# MINUTES OF MEETING

## FLACS USER GROUP (FLUG)



**Venue:** London, England, hosted by DNV
**Meeting:** 8-9 November 2011
**Issued:** 6 December 2011
**Prepared by:** Djurre Siccama, Idar Storvik
**Checked by:** Trygve Skjold
**Approved by:** Prankul Middha
**Distribution:** FLUG mailing list

**List of Participants:**

**External Participants**

| First Name | Last Name | Company | Country |
|---|---|---|---|
| Steve | Howell | Abercus Limited | United Kingdom |
| Paul | van Rossum | Arcadis Vectra | The Netherlands |
| Daniel | Mahoney | Atkins | United Kingdom |
| Robert | Melville | Atkins | United Kingdom |
| Patricia | Pino | Atkins | United Kingdom |
| Kristopher | Saunders | Atkins | United Kingdom |
| Alexandre | Lebas | BMT | United Kingdom |
| Johnathan | Green | BMT | United Kingdom |
| Rohan | Samaraweera | BMT | United Kingdom |
| Craig | Pregnalato | BMT | Australia |
| Vincent | Tam | BP | United Kingdom |
| Savio | Vianna | DNV | United Kingdom |
| Paula | Lote | DNV | United Kingdom |
| Benjamin Choon Kiat | Wong | DSO National Laboratories | Singapore |
| Parag | Gupte | ExxonMobil | USA |
| André | Carrau | FASIS SAS | FRANCE |
| Baptiste | Géniaut | GDF SUEZ | France |
| Chris | Mumby | GL Noble Denton | UK |
| Matthew | Ivings | HSL | United Kingdom |
| James | Hoyes | HSL | United Kingdom |
| Rémy | Bouet | INERIS | France |
| Clement | LAPIERRE | IRSN | France |
| Espargilliere | Julien | IRSN | France |
| Jennifer | Wen | Kingston University | United Kingdom |
| Tim | Jones | MMI Engineering | United Kingdom |
| Phillipe | Rogez | Rhodia | France |
| Olga Merete | Wiggen | Safetec Nordic | Norway |
| Ranveig | Niemi | Safetec Nordic | Norway |

| First Name | Last Name | Company | Country |
|---|---|---|---|
| Stefano | Chiaraviglio | Saipem | Italy |
| Joar | Dalheim | Scandpower | Norway |
| Øystein | Spangelo | Scandpower | Norway |
| Alexandre | Brigadeau | Scandpower | Norway |
| Ole Kristian | Sommersel | Statoil | Norway |
| Jerome | Hocquet | Technip | France |
| Henri | Tonda | Total (France+Norway) | France |
| Marion | Torre | Total (France+Norway) | France |
| Rune | Teigland | Total (France+Norway) | Norway |
| Francesco | Chille' | ZCStudio | Italy |

**GexCon/Internal participants**

| First Name | Last Name | Company | Country |
|---|---|---|---|
| Are | Bratteteig | GexCon | Norway |
| Olav R. | Hansen | GexCon | Norway |
| Trygve | Skjold | GexCon | Norway |
| Erik | Aadland | GexCon | Norway |
| Are | Bratteteig | GexCon | Norway |
| Idar | Storvik | GexCon | Norway |
| Ole Jacob | Taraldset | GexCon | Norway |
| Djurre | Siccama | GexCon | Norway |

# FLUG meeting 8-9 November 2011

**FLUG Chairman:** Previous chair Jérôme Taveau has left IRSN (on leave to US, BakerRisk). A new chairman would be elected on the second day, Erik Aadland (GexCon) would lead the FLUG meeting this time.

**Welcome to FLUG**
Erik Aadland (GexCon) welcomed the participants to London and the FLUG meeting on behalf of GexCon.

Information about particular arrangements was given:
1) User presentations during the first day would be recorded on video.
2) The formal aspects of the FLUG meeting would be covered next day.
3) Election of a new FLUG chairman was scheduled for the next day, and Chris Savvides (BP) had agreed to be a candidate.

Editor's comment: Copies of (most of) the presentations shown during the meeting can be found at the FLUG web site (login link at http://www.gexcon.com/FLUGmembers). Links to the videos of the presentations recorded the first day have are also on the FLUG web site and on YouTube (http://www.youtube.com/user/FLACScfd). As all the presentations of the first day (including discussions have been integrally recorded), the minutes will be kept relatively concise.

**Welcome to DNV**
Frank Ketelaars (DNV) welcomed the participants to DNV-London on behalf of DNV.

He briefly talked about the usefulness and application of CFD in safety/risk analyses.

Information about escape routes was given (no planned fire alarm drills were planned that day).

**FLUG, user presentations – Tuesday 8 November:**

**FLACS-Dispersion: better, faster and more versatile**
Olav R. Hansen (GexCon).

- History of FLACS dispersion
- Validation benchmarks, large scale and small scale
- Safety studies
- LNG Model Evaluation Protocol
- "There can be only one" : FLACS
- Integral models versus CFD, i.e. 2D versus 3D : "the world is not flat"
- Flashing releases

Q&A + comments and wishes:

- Inclined leaks, are there any new guidelines?
- Can you achieve the same results by following the guidelines in the manual?
- Are the NFPA tests available?
- Where do we see potential for improvement in FLACS?
- Local grid refinement?
- Parallel version performance? Scale-up in the range N/2 to N for N processors.
- Validity of FLACS for different application areas? Need to understand the limitations.
- Air entrainment model could make FLACS more user-friendly.

**Integrating blast analysis into structural design**
Tim Jones (MMI Engineering).

- Explosion loads from FLACS into FEM model (SACS)
- Various ignition points lead to various explosion loads
- Transforming pressure-time curve into five-point simplified load

Q&A + comments and wishes:

**Evaluation of dispersion and source term models for LNG spills**
Matthew Ivings (HSL).

- Defining statistical variables for meeting criteria
- Integral models used by HSE: DRIFT, CRUNCH

**Transient gas dispersion simulations in confined modules**
Joar Dalheim (Scandpower).

- Presentation on challenges associated with calculating explosion risk in confined modules in arctic regions.

Q&A + comments and wishes:

- Need for efficient FLACS for dispersion:
  - non-compressible flow solver
  - parallelized FLACS version
- Accuracy of turbulent mixing in FLACS depends on turbulence model (*k-e*ps)
- Mitigation measures? Purging with $CO_2$, $N_2$ or $H_2O$?

**Equivalent gas clouds – Motivation, guidance and experiences**
Olav R. Hansen (GexCon).

- Describing the "equivalent cloud" concept using Q5 or Q9

- Definition of Q5 and Q9:
  - X(i) = fuel volume fraction for control volume (i)
  - S(i) = laminar burning velocity for CV(i), Smax = maxval(S)
  - E(i) = expansion ratio for CV(i), Emax = maxval(E)
  - SE(i) = S(i)*E(i), SEmax = maxval(SE)
  - Q5 = sum( X(i) * S(i)/Smax * E(i)/Emax )
  - Q9 = sum( X(i) * SE(i)/SEmax )

Q&A + comments and wishes:

- Vincent Tam: GexCon uses "Olav magic" on the numbers
- BP does not use Q5 or Q9 (Vincent)
- GexCon (Olav Hansen) requested that Vincent Tam should send the BP simulations that show Q9 discrepancy so they can be compared to the GexCon results

**Modelling an explosion in a LPG bottles storage with FLACS**
André Carrau (FASIS SAS).

- RIGOS experiments by TNO, small scale
- Two congested sections with given separation gap: donor and acceptor
- Donor is generally well simulated, the acceptor shows too high pressures

Q&A + comments and wishes:

- Can the same effect appear for real scale onshore geometries, e.g. Mongstad?
- Olga Merete Wiggen (Safetec) wanted more information about this. (GexCon currently investigating this)
- Øystein Spangelo (Scandpower) expressed his concerns about safety Gap modelling in FLACS and requested GexCon R&D to address this issue. GexCon confirmed they recognize the importance of addressing this issue and GexCon will investigate and give feedback to FLUG.

**A comparative study between constant and dynamic pool dispersion modelling**
Savio Vianna (DNV).

- Using diffuse leaks and pool spread model in FLACS
- The geometry in these simulation cases was an FPSO

Q&A + comments and wishes:

- Is there a plan for Rapid Phase Transition (RPT) modelling in FLACS?
- Solar radiation was set to1000 W/m$^2$, should perhaps be reduced due to obstacles shadowing.

**Natural ventilation assessment – A case study**
Alexandre Lebas (BMT).

- Using CFX / FLUENT
- Average Age of Air (AAA): simulating 1 extra scalar
- Air Changes per Hour (ACH) = 3600/AAA
- Annual Ventilation Exceedance
- Local or global approach: pros and cons
- Wind tunnel validation
- Comparing CFX, FLACS and wind tunnel data

Q&A + comments and wishes:

**Turbulence rules – Dispersion above sea from subsea release**
Asmund Huser (DNV).

- Atmospheric boundary layers and buoyant plumes
- Turbulence dominates the mixing
- KFX and FLACS has different formulations for the buoyancy term in the epsilon-equation
- A constant in the epsilon-equation, Ce3, may be used to modify the buoyancy term
- Possible to set Ce3 so that KFX and FLACS shows good agreement
- Using the Briggs' formula as reference to compare KFX and FLACS: buoyancy factor range 1.0 to 3.0? KFX was close to the 1.6 curve, FLACS was closer to the 1.0 curve

Editor's comment: see
http://en.wikipedia.org/wiki/Atmospheric_dispersion_modeling#The_Briggs_plume_rise_equations

Q&A + comments and wishes:

- FLACS shows good agreement with hydrogen (HYSAFE) experiments (ref. Olav), should not change Ce3 in FLACS.
- Not easy to find a single fixed value for Ce3 that gives good results for all types of flows.
- Which Pasquill class was used in the simulations (neutral or stable?).
- Reynolds-stress models may be better suited to preserve the k-epsilon profiles downstream of the inflow boundary.

**On-going research activities**
Trygve Skjold (GexCon R&D) presented plans and prospects for the R&D department.

- Presentation on various R&D projects and plans within GexCon

**Vinopolis wine tour**
At the end of the first day a wine tour was organised at Vinopolis.

**Dinner in the Cantina Restaurant**
The FLUG dinner was organized at the Cantina restaurant in London. Approximately 50 people attended the dinner.

## FLUG Meeting – Wednesday 9 November:

**Election of new FLUG chair**
Erik Aadland (GexCon) organized the election. There was only a single candidate.
We are pleased to announce that Chris Savvides (BP) was elected as the new FLUG chairman (not present at the meeting). In Chris's absence, the meeting was chaired by Erik Aadland (GexCon).

**Adoption of agenda**
No comments on the agenda

**Minutes from the previous FLUG meeting**
There were no comments to the minutes from the previous FLUG meeting in Bergen 11-12 May 2011.

**FLACS Maintenance**

Ole Jacob Taraldset (GexCon) gave a presentation related to FLACS Maintenance.

- On-going activities and upcoming bug fix release
- Bug fix release: FLACS v9.1 release 4 (Release date 16 December 2011)
    - No or only minor changes in simulator

    Selection of changes:
    - In CASD
        - Don't ask for save & exit when object is not changed
        - Automatically add UNIONs as needed
        - Delete button on keyboard also works in database dialog

        - Load filter also for co-files
        - Load filter «size» (largest size of bounding box)
        - Easier to select snap points
    - In Flowvis
        - Memory handling has been improved
    - Flacs simulator and utilities
        - 64 bit simulator are included in package (for large simulations)
        - Windows cofile and Linux GM crashing issue resolved

- Future FLACS releases
    - Aim to have 2 release in 2012, slowly increasing to 4 releases annually in the future
    - Investigation automatic upgrades
    - Major release in summer, other releases bug fixes
    - Currently doing a complete rewrite of Flowvis and Geo2Flacs

- Next Major FLACS release 6 June 2012
    - New scenario menu
    - Wizard to help scenario setup
    - Better graphics engine (CASD)
    - Major rewrite of geo2flacs
    - Technology preview of new Flowvis
    - 64 bit and 32 bit versions (Linux and Windows)
    - Plugin architecture in CASD
    - Native support for terrain formats (dem, gws, ArcGIS)
    - Older Linux distributions will not be supported (RedHat EL 4.x, openSuse 10.x, Fedora < 11, Debian 4)
    - Python scripting for “all” features in CASD
    - Include wizards for quickly setting up common simulations types
    - And much more…

- FLUGwishes
    - Presentation on progress on list of FLUG wishes
- Discussion

Q&A + comments and wishes:

- Want to have axis/ruler (measurement tool) in Casd.
- Ability to plot data from multiple folders in same presentation in new Flowvis.
- Want to have a complete list of short-cut keys in Casd.
- Ability to change position of object instances / assemblies in the database dialog in Casd.
- Want cofile output in CASD (Ø. Spangelo might send more information to GexCon on this).
- Ability group select of primitives in Casd.
- Want guidelines for using artificial congestion.
- Different jet leak representation in KFX and FLACS. KFX uses a model for air entrainment and seems to have higher values for the momentum than FLACS (J. Dalheim might send more information on this to GexCon).
- Ability to change Ce3 in standard version of FLACS.
- Want area leak functionality in standard version of FLACS.
- Want test cases to validate Ce3 settings.
- Want transparency in Casd.
- Ability to run Porcalc in batch on non-GUI machines, must remove bindings to GUI-libs.
- Can geo2flacs import a given set of “levels” defined in the dgn-file?
- Want separate cut levels for results and geometry in Flowvis.
- When will FLACS-Fire be available?
- When will FLACS-Turbo be available, and how much will it cost?

**Turbulence rules – Modelling of anticipated small pieces factor**

Asmund Huser (DNV).

- DNV presented summary of their analysis of congestion factors in a selection (representative) DNV project geometries
- DNV recommends to stick with L(ength)/V(olume) rather than A(rea)/V to quantify congestion
- Used to classify "completeness" of the geometry model

Q&A + comments and wishes:
A/V may be better suited to classify "congestion density" of "guessed explosion load".

**CFD in the French context. Status and looking ahead**
Rémy Bouet (INERIS).

- French environmental ministry concluded that there is a huge divergence in safety distances (especially between CFD and integral models)
- Consistent PPRT (Plan de Prevention des Risques Technologiques) approach needed for whole op France, which is easily understood by general public.
- Therefore method needed for determining realistic distances without unrealistic costs
- Until the above issues have been resolved, there is a temporary moratorium on using CFD for PPRT studies in France
- Ineris have carried out a benchmark study to evaluate inter user differences in results of CFD atmospheric modelling with goal to determine and set up a best practice for this type of modelling
- Creation of a new Working Group to determine guidelines for CFD explosion modelling
    - First meeting planned in 2012

**Lunch**

**GexCon R&D**
Trygve Skjold (GexCon R&D).

- Future prospects and opportunities
    - Modular design
    - Looking into combining with focus on structural integrity
    - QA and methodology
    - Fire modelling
    - QRA methodology (and/or setting up many simulations automatically)
- JIP work
    - Validation work and catalogue
    - Performance (parallel + non–compressible version)
    - Static embedded grid
- Future JIP work
    - Further advancement in parallelisation
    - GPU computing?
    - Adaptive grid refinement
- NORCESS
    - Wind park modelling with special version of FLACS
- Discussion

**Unconfined gas explosion simulation** (This presentation was postponed to a future FLUG meeting)
Clément Lapierre (IRSN).

**Differences in airflow using FLACS v.9.0 and v.9.1 (Solver 2.2.7 and 2.2.8)**
Ranveig Niemi (Safetec Nordic AS).

- FLACS v9.1 gives lower ventilation (in ACPH) than v9.0
- Problem relates to the wind profile definition

Q&A + comments and wishes:

- Differences in ventilation rates likely a result of the more accurate wind boundary definition in v9.1+ version of FLACS
- It was commented that these types of changes and their possible impact on existing results should be better communicated and documented.
- Editor's comment: A technical note describing the differences might be distributed.

**LNG spreading and vaporization modelling, comparing FLACS with KFX-LNG and PHAST**
Marion Torre (TOTAL E&P NORGE AS).

- Two different ground temperatures not possible
- Good validation results on water surface
- Comparison PHAST/FLACS/KFX-LNG: Importance of source term

Q&A + comments and wishes:
Want to have 2 (or more) different ground temperatures for different parts of the pool ground.
Olav Hansen: You can simulate sloping pool ground

**Coffee and refreshments**

**US Approval of FLACS for LNG modelling, under U.S. Federal Regulations**
Djurre Siccama (GexCon).

**FLACS-Dispersion with incompressible solver**
Are Bratteteig (GexCon).

- Speedup factors of 5-10 when using the non-compressible flow solver in FLACS
- Speedup factors of 2-3 on 4 cores with the parallelized version of FLACS
- The deviation from normal (compressible solver) FLACS results is very small

**Summing up**
Erik Aadland (GexCon) (new chairman not present).

- Next meeting
- Discussion

**Next meeting**
Dates for the next FLUG meeting are tentatively set to 15-16 May 2012. The meeting is planned to be in Bergen and GexCon is expected to host the meeting.

**Discussion / AOB**
None of the participants brought forward any additional issues.

**End of meeting**
The speakers and the participants were thanked for joining the FLUG meeting, and the meeting was closed.