

Environmentally Friendly Drilling European Workshop

held at the

GE Oil & Gas – Florence Learning Center
23rd September 2010



www.efdsystems.org

Minutes of Meeting

Introduction

Dr. Richard Haut, manager of the EFD Systems program and senior research scientist at the Houston Advanced Research Center (HARC), gave the welcome and EFD Project overview. Rich indicated that the purpose of the RPSEA sponsored program was toward “integrating advanced technologies into systems that significantly reduce the impact of petroleum drilling and production in environmentally sensitive areas.

He made early introductions of the key speakers to the participants of the workshop, including Steve Beach of RPSEA, Mike Killalea of the IADC, David Burnett, Director of Technology of the Global Petroleum Research Institute at Texas A&M University, Eric Quinlan of Huisman, Gerhard Thonhauser, Manager of EFD-Europe and Chair of Drilling and Completion Engineering at the University of Leoben, Tom Geehan of MI/SWACO, Volker Artel of Siemens, Trevor Smith of the Gas Technology Institute (GTI), Jim Slutz ,Formerly of the U.S. Dept. of Energy and now with Global Energy Strategy and CAPP, and lastly Lori Wrotenbery, Director Oklahoma Corporation Commission, Oil & Gas Division.

The EFD Program in the United States and the Link to Europe

Haut informed that the EFD EU Initiative is to identify and transfer innovation and cost effective best practices in the US and Europe, citing that this meeting is expected to help identify technology transfer opportunities. He acknowledged that regulatory requirements in the EU have prompted innovation and that the EFD was seeking to identify applicable and cost effective practices in both the US and Europe and that a goal of the EFD was also to provide feedback to regulators relative to those requirements that have not worked well. Since the RPSEA sponsored program began, the EFD has been working to join operators, service contractors, equipment manufacturers, and major university and research laboratories to devise innovative methods to reduce the environmental footprint of horizontal or directional wells from a single pad using smaller and lighter rigs, well site and road construction using low-impact technologies, small-hole coiled tubing drilling, “green” completions in shale gas plays, centralized hydraulic fracturing locations, and recycling flow-back water from large frac jobs. Haut then showed a slide of the Jonah gas field (near Pinedale, Wyo.) showing single well pads marking the high sage brush valley off into the sunset, criss-crossed with lease roads. He then contrasted that with a picture of a Williams location in the Piceance basin which showed one well near the Colorado River, on which nine other wells already existed, demonstrating the industry’s current ability to

drill multiple wells from one single well pad. Haut then reminded all of what the key components of EFD are:

- What gets measured gets done
- What gets identified gets dealt with; and
- What gets inspected, gets respected.

The Role of RPSEA as a platform to sponsor R&D Work in the United States

RPSEA's Steve Beach then took the podium and explained the RPSEA history, being a unique 501 (c)3, non-profit entity, having formed a constituency which consists mostly of North American O&G producers, as well as other multinational companies, (such as Siemens, who just joined) with a significant representation of world renown Universities known for their energy expertise, as well as a significant number of national laboratories. He went on to describe how they now have selected over 100 projects to fund. Steve went on to describe how they receive \$50 MM per year of funding to distribute over the 10 year commissioned life of the non-profit research administrative entity, and how they review the projects funded (by the Department of Energy) and how they design each subsequent year's solicitation so as to focus on areas of perceived need.

Each year they distribute the funds among 3 different research areas, with typically \$37.5 MM going to onshore Unconventional Gas research projects, \$15.5 MM going to Ultra-Deep Offshore research, and \$3.75MM to the Small Producer program. RPSEA employs a limited staff, and relies heavily on volunteers to man the technical Program Advisory Committees (PAC's) who do a lot of the project reviews and selections of final recipients. Additional detail was given relative to the 2007-09 Unconventional Gas solicitations, wherein 162 proposals were received, of which 39 were selected for funding. In the same time period, 19 projects were selected for the Small producers and 41 for the Ultra-Deep water, for a total of 99 projects. Steve went on to inform the audience that by law, all the Principle Investigators receiving DOE research funding must be resident of the United States, adding that the same restriction did not apply to sub-contractors, who could be multi-national and were often European. In answer to a question about Intellectual Property resulting from funded research, Mr. Beach informed that it was up to the PI to arrange for the protection of any developed Intellectual Property, as neither the Federal Government nor RPSEA have any interest in securing or owning such property. A Frenchman in the audience informed the group that a similar entity called Demo 2000 in Europe, though funded to a lesser level than RPSEA.

IADC's Activities in HSE

Mike Killalea of the IADC took to the podium next. He advised that their mission was to Advance the Drilling, business, disseminate Health, Safety and Environmental training and to help educate participating companies as to the implications of new rules and regulations. Mike then advised the group as to the many and various meetings which the IADC was soon going to participate and gave a website (www.IADC.org) where additional information could be obtained.

EFD University Research Programs Examples from the United States

David Burnett then took the stage and discussed some programs developed at Texas A & M University which would point to ways to optimize the environmentally friendliness of a given location, be it for a well or other production battery or facility, and actually generate a detailed AFE for the associated work. He advised that the program was currently being commercialized by a consultant. This opened the opportunity to point out the Intellectual Property generated by RPSEA sponsored project was to be secured by the Principal Investigators of the individual projects and not the object of ownership by either RPSEA or the Federal Government. Other research being conducted at the University of Arkansas to generate programs to assist customers in picking optimized drilling or facility locations considering all factors and guidance available from regulatory authorities relative to construction requirements and consideration was also gathered under the direction of the EFD in order to assist in the technology transfer and commercialization of the site selection and design software.

He also stressed the safety culture issues being currently addressed and a related need to initiate and publish an ecological sequel to the culture changing book "Safety 24/7" Building An Incident-Free Culture, by Gregory Anderson & Robert Lorber. EFD management has been seeking funding for this new initiative,

Gene Theodori of Sam Houston State University then took the floor and addressed some societal issues, especially those contrary to drilling and development in the Western U.S., and special challenges posed by developers attempting to secure rights to develop public lands, and those on Tribal or Indian Reservations, citing that good communication and dialog with all the local stake holders was key to success. He also cited cases in the Eastern US where this bore fruit in addressing concerns about hydraulic fracturing there. He also pointed out that this was a good way to educate others to dispel misconceptions about the danger of hydraulic fracturing.

Disappearing Roads

Dave Burnett then took the floor to discuss advances in the "Disappearing Road Project" and student competition and he showed slides of various versions of the same that had been developed and were beginning to be accepted and used by the industry. He also addressed water treatment and disposal issues facing the industry with hydraulic fracturing jobs now commonly growing in size to the 10 to 13 million gallon ranges. He also cited the legal challenges being posed by such requirements and methods developed to meet those. He then discussed how meeting these challenges in an environmentally friendly way has led to the development of "Best Management Practices" which are being detailed and disseminated to the industry (see www.oilandgasbmps.org).

EFD Scorecard

Next was discussed the various ecosystems throughout the US and how the EFD Scorecard was developed, so that pre-and post-drilling conditions could be measured and compared and the developmental tradeoffs thereby quantified. Other areas of activity were discussed, including outreach activities which included a number of publications in various trade journals and magazines, including the most recent in Harts Daily E&P Journal, World Oil, and noted the US DOE published a feature article last fall on the EFD Program . Next was shown a virtual rig tour, with visions for the future when one could log on and erase the pits, then shorten the derrick, (like the LOC 400 derrick) then erase the access lease road, etc. to show visually what an environmentally modified drilling rig and operation would look like.

They then made a pitch relative to the benefits of sponsorship of the EFD project. The mission of transforming Basic Research to Commercialization and Science to Policy was stated.

Rich Haut goes to Washington, D.C. soon for hydraulic fracturing consulting. Also discussed was the contradiction of the movie Gas Land, which was described as a phony documentary. Several sessions were reported that directly debunked the movie on a detailed basis. The director of the film, Josh Fox, claimed to be from rural Pennsylvania, actually grew up in New York City, and only occasionally visited his parents vacation home in Pennsylvania. Some discussion ensued about possibly changing the focus of the mission statement so that it does not appear like we are merely talking to ourselves, but rather focus on a different audience. The suggestion was to place more emphasis on environmental issues and less focus on petroleum, drilling and production. Some in the audience suggested that what the opposition wanted to do was to stop any and all development.

General Electric's Oil and Gas Business

Next came an executive of GE, Gabriele Peri, who welcomed us and began with an interesting story of how in 1994, GE got into the Oil and Gas power business by way of their purchase of Nuovo Pignone, and how with the extra financial strength and discipline that GE brought, they grew the company from a \$1.3 billion company to an \$8.3 billion company, and informing how they started on surface facilities and compression and now they are working on designing and developing subsea compression facilities and BOP's, etc. He then cited the large number of compression projects that they would be soon pursuing throughout the world including a large CO2 sequestration plant in (Gorgon) Australia. He also informed of the large testing facility about 100 km. from Florence at Mazza where they could test turbines under full load until failure. He showed a slide which indicated that since their entry into the O&G business that their investments into R&D went from \$211 MM in 2003-05 to \$311MM in '06-'08, and will be \$500+MM in '09-'11. He also showed how despite downturns in the Oil and Gas sector, they have continued to "invest through the cycle". He also informed of the creation of a 6 mo. Oil and Gas University at GE to re-tread their personnel for this business.

Eagle Ford Shale – water issues

Next, Dave Burnett of the Texas A & M University took the floor to discuss the size and scale of typical South Texas operations, especially with respect to the size of the scheduled developments for wells and infrastructure there. Major issues there include land use and protection of limited water resources. He ran down the size of operations anticipated by the big players including EOG, who have estimated potential reserves of 900 MMBO under their leasehold (in the newest Eagle Ford shale play), one of the largest players in the region with 90 rigs running. He reported that among those is Pioneer with 2 wells drilled and 1 rig running. Land use agreements now number over 100 pages. He indicated though that current practices typically have only 1 well per pad. Other environmental issues being debated include emissions which might affect air quality, and post-flowback and processing of brines. He then projected the use of series of successive filtration processes to pre-treat water prior to de-salinization efforts currently being tested in a 28 foot water treatment trailer prior to disposal. Currently the pilot project can treat 2-5 gpm.

Case Studies

Environmental Friendly Rig

Next, Eric Quinlan discussed the LOC 400 rig used to drill Geothermal wells in a pad located in a residential area in the Hague, Netherlands. The production of the geothermal energy from the two wells whose bottom-hole locations are 2000 meters apart, will generate heat for residential use that will produce 70% less CO₂ than normal conventional methods. A number of innovative features relative to the new drilling rig were discussed as well as the details of the well planning management. Noise emissions were discussed including the fact that power for the rig was taken off the existing grid under restrictions that the power load was not to interfere with the hospital located next door. Move in and rig up was also organized so that access to that hospital were assured to never be blocked by trucks. The rig was set to be drilled with an noise shrouded electric top drive with a super-single derrick that drilled with 45' joints of drill pipe. The projected TD for the wells was 2600' and the drilling mud used was mixed with rainwater accumulated before spudding in the wells. A wall of international cargo containers was built between the rig and the adjacent apartment buildings and the rig was manned by 5 people, 3 operators and 2 roustabouts.

Many features of the rig and surrounding sound attenuating construction of the periphery (consisting partly of stacked sea-going containers and sound absorbing panels on the low profile (super single) draw-works, which appeared to travel with the electric top drive. All mud pumps were electric, as well as all other prime movers.

Waste Management Example from Austria

Karin Hofstaetter from the University of Leoben then presented a short talk explaining issues of translating EU law into local law using the example of drilling fluids and waste management, especially the use of Potassium Carbonate mud systems in Austria. The level of total organic carbon (TOC) in drilling waste will be limited by latest EU regulations, in response to that ways have to be found to either avoid, dispose, or reuse drilling waste, namely cuttings. New regulations leave a wide area of possible interpretation and will have to undergo revision or be expanded with a set of best practices to make them workable.

The amount of cuttings generated in Austria was put in context with the available storage facilities, which are limited. This is a common problem in continental Europe as cuttings reinjection is used in very limited ways. Future exploration targets, such as shale gas plays will pose a dramatic challenge under current legal depositions regulations.

Karin pointed out that the focus in an Austria/European context should be the value added reuse of drilling cuttings. Important element there is the avoidance

of the term “waste” as such material should reenter the product life cycle as secondary raw materials.

Example from MI-Swaco

Thomas Geehan of MI/Swaco talked about the “Race to be #2”, that nobody in the oil & gas business wanted to employ new equipment with Serial Number #1. He spoke of new water treatments being discussed at the SPE Water Panel recently in New York, addressing the high salinity brines flowing back after some fracturing in the Barnett, (> 100 K ppm) and in the Marcellus Shales (> 200K ppm) and how pre-treatment of those fluids allow them to remove solids and oil to avoid fouling membranes used to reduce the salinities of those fluids, resulting in recycled fluids of only 50 Kppm. He also discussed how to minimize bacterial growth in water storage areas without the use of toxic chemicals. Also discussed were some recent findings by Teas A & M that indicated that wells should not be turned back on for 2 days, resulting in improved productivity from the wells. Some history of hydraulic fracturing fluids was then given, pointing out that as time went on, additives were reduced from crossed linked guar to foams and finally to slick water.

Example from Siemens

Other issues, beyond drilling, were the topic discussed by Siemens’ Volker Artel, who discussed how to save energy in oil and gas operations. Siemens, according to Artel, employs 460,000 people in 140 countries and focus in Industry, Energy and Health Care. From the industrial side, Drive Technologies, Automation, Communications and Lighting are areas where Siemens is seeking to supply innovations to help reduce energy consumption in oil and gas operations. Artel also revealed that according to Siemens surveys, 15 to 20% is spent on fluid transfer and transport, and as such, focusing on improvements in this area will be likely to yield the greatest breakthroughs in energy savings. Use of variable frequency drive systems in pumps used for fluid transfer is therefore one of the early focuses of the application towards these improvements. Obviously, savings in this area will have positive environmental impact and will result in lower drilling costs. The use of in-line filters will reduce the power factor shift, a negative impact on local power grids that can occur with high use of these variable speed drive controllers.

GTI Presentation

Trevor Smith of Gas Technology Institute (GTI) then gave some history of GTI, how they are a large non-profit research entity, in existence for 65 years, with experience in early tight formation CBM, and other unconventional gas for the last 30 years). He followed with a summary of recent headlines relative to the dramatic increase in gas reserves in the US from prominent sources, such as “a game changer,” & “a gas revolution”, that the increase has resulted in “a paradigm shift” and “the biggest energy innovation of the decade”, noting that currently 46% of the gas reserves in the US comes from unconventional sources, and that (according to the Energy Information Agency) within 10 years, that figure will grow to 50%. Smith posed to question to the largely European audience: “to what extent can the US experience be exported to the rest of Europe and the world? He ran down how this topic fared in the recent International Gas Conference in Amsterdam, attended by 150 delegates from 90 different producing regions and 25 countries.

He also cited other areas where the topic will be highlighted, in upcoming DUG Conferences on the Eagle Ford (in early October) and on the Marcellus (early November) as well as Shanghai, China. Statoil recently estimated the potential in-place resource to be 920 Trillion m³ in Norway, and with a nominal 10% recovery factor, the potential reserves are significant. Aubry McClendon of Chesapeake Energy pointed out at one of these recent conferences that 4 of the 7 largest gas fields in the world have recently been found in the US adding to these large resource additions. He pointed out the challenges facing the industry in the wake of the BP disaster in the Gulf of Mexico, and that our key message must be couched in proactive commitment and local outreach. One of the key criticisms is that our industry has not gone outside with good public outreach with our message very well, though it truly is a great story. Careful project management for drilling and pipeline operations, such as that done in Barnett Shale in the Dallas – Fort Worth area and with the recent drilling in the Hague, Netherlands are stories that should get out there. Water is definitely a key issue in Pennsylvania, Europe and India. For our industry to be most effective in communicating gas issues, we need to be making good societal response to complex issues. We need to spread risk, collect data, make partnerships and transfer learnings. Other things we need are to secure Service Industry support, deal with demand uncertainty and an ever-changing regulatory environment. The benefits in a job well done are job security and a reduced CO2 footprint. US funding would help this along, especially if fiscal terms could be modified to encourage development of the infrastructure to utilize compressed natural gas, as well as other business model alignments, as well as supply and demand incentives to do more technically to reduce costs. He offered that more information was available about these and other relevant topics on the GTI website.

European Outlook

Gerhard Thonhauser (Manager of EFD-Europe and Chair of Drilling and Completion Engineering at the University of Leoben) then took the stage and outlined some of the challenges that may face Europe should they begin to follow the US lead in shale gas development. He cited the US rig count that went from 1800 in 2008 to 800 operating in 2009 (following the economic downturn) and rebounding recently to 1580 as development continues on the major shale plays. He compared those with the fact that there are currently 98 rigs operating in Europe. Based on early assessments, they will need 10000 wells in Poland. Assuming 30 days per well, they will need 100 rigs just to drill the Poland's wells alone over the next 10 years. This he said was a "brilliant opportunity to build up a new rig fleet in Europe with all the new environmental bells and whistles". Considering how we squabble about +/- 500 Euros/day in daily rate negotiations in the range of 10-15K Euros, it seems that the extra financial savings from avoiding environmental entanglements fines and cleanup could well pay dividends.

The Role of Poland as Player in European Shale Gas

Jim Slutz (formerly of the U.S. Dept. of Energy and now with Global Energy Strategy and CAPP) then discussed how Poland has just recently leased up approximately half the country to companies interested in pursuing shale gas development there after passing 4 laws aimed at making such leaseholds available. The average lease is going for 73 Euros per acre, with 3-6 year terms, and a maximum of 1200 sq. km. per lease, but with no restrictions on any company from taking multiple leases. So far, 2 new wells have been drilled in Sweden and Poland with no data yet on the results. He cited some issues with LNG facilities that were built in the US that were not being utilized to import gas supplies that are now not needed as reasons to plan facilities well. Three weeks ago, an export license was signed to export LNG to Mexico. Problems facing the industry include lack of trained people, lack of instructors to educate and train drilling staffs, lack of licensing infrastructure, lack of gas storage systems. In general, the rights to the hydrocarbons belong to the countries. He cited the role of the universities as that of a credible independent messenger to the public. He also cited the role of industry trade associations to operate collectively and help negotiate for and guide the industry, citing the example of Aurellia, a recent Unconventional Gas Operators Association. He also addressed the role of federal regulation and cited one case in Germany where it was mandated that the rig crew speak German, and how this might be an example of a regulation that would not work well for the industry.

Examples from United States Regulators - Oklahoma

Lori Wrotenbery, (Director Oklahoma Corporation Commission, Oil & Gas Division) advised to involve all stakeholders, local, regional federal and environmental to discussions about new drilling programs, citing that in the US, all states are different. Providing a bit of background about the state, she informed that Oklahoma has about 450,000 oil and gas wells, with tens of thousands having been drilled before there were any regulations or regulatory authorities in existence to monitor them. She advised to see the movie "Tulsa" to get a good idea about the history of the early development of the oil and gas industry in that state. She then gave some background about the Oklahoma Energy Resources Board, which subsists upon a small refundable fee charged to current oil & gas operators on production, (noting that most operators do not reclaim the fee) which is used to reclaim some of the pits and other environmental issues caused by the pre-regulatory wells, many of which were improperly plugged prior to the days of regulation. They also do public education via basic petroleum education classes that are taught at schools by volunteers. Still, regulating an industry in a state that has 2,660 active operators, 137,800 active wells 36,000 gas and 83,700 oil) and 10,000 injection wells, with 140 active rigs, is no small task.

When she shows people from back east a map with all these wells on it, they immediately conclude that the state must be an industrial wasteland, but the fact could not be further from the truth. The production of significant hydrocarbons in the state (once a world-leader) has lowered the tax base to the public considerably and as such, the public and the oil and gas industry have learned to peacefully co-exist in an environmentally friendly manner that could be a good example to others that are now considering the impact of significant impending oil and gas development. She closed with the disclosure of several websites that could be useful relative to groundwater protection issues, and to reveal where underground pipelines may be located.

After a break, the agenda had the participants to discuss the goals outlined above.

The Future of EFD Europe

Gerhard Thonhauser was collecting the feedback from the workshop participants to define a list of items of interest and action points which will help grow the EFD program in Europe.

The results of the discussion can be summarized as follows with a number of action points:

Link to Stakeholder Groups

THE EFD Europe needs to establish itself as a link between the different stakeholders. There is a need for an independent and objective body to foster the development toward zero emission exploration and production work. In a first step the EFD Europe will aim at establishing collaboration with other interest groups, examples are

The R&D Community

- GTIs new EU Gas Shale Consortium
- IOGCC International Coordinating Committee
- IADC International Committee
- GASH group with Brian Horsefield at GFZ Potsdam
- University/Academy partnerships in Europe with IFP, Delft, University of Clausthal, Herriot Watt, Imperial College, University of Leoben etc.

The Regulator Community

- The European Commission (Gerhard Thonhauser to meet 18th October)
- Local European Governments
- US Regulators

The Industry Community

- Oil and gas operating companies
- Oil and gas service companies
- Equipment manufacturers
- Chemical manufactures
- Waste management industry

The public

- Non-governmental environmental organizations
- Schools (teachers)
- Universities (non-petroleum related)

Part of this role as a platform could be a network of "EFD Europe Correspondents" with responsibility to keep all EFD members current on developments (technical, environmental, regulatory-societal) using a current web site as information portal.

Have a Mission

EFD Europe can create interest by offering the promise of

- a) energy security and independence, by significantly adding local cleaner energy resources by enabling gas production with minimal environmental impact

- b) employment, by creating a “new” clean E&P business in Europe with up to 100 new rigs and associated services
- c) minimum environment footprint with rigs and hydraulic fracturing units that have least possible visibility and working at highest possible energy efficiency aiming at zero emissions
- d) Be a champion of “Best Practices Technology” based on Score Card principle

The challenge – which at the same time is an opportunity – are

- a) lack of drilling and hydraulic fracturing infrastructure to deploy large scale gas shale developments with a potential of 10,000 or more wells being drilled (currently approx. 800 wells already committed in Poland as part of exploration licensing)
- b) sparse data on gas shale reserves, which will have to be compensated with adequate exploration activities
- c) regulatory framework needed in countries with currently limited exploration activities to perform exploration and to deploy large scale industrialized drilling campaign
- d) capital investment necessary to develop such projects

Generate Visibility for EFD Europe

The EFD Europe program will develop a show case project with the potential to attract attention.

An example could be the development of a highly automated rig with the least possible environmental footprint following the example of the Huisman example project in The Hague.

This initiative will allow promoting the industrialization of drilling operations with elements such as

- Factory drilling
- Streamline regulatory practices
- Promote centralized facilities (drill from pads, self-moving rigs)
- Centralized fracturing, centralized water treatment, services and supplies

The creation of a “World Shale Gas Awards” or “Zero Emission Drilling Award” (a-la World Oil Awards, or X Prize awards) could attract young talent from outside the industry to compete in competitions for best ideas to achieve targets set.

Ideas and Opportunities to Assist Development of the EU-Shale Gas Opportunities

The following ideas were listed as part of the discussion and form corner stones of the action list above:

- Create a regulatory link between regulator in US and in EU
- Utilize the Results of STRONGER (i.e. duplicate STRONGER process in the EU) to create a regulatory template for “fair play” in permitting and regulating EU – Shale Gas
- Create links to aid in transfer of BMPs (example Oklahoma Energy Resources Commission)
- Pass along PA Hydraulic Frac Review report (Sept. issued)
- Emphasize EFD “eco friendly footprint” i.e. water reuse, lower air/acoustic emissions, lower surface footprint
- Use the EFD EU as a link “industry to industry” to aid info and technology transfer between EU and USA
- Investigate the idea of an oil and gas industrial park (zones for E&P services and drilling activity)

Best Technology Highlighted

- Waste elimination –closed loop mud systems
- Treatment and reuse of water thermal and mechanical, absorption
- E&P solid waste management to avoid landfills all combined to aggressively protect surface and water resources