:**

**Geometry import from laser scans, etc.**
Olav R. Hansen (GexCon) gave a presentation on a possible future project focusing on geometry import from laser scans. Here the aim is for (as much as possible) automatic import to FLACS. Bob Brewerton (GexCon/Natabelle) commented that manual import is in general much less costly than use of current laserscan technology. Olav R. Hansen (GexCon) also presented some considerations on recent onshore accidents. In some of these onshore accidents, occurrence of DDT is suspected. Furthe, Olav R. Hansen presented some aspects on using non-aligned objects in FLACS. A question was raised on when it is expected to be better to include (a limited number of) non-aligned objects in the FLACS geometry. GexCon answered that more testing is needed for better guidance on this.

**Interface between FLACS and LS-DYNA for nonlinear structural consequence analysis**

Jeom Kee Paik and Sang Jin Kim (Pusan National University) presented an interface (tool) between FLACS and LS-DYNA for nonlinear structural consequence analysis. Details on how to map from FLACS result data to input data when running LS-DYNA (finite element program), were presented.

**FLACS as a tool for a vented deflagration with and without obstacles**
Elena Vyazmina (Air Liquide CRCD) presented a study on FLACS as a tool for a vented deflagration with and without obstacles. In some cases FLACS overestimates significantly the experimentally observed overpressure for hydrogen explosions. Olav R. Hansen (GexCon) suggested considering the possibility to rerun the FLACS simulations employing the same sub-grid turbulence model that was presented by Vagesh D. Narasimhamurthy (GexCon).

**The effect of air entrainment on gas releases; a comparative study between FLACS and KFX**
Joar Dalheim (Scandpower) gave a presentation on the effect of air entrainment on gas releases including a comparative study between FLACS and KFX. The difference in observed results between the two tools is relatively small for unobstructed jets, a significant difference is observed for obstructed jets. A question was raised whether comparison with experiments had been performed. Joar Dalheim (Scandpower) answered that it had been decided to just compare the two tools FLACS and KFX (i.e. no focus on experiments).

**Differences observed when modelling an atmospheric dispersion with non-collinear and collinear wind direction and leak direction**
Marion Torre (Total) gave a presentation on differences observed when modelling an atmospheric dispersion with non-collinear and collinear wind direction and leak direction. Some differences are seen when comparing simulation results and experimental results. The study is still on-going.

**Explosion Risk Analysis of Large Floaters**
Pedro Araujo (DNV) gave a presentation on Explosion Risk Analysis of Large Floaters. When modeling pool dispersion using CFD (FLACS), a dynamic pool spread model is found to be better suited than a static model.

**Explosion Risk Analysis based on experience databases from Computational Fluid Dynamics results**
Jens Garstad (DNV) gave a presentation on explosion risk analysis based on experience databases from Computational Fluid Dynamics results. A simplified Explosion Risk Analysis (ERA) method has been developed for calculating the explosion pressure exceedance curve and dimensioning explosion loads for congested and confined areas of the geometry.

**Minimizing Explosion Overpressures Through the Use of Safety Gaps**
Alex Bond (ARCADIS Vectra) gave a presentation on minimizing explosion overpressures through the use of safety gaps. No evidence was found that increasing safety gap width within economic range reduces overpressure (without invoking probabilistic arguments).

**Risk-based explosion integrity study**
Lin Hong, Scandpower gave a presentation on risk-based explosion integrity study. Advantages of using FLACS results as part of probabilistic structural explosion integrity analysis, were emphasized. Non-linear dynamic structural analysis can be performed using probabilistic explosion loads (employing pressure versus time curves from FLACS).

**Using FLACS for onshore siting studies**
Scott Davis (GexCon US) gave a presentation about using FLACS for onshore siting studies.
Using FLACS for onshore siting studies. The Homogeneous Equilibrium Model (HEM) for two-phase releases, has been applied (confer presentation by Mathieu Ichard described above). An important aspect is to identify the realistic worst case based on knowledge of provided release scenarios. A FLUG wish here is to have feet cube easily available in FLACS (in addition to m^3 based on SI units) when volume of cloud is quantified.

**DDT Onset Parameter Examination (II) for Unconfined VCEs**
Jihui Geng (Baker Risk) gave a presentation on DDT onset parameter examination for unconfined VCEs. Results using BakerRisk's DDT onset criteria, were presented. A special FLACS version has been developed by GexCon looking at the maximum dP/dt (but no mechanism for DDT is modeled in

this special version of the flacs simulator). Some difference is seen between the approach adopted by BakerRisk and the approach adopted by GexCon (this can be investigated further in the future).

**Development of Geometry Models for Explosion Pressure Analysis and Sensitivity of Results to Completeness**

Bob Brewerton (GexCon/Natabelle) gave a presentation on development of geometry models for explosion pressure analysis and sensitivity of results to completeness. The importance of implementing anticipated congestion into the geometrical model in the design phase, was emphasized. Different congestion parameters were discussed (total length of obstacles came out best). Large module study shows that explosion overpressures are very sensitive to congestion level.

**FLUG wishes**

Ole Jacob Taraldset (GexCon) gave a presentation on handling of FLUG wishes. GexCon is working continuously on the FLUG wish issues. A large number of FLUG wishes will be met and implemented as part of large development projects, including those for FLACS 3, Flowvis 5, and CASD 7. A list of completed FLUG wishes (to be released), were presented. And status for on-going work on some FLUG wishes, was presented. A question was raised whether FLACS in the future will allow more monitor points at a time than the limit today. GexCon answered that FLACS 3 is planned to have dynamic memory allocation, allowing for more monitor points defined at a time. Two new FLUG wishes were communicated during this session: A wish to more easily define wanted output and extract data for mass/volume of fuel-air cloud with concentration above LFL. A wish that the cn-file (time dependent CFL file) in FLACS is read each time step, so that the FLACS user may change CFLC and CFLV numbers while the simulation is running.

**Formal issues - Closing**

The next FLUG meeting is planned to be held in Pau, France hosted by Total (R&D center of Total). It is planned to have the next FLUG meeting in the period around last part of October - first part of November 2012 (dates later determined as 30-31 October). GexCon will inform the FLUG member when fixed dates are known. The chair Chris Savvides (BP) thanked the participants for all contributions (during presentations and in discussions) and closed the meeting.