

Complex Well – Core Competency - 2010

(An Asset Team Program, **Not a drilling** course, but an intense cross-training course for drilling supervisors and all asset team members)

BACKGROUND

The core program originated from the DEA 44 Horizontal Well Technology JIP of the late 80's, and has since evolved through constant update and delivery over 200+ times in every major petroleum basin globally, with consistently excellent review. During the 90's it was delivered by Maurer Technology (subsidiary of Noble Drilling) to DEA 44 members and via open-industry commercial staging. In 2000, the program was available exclusively via the Petroskills global training consortium, and was unavailable to any other entities. As of April 2007, the Petroskills relationship terminated, and the course is now available via the AAPG, NExT, Midland College, and other technical training organizations globally. The program is very interactive and flexible, with easy customization to any specific asset or corporate culture setting for in-house staging.

SCHOOL OBJECTIVES

The primary objective of this intense, five-day program is to provide students (operator asset team, D&C operational staff, management & support staff, key service providers and regulators) with an appreciation of the crucial multidiscipline aspect of optimized horizontal and more complex development well applications. The program provides a practical-based “big picture” of all the disciplines, issues, and team functions inherent in basic screening, assessing value-added and implementation; and then addresses the advanced technical options of horizontal well design, construction, intervention and production including multi-branch, MPD (managed pressure drilling), CBM, UTG, SAGD, advanced stimulation/intervention options, etc. In addition, the course will:

- **Review successful and unsuccessful complex well technology applications**
- **Expose common failure reasons and provide practical solutions**
- **Review well design attributes and competing completion options**
- **Foster multidisciplinary approach to horizontal & complex wells**
- **Enhance awareness of advanced exploitation operational risks vs. geological risks**

The program features hands-on training with computer models utilizing actual field data. Class exercises walk through the “decision-making” process from candidate screening through multi-well development and work-over operations. Additionally the school reviews the latest technical developments and novel applications. This multidiscipline program covers:

Horizontal/Complex Well Applications	Completion Technology	Well Design, Multi-branch
Geological Considerations	Production Engineering	Drilling Technology, CT, ERD, MPD
Reservoir Engineering Principles	Field Execution	Field Case Studies
Candidate Screening and Prioritisation	PC Program Examples	Problem Identification and Avoidance

TARGET AUDIENCE

The program, which is continually updated, will benefit managers, geologists, geophysicists, engineers (drilling, completion, production and reservoir internal staff and key service providers), technicians, and others involved with modern exploitation technology applications. Students with no horizontal/complex well experience will get a good feel for the potential of this technology and learn what analytical tools are available to them to screen, design, and implement this exploitation process in an optimal manner. Students with horizontal well experience will broaden their interdisciplinary knowledge and learn some of the latest technical breakthroughs and design options in respect to complex/smart completion technologies, MPD, CT and CBM applications, as well as the latest field experience do's and don'ts.

MISSION STATEMENT

Provide a practical, core-competency cross-training program to help the asset team in optimally applying advanced exploitation technology to make **more oil/gas faster, cheaper, at maximum social benefit.**

Complex Well Core Competency – 10 Key Elements

Some of the elements which make the program a truly unique technical cross-training experience within our global industry are summarized as follows;

A; the course is constantly up-date with relevant real field data and experience, and has unique capability to be customized to the specific asset setting of the local industry. The program's historic track-record is un-matched in the industry, being delivered and constantly evolved over the last 2 decades and 200+ presentations globally, with consistently excellent review.

B; the mandate and focus of the program to effectively deliver all the asset team core competencies utilizing actual field data, supported by daily quizzes, current asset specific field examples, and detailed exploitation project simulations, and the resulting practical tools and methodologies delivered related to optimized complex well asset-specific/site-specific NPV & EUR goals, design, construction and operation.

C; the asset team approach utilized in course format, material and delivery is unique. This program is the only course designed specifically to deal with the reality of asset team dynamics, to expose the numerous miss-conceptions of complex well design and application, and to address the un-avoidable disconnect, which always exists to varying degree, between the various technical disciplines and field operations supervisors. The program dramatically exposes the fundamental need of the team to find the balance between the various discipline-specific wants, the true value-added project site-specific needs, and the realistic capabilities and limitations facing field operations staff related to all aspects of well construction, stimulation, intervention and production.

D; We are constantly striving to ensure that interested parties have the proper anticipation of the program's unique mandate; In that light, below is a recent e-mail from the Husky Drilling Manager in Calgary. We staged an in-house version for 21 Husky asset team and D&C operational professionals earlier this month, with excellent review. After which Mike sent this to his drilling manager counterpart on the East Coast of Canada. This is presented to illustrate a recent "driller's" view of the multi-disciplined cross-training aspect of the course. Typically, the G&G managers and team leaders quickly understand the cross-training necessity, but the D&C and field operational people seem to find it hard to understand that it is not a course on "making hole", but rather "making oil/gas", as the mission statement reads, **Provide a practical, core-competency cross-training program to help the asset team in optimally applying advanced exploitation technology to make more oil/gas faster, cheaper, at maximum social benefit.**

“Last week I participated in a Complex Well Construction school. It was a one week school that Husky organized, involving Drilling, Completions, and various staff members of the business units, reservoir, production, geology, etc. Bob Knoll was the instructor. The course was excellent, and it was highly rated by our folks. I myself enjoyed it, Bob's vast experiences gleaned from his travels around the world were of most interest to me, in terms of the problems and learning's from other operators. I recommend this school for our East Coast offshore development team. Husky Drilling Manager, Calgary, October 2009.

Complex Well – Core Competency 2010

Table of Contents

Chapter 1	Introduction, Objectives, Basic Themes
Chapter 2	World Trends, Typical well profiles, Economic Screening
Chapter 3	Basic Geology, Optional EOR/SAGD*
Chapter 4	Reservoir Considerations
Chapter 5	Drilling Systems, Optional DWC & RST*
Chapter 6	Guidance & Geo-steering Core Competencies
Chapter 7	Torque and Drag, Gravity and Friction
Chapter 8	Re-entry*
Chapter 9	Hole Stability
Chapter 10	Hole Cleaning, Drilling Fluids and Hydraulics
Chapter 11	Well Control*
Chapter 12	MPD*
Chapter 13	Logging and Coring*
Chapter 14	Formation Damage and Mitigation
Chapter 15	Clean-up and Stimulation*
Chapter 16	Completions, Zone Isolation
Chapter 17	Optional UTG & CBM*
Chapter 18	Multi Branch Technology
Chapter 19	Interventions*
Chapter 20	Coil Tubing & CT over Top Drive*
Chapter 21	Production Operations*
Chapter 22	Field Execution, Course Summary

Handout #1	Course Pre quiz (Monday)
Handout #2	Mid-week quiz (Wednesday)
Handout #3	Final Quiz (Friday)
Handout #4	Miss Lime Exercise
Handout #5	Wet Sand Exercises
Handout #6	Course Evaluation

Note: Those chapters, or additional topics, denoted with (*) are optional, and used to customize to local asset setting as all can't be covered in a one week program, the remainder are considered core curriculum and are always delivered.

Agenda-Complex Well Technology – Core Competency 2010

- Day 1 Covers: Introduction, Format, Quiz; Industry Trends, Well Profiles, Candidate Screening, Geology Considerations; Reservoir Engineering Considerations; Simulators and Reservoir Models; Team Exercise.
- Day 2 Covers: Drilling Systems; Guidance, Geo-steering, Wellpath Models; Drill String Torque and Drag Concerns and Models; Extended-Reach Drilling Technology; Re-Entry — Side-Tracking; Rock Mechanics/Borehole Stability; Drill Bits and Coring; Team Exercise.
- Day 3 Covers: Hole Cleaning, ECD Concerns, Hydraulics Models; Well Control Concerns; Underbalanced Drilling & MPD technology; Logging and Perforating; Formation Damage; Team Exercise.
- Day 4 Covers: Completions; Zone Isolation; UTG and CBM, Multi-branch Technology; Workovers; Stimulation Design, Operations, and Concerns; Coiled-tubing Operations; Class Presentation/Team Exercise.
- Day 5 Covers: Artificial Lift Systems and Concerns; Production Operations; Field Execution; Class Presentations, Final Quiz, Review/Critique/Wrap-up.

Standard Schedule runs 8:00 A.M. - 5:00 P.M. daily, with coffee and lunch breaks.
Note: In-house school agenda and schedule can be modified, or extended, to best fit the working schedule of attending staff members.

Complex Well Technology – Core Competency 2010

Course Comments

I thoroughly enjoyed your Complex Well Technology Course I attended in Midland and found it tremendously valuable. Currently, I am a development geologist in the Horn River Team in northeast BC. I am very glad that I was able to attend the course at this time, because it has allowed me to become familiar with all aspects of horizontal well design and has changed my approach to how these wells are drilled, completed and produced, as being truly a multidisciplinary collaborative effort. The most important take away that I had, was how complex and integrated all parts of well design are and that it is erroneous to think that each discipline is only responsible or should only have input, on their given specialty. Serious problems will arise if a program is approached in this way. Truly, complex well planning occurs as team collaboration from day one, and begins by considering "how the last barrel will be produced".

A course like this provides a basis for all disciplines to "get on the same page" and to be able to communicate since many times geologists, engineers, drillers and field consultants do not always speak the same language. I now feel that I am able to understand the concerns that other disciplines have, and how, as a geologist, I can communicate more effectively. Given Encana's resource play model, in which most reservoirs are economically utilized by horizontal well-bores, I feel that this course and the asset-team cross training that it provides, would be extremely useful. Jesse Dean, Encana, Midland Texas, November-08

I want to drop you a note regarding the Complex Well course that I attended in May. I must say it was one of the better courses I have taken in my career. It is not a theory course, but rather a practical instruction based on Bob's extensive experience with leading edge horizontal well technology. I took a number of experience-based recommendations from the course that will be applied in the coming winter-drilling season. I would not only recommend the course to anyone involved with horizontal well applications, but would also suggest the technical people in asset teams that work together take the course together." – Murray Weatherhead – Devon Canada – September, 2008

"Bob: Hope all is well with self, family, and your golf game. I just wanted to give you the credit, after giving you a lot of resistance at your school last year. DOC drilled seven horizontal New Albany Shale wells in SW Indiana, and if you remember, my fear of collapsing shale caused me to run slotted liners. All would have been okay, if the drilling results were also the IP's (100-125' flares while drilling overbalanced, with rotating head and buster), but things went south after leaving them shut in for 12 months while putting in gathering and infrastructure. You told me to pull the liners, remember?

I attempted to run in with a 2 7/8", 8 rd tubing work-string, but couldn't get left hand torque down to the top of the liner to screw into the left hand 4 1/2" XH box x 4 1/2" 8 rd casing pin. The tubing backed off. I then laid down the tubing, picked up a string of 2 7/8" rental string of DP and a casing spear, slicked down the hole, stabbed the hangar and pulled the 4000'+ of 4 1/2" 10.5# casing with 18K# over pull. **Old Bob was right**, you can quote me on that (you said you

would put any money on pulling 9 out of 10). Everyone in Indiana thought I was insane and just wasting money. Thanks for your recommendation; we will be facing the horizontal as soon as equipment and design can be finished.” – Terry J. Cammon, President Diversified Operating Corporation, 303-384-9611, July 2008.

“Thanks for letting us know about the Complex Well Technology-Core Competency '08. I would like to send two other members of my team to attend this unique training - I still consider this course the best ever training in my life and still continue to use almost all of the advices you gave me. In my role as Completions Coordinator and former drilling engineer I came to appreciate more and more all the experience you shared during the class - it has been very valuable and now I have the opportunity to make the difference, I've been able to bring the drilling and completions departments closer and closer especially now that we are in the process of drilling more HZ wells for heavy oil.” – Hector Munoz, Husky Energy, Calgary, 2008.

“I wanted to thank you for extending the invitation to attend the Complex Well Technology Core Competency class you taught through Petris a few weeks ago. Even though I have less than a year of experience under my belt, your class was of great value to me. Much of what you discussed was detailed enough for more seasoned students but still taught so that I could follow along. Also, many points you made were meant to change the way people address horizontal wells; with someone at my experience level, this course has taught me to envision horizontal wells the correct way from the beginning. I would definitely recommend this class to anyone that either is involved directly in working with horizontal wells or to someone that just wants to learn more. Any and all experience levels will take a great deal from this course. Thanks again.” – Matthew Dernick, Weatherford EDI. DwC Engineer, Houston, November, '07.

“My name is Tom Radford and I work for BP. I am currently seconded into Kuwait Oil Company, where I head up the geophysical group for the West Kuwait Field Development team. I have been drilling horizontal well and multi-lateral wells since 1997. I attended Petroskill's Well Planning and Operations, Asset Team Cross-Training class, taught by Bob Knoll, in December of 2005 in London, and was overwhelmed with the course. In the 3 decades that I have worked for Amoco/BP, this is the best course I have attended. This course is at least in an order of magnitude above any other course that I have been on, heard about, or read about. Throughout my career, I have attended industry, internal, and academic courses. Until this course I had yet to find a course where the instructor knew the academic part, had a significant amount of first hand experience, and had been intimately involved with the industry's experience. Bob brings all three of these aspects together. Furthermore, his approach in the classroom makes for an engaged and interactive participating class. Moreover to what Bob brings to the class, the content of the class is absolutely vital and critical to drilling non-vertical wells in our industry today.

This alone would be enough to write this note to you, but there's more. Horizontal drilling is in its infancy, yet everyone in the industry is an expert. However when you question their experience you often find that their stated qualifications is that they possess an OBE “Other Bugger's Effort”. In the oil patch today, there are really only a small handful of professionals that have drilled more than 20 horizontals. But everybody is an expert. The great thing about Bob is that he really is a world-class expert. The Well Planning and Operations, Asset Team Cross-Training (formerly DEA-44) course is different. The examples are first hand. The examples are many and from different basins, continents, drilling practices, the list goes on. After taking the course, either a working professional or a cigar puffing manager can understand the horizontal well from conception to production. Not only will they understand it, but they will have real data examples as their backup for making their decisions.

So far these are only words, but my commitment to this course is so great, that upon my return to Kuwait from taking the course, I initiated and drove the process to bring this course to Kuwait.

As you may be aware, as of this week, Bob is turning 20 more Kuwait professionals from simple vertical well designers to 20 knowledgeable, trained, and confident horizontal drillers.” – Sincerely yours, Tom Radford, West Kuwait Geophysical Group Leader

“I recently attended a week-long course entitled: Exploitation Technology, an Asset Team Cross-Training Program. The course instructor was Bob Knoll, consultant out of Calgary. I would highly recommend this course to anyone involved in planning and executing well plans, completions, and production operations. Bob communicates well his in-depth knowledge of current exploitation technology, including strengths and weaknesses, and how technology is employed on a case by case basis to achieve the desired results. The material is presented utilizing real world examples and multiple "what if" scenarios. Several hands-on exercises reinforce the concepts developed in the class. At the end of the week I had a more thorough and integrated understanding of how and when to use selected technology depending on changing subsurface conditions.

The reason I'm writing you is to give you feedback on this course and to let you know that internally, folks must not be aware of the value of this course. This is a Petroskills-OGCI school, supported by BP, yet I was the only BP person represented. Please forward this note to someone within our technical training staff or possibly HR. Hopefully it will stimulate some interest among engineers and geoscientists in this very practical and worthwhile school”. – BP, Houston, 2004

“I recently attended the Petroskills, LLC sponsored Exploitation 2004: Asset Team Cross Training in Houston, TX, taught by Bob Knoll. The title of the course is somewhat misleading in the fact that the course covers all crucial disciplines of horizontal well applications. This course was formerly known as DEA-44 Horizontal Technology. I highly recommend this course for managers, engineers (drilling, production, reservoir and completion), geologists and geophysicists. I had some experience in onshore horizontal well drilling and production before the course. I was amazed by the multidiscipline techniques this course provided for candidate screening, reservoir considerations, well course design, drilling technology, field execution and production (artificial lift). The most valuable portion of the course for me was "Minimizing Reservoir Damage". The input from those present that work in other parts of the world was also valuable. There were many good case studies provided as well as challenging classroom exercises. The course helped me see how important "big picture" planning is for all members of the asset team. I wish I had attended the course before we drilled our wells and noted many things I will do differently the next time around.” – Amerada Hess-Houston – December 2002.

“My development team recently attended "Exploitation Technology 2003: Asset Team Cross Training" an OGCI/Petroskills sponsored course. This course (formerly known as DEA-44 Horizontal Technology) covers the multi-disciplinary aspects of horizontal well applications, and the related new technology which continues to develop at an increasing rate. I would recommend that those managers, engineers, geologists, geophysicists and commercial analysts interested in broadening or refreshing their knowledge consider this course. The course materials include significant reference lists for topics like candidate screening, reservoir considerations, well course design, drilling technology, field execution and production (artificial lift). It has previously been widely attended by many of EnCana's drilling personnel who can also share their thoughts with you.

Taking my development team on this course also provided an opportunity for team building and sharing thoughts on "big picture" or multi-disciplinary planning. Depending on your team's demographic and skill sets you may find this course of great value in your asset planning discussions. You may also find the input and experience of industry attendees from your region

will help to focus your horizontal well planning and applications.” — Gary Hyde, EnCana — East Coast Development —Jan. 2003

“This is the most value-adding, thought-provoking and change-fostering course I have ever had in 23 years in the O&G industry!” — BP, Houston — August, 2002

“This course is a must for those evaluating the use of horizontal well technology within an asset group. Although there is ample material available from industry and academic sources which address the technical aspects of horizontal well technology, a void exists when searching for good practical knowledge presented in a logical fashion. The course fills this void by presenting practical knowledge of do’s and don’ts, case studies with both technical and operational outcomes, and perhaps, most importantly, a multi-disciplined approach to horizontal well applications.” — D.W. Eubank, Professor, Petroleum & Geological Engineering, University of Oklahoma — December, 2000

“I just wanted to take a moment to pass along a positive recommendation for the asset team school I attended here in Anchorage. The class entitled “DEA-44 Horizontal Technology” was sponsored by Marathon Oil and taught by Bob Knoll of Maurer Technology. The course content is comprehensive and covers a majority of the technical aspect and issues we deal with on a day-to-day basis in a development /resource exploitation environment. Mr. Knoll shares a great breadth and depth of knowledge from his years in the industry. The class materials and exercises are up to date, and have direct application to the business. Perhaps Mr. Knoll's single most important message is to urge asset teams to question all steps in the process of well planning, designing, drilling and completion. While not opposed to the use of technology and the design of "smart wells", Bob continually expressed a fit-for-purpose design to both manage well cost, and allow future well interventions.” — Bob Metzger, BP, Alaska — September, 2000

“This course provided me with new insights that I was able to apply immediately. The class starts with the basics and rapidly progresses to real applications. The logic behind the decisions is presented in a clear and energetic manner. I highly recommend this course to others.” — Don Clarke, Divisional Engineer, City of Long Beach Department of Well Properties — Long Beach, CA — June, 2000

“I attended an earlier version of the DEA-44 program and would highly recommend it to all asset team members.” — Young Kirkwood, Aera Energy, Bakersfield, CA — June, 2000

“Excellent!” — American Association of Petroleum Geologists, Hedburg Symposium — Houston — November, 1999

“Terrific speaker, lots of relative and practical info and advice.” — Houston — 1999

“Most effective course delivery by the speaker I have encountered in 23 years in the oil industry.” — Houston — 1999

“A great course to train all our disciplines to work together, smarter — very informative and entertaining.” — Kuwait —November, 1998

“The examples of mistakes mirror many of our own field experiences. Should have had this program 3 years ago.” — Midland — October, 1998

“A great eye-opener on the do’s and don’ts of multibranch, underbalanced, ERD, etc.” Bogota — September, 1998

“This course was extremely valuable for all our team; now we have a practical methodology to

screen our applications and properly design our wells. This course has resulted in a complete re-thinking of our upcoming exploitation program.” — Bogota — September, 1998

Instructor

Bob Knoll is one of the world’s leading horizontal/complex well experts. He has more than 33 years of uniquely diverse upstream experience, holding senior operational, technical, and managerial positions in oil and gas projects worldwide. As project coordinator of the internationally acclaimed DEA-44 Project (Horizontal Technology JIP), he has acquired unparalleled exposure in applying modern exploitation technologies to real-world problems. Since 1990, he has authored and presented more than 260 technical training and management programs in every major petroleum province in the world, with consistently excellent reviews. When not teaching, Bob keeps directly involved as a contract “Team Leader” in complex well design and construction for Operator’s globally. His multidisciplinary background of drilling, drilling engineering, geology, field operations, and management, accompanied by an entertaining talent for explaining complex issues, provides for a uniquely positive and immediately applicable learning experience.



**R.G. "BOB"
KNOLL**