The SPE Technical Knowledge for Graduating Engineers Matrix

SPE Talent Council
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Introduction

Based on the perception of a need to define specific skills that graduates should possess, the SPE Talent Council conducted a study of university curricula as well as industrial expectations regarding the technical knowledge of recent graduates in petroleum engineering. A matrix of "technical knowledge sets" was created using data from numerous universities, where particular attention was placed on knowledge outcomes. These technical knowledge sets were used to create a survey that was sent to a wide variety of of companies in the E&P sector (integrated oil companies (IOC's), national oil companies, (NOC's), and service/technology providers. Companies were asked to rank each knowledge set as follows:

- "Required" (indispensible),
- "Valued" (desired, but not necessary), or
- "Not required" (not necessary or not applicable).

The long-term objective of the SPE Graduate Technical Knowledge Matrix is that this serves as a *reference* tool for industry, academia, and students. The matrix *is not meant to be definitive* with reference to curriculum criteria, entry-level hiring requirements, or student self-assessment — nor should the matrix is be seen as any component of the accreditation process for assessing university programs in Petroleum Engineering. The matrix as it exists today is simply a mechanism to gather information and to disseminate reference points for the use and benefit of industry, academia, and students.

Definitions

The following defines classification of response in the initial survey and matrix:

- *Required:* The basic knowledge that companies see as a foundation technology knowledge set for newly hired petroleum engineering graduates
- *Valued:* The technical knowledge set that, while not required of new hires, it is none-the-less valued by employers.
- "*Not Required:* The technical knowledge set that is NOT required by industry (or is not applicable) with regard newly hired petroleum engineering graduates.

Development Principles

The matrix was constructed from an exhaustive review of industrial and academic sources, as well as using input from expert-level colleagues in industry. In particular, university curricula and learning outcomes were compiled around the knowledge sets in general engineering and various technical disciplines within petroleum engineering. In addition, targeted personnel in industry were asked to provide technical knowledge sets in their area of expertise which they believe should be required, valued, or not required of new petroleum engineering graduates. SPE staff and resources were then utilized in producing the survey and tabulating the results.

Development Process

The SPE Talent Council charged a subcommittee from a diversified group of participants from industry and academia for this effort. It was recognized that the matrix would need to be a "living" document (i.e., not a static set of criteria). As such processes have been implemented to ensure continued updating, revision, and resurveying.

A survey was created and sent to 109 companies (including international and national oil companies, as well as mid-size companies and companies in the service sector). The participation rate was approximately 51 percent, which stands to validate the results in the survey.

Conclusions

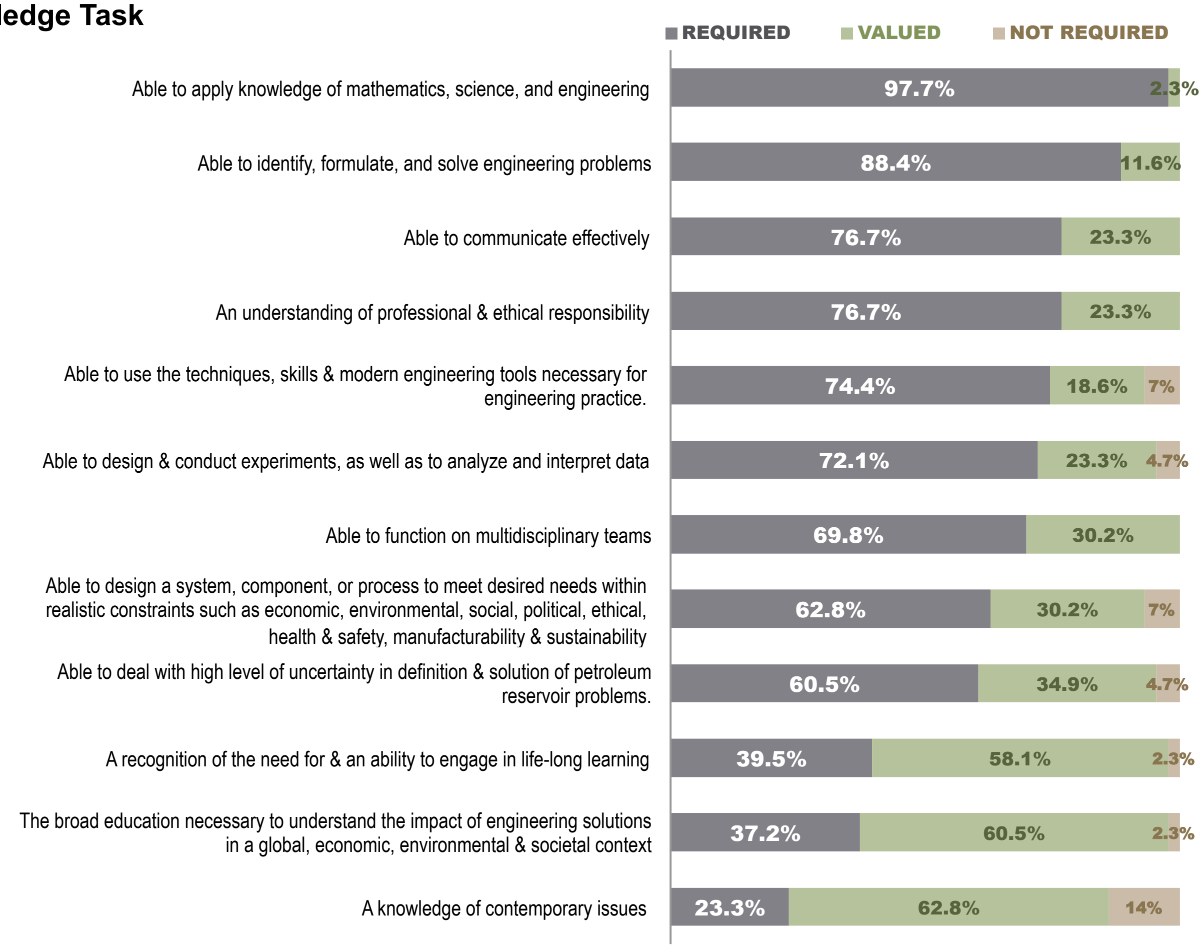
The survey response to the proposed SPE Graduate Technical Knowledge Matrix suggests that the E&P sector of the petroleum industry assigns essential value to specific technical knowledge sets for petroleum engineering graduates. In particular, it is absolutely clear that graduates in petroleum engineering must have a solid foundation in breadth knowledge and engineering skill sets.

The survey responses clearly reflect a desire for graduates in petroleum engineering to have a practical knowledge of field practices and operations, as well as a working knowledge of the foundations of petroleum engineering — drilling, production, and reservoir engineering — as well as geoscience, economics, technical writing and technical presentations.

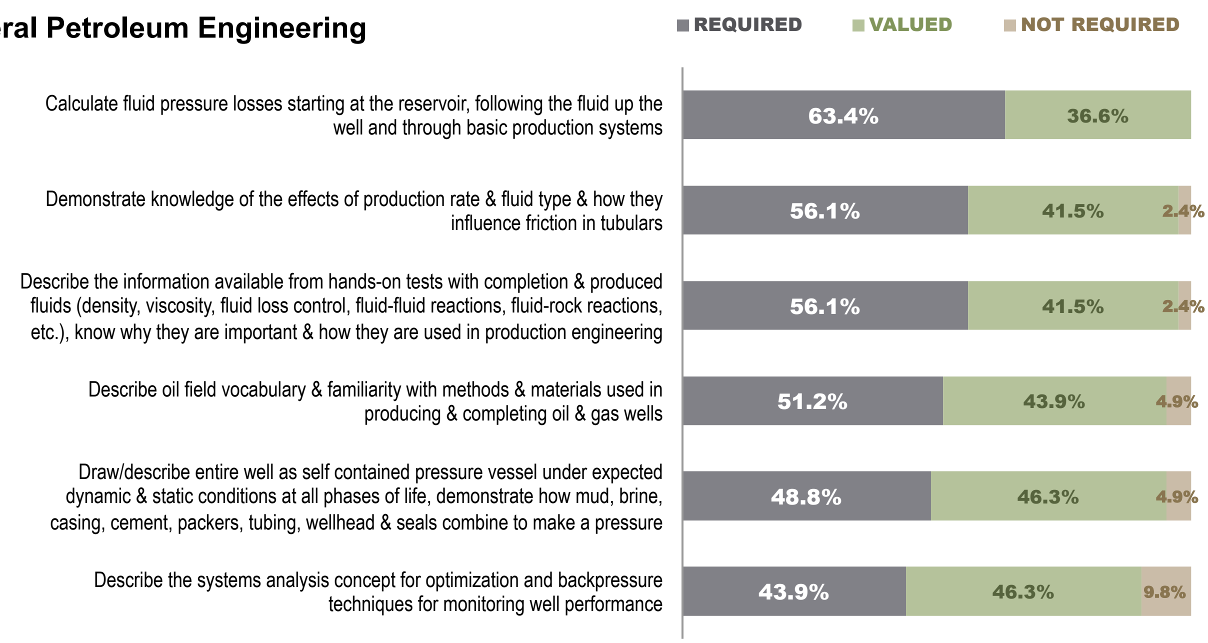
Acknowledgements

The SPE expresses its appreciation to those practicing engineers who participated in the construction and evaluation of the SPE Graduate Technical Knowledge Matrix.

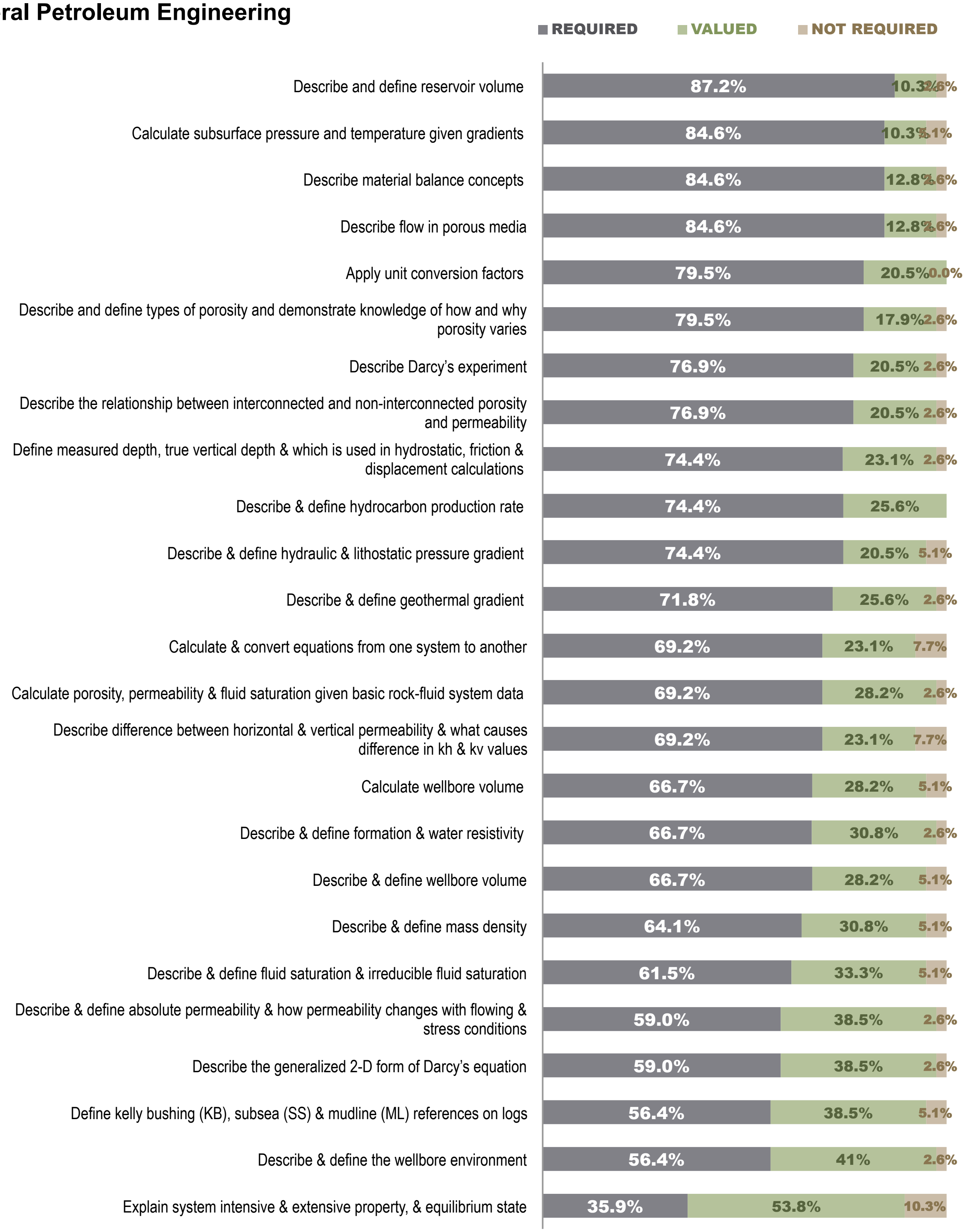
1: Knowledge Task



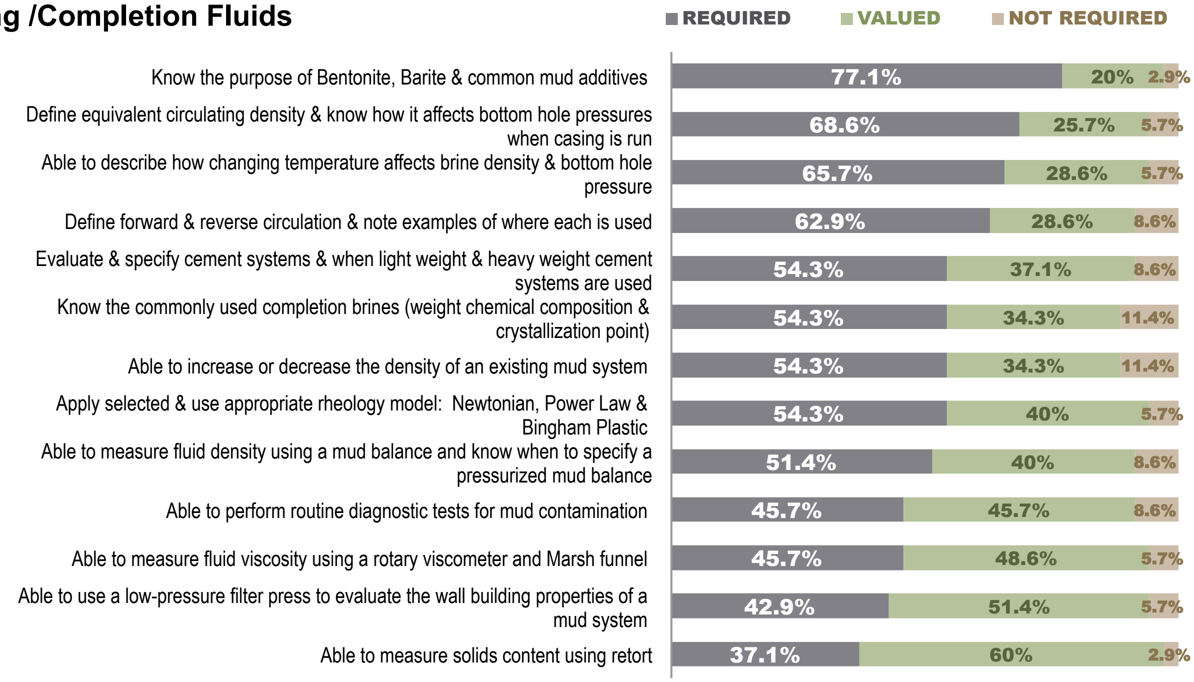
2: General Petroleum Engineering



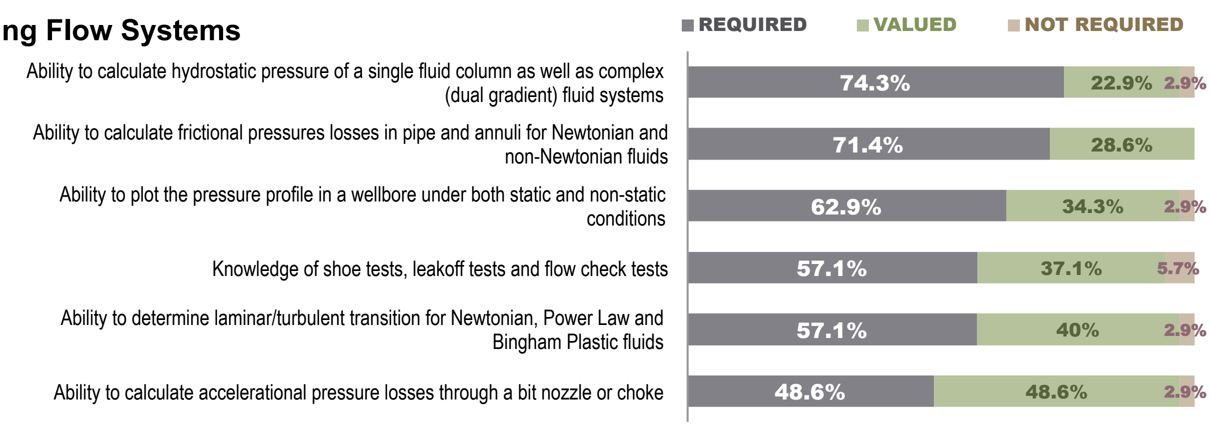
3: General Petroleum Engineering



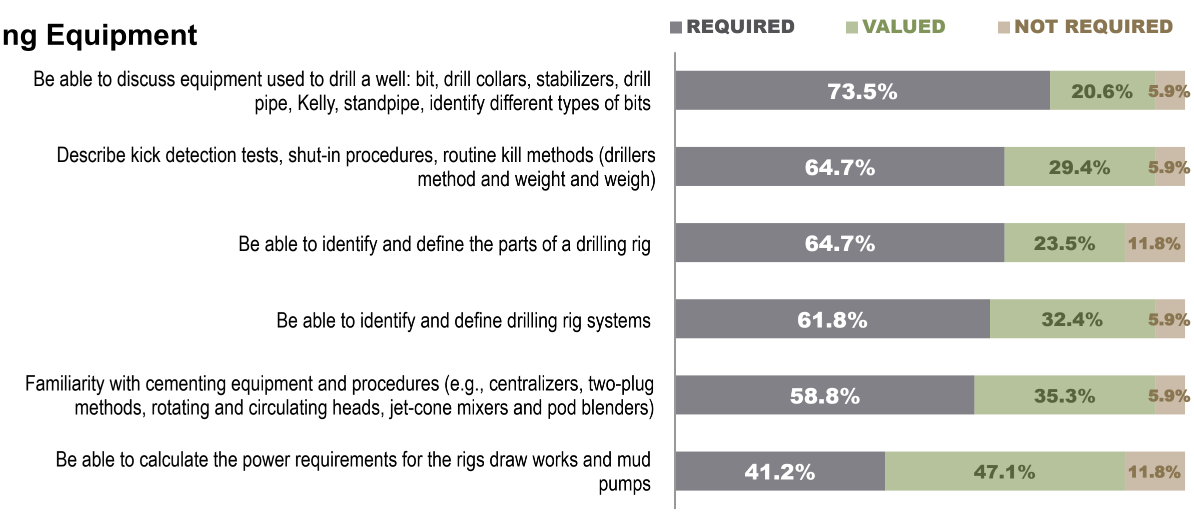
4: Drilling /Completion Fluids



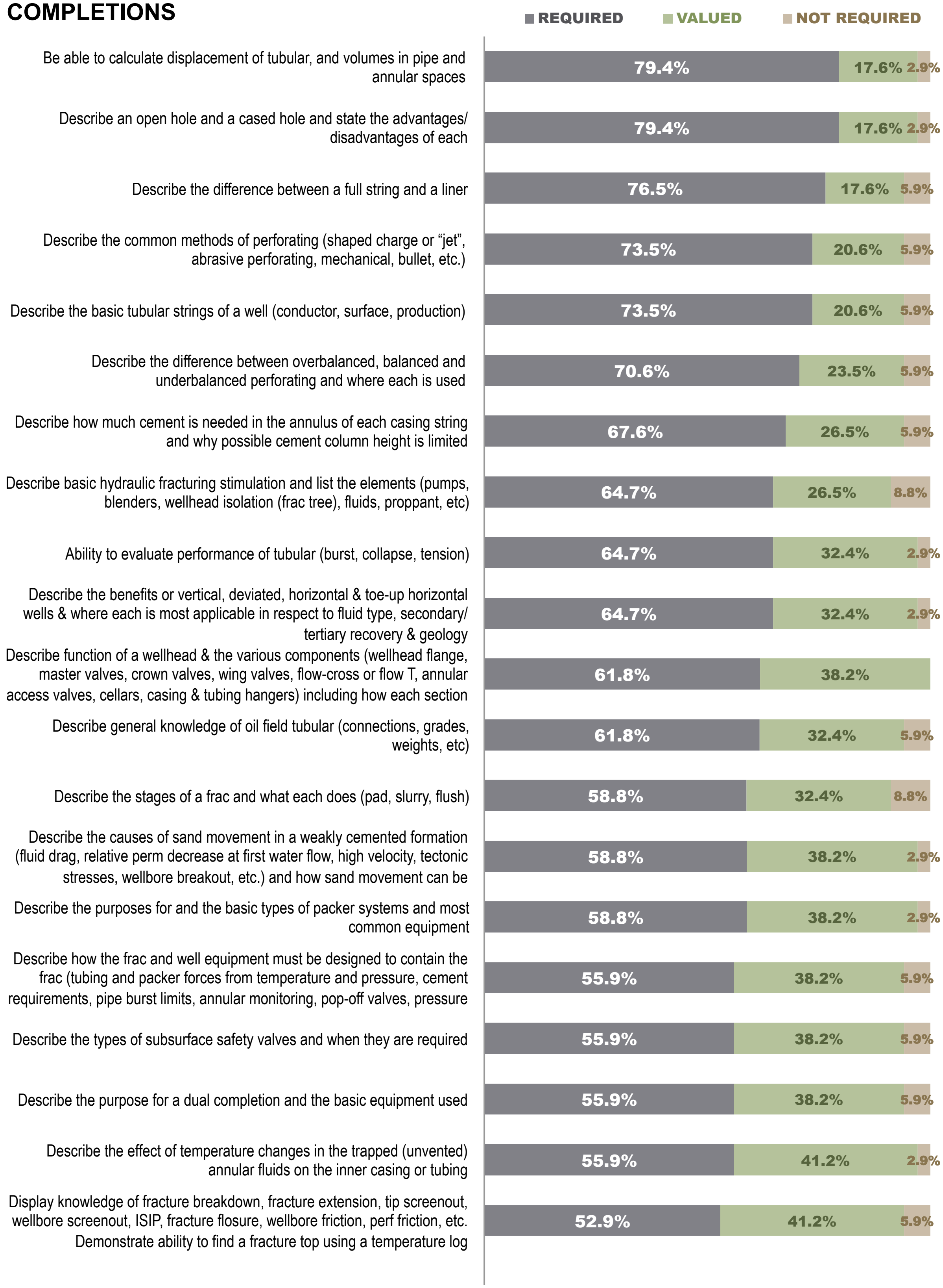
5: Drilling Flow Systems

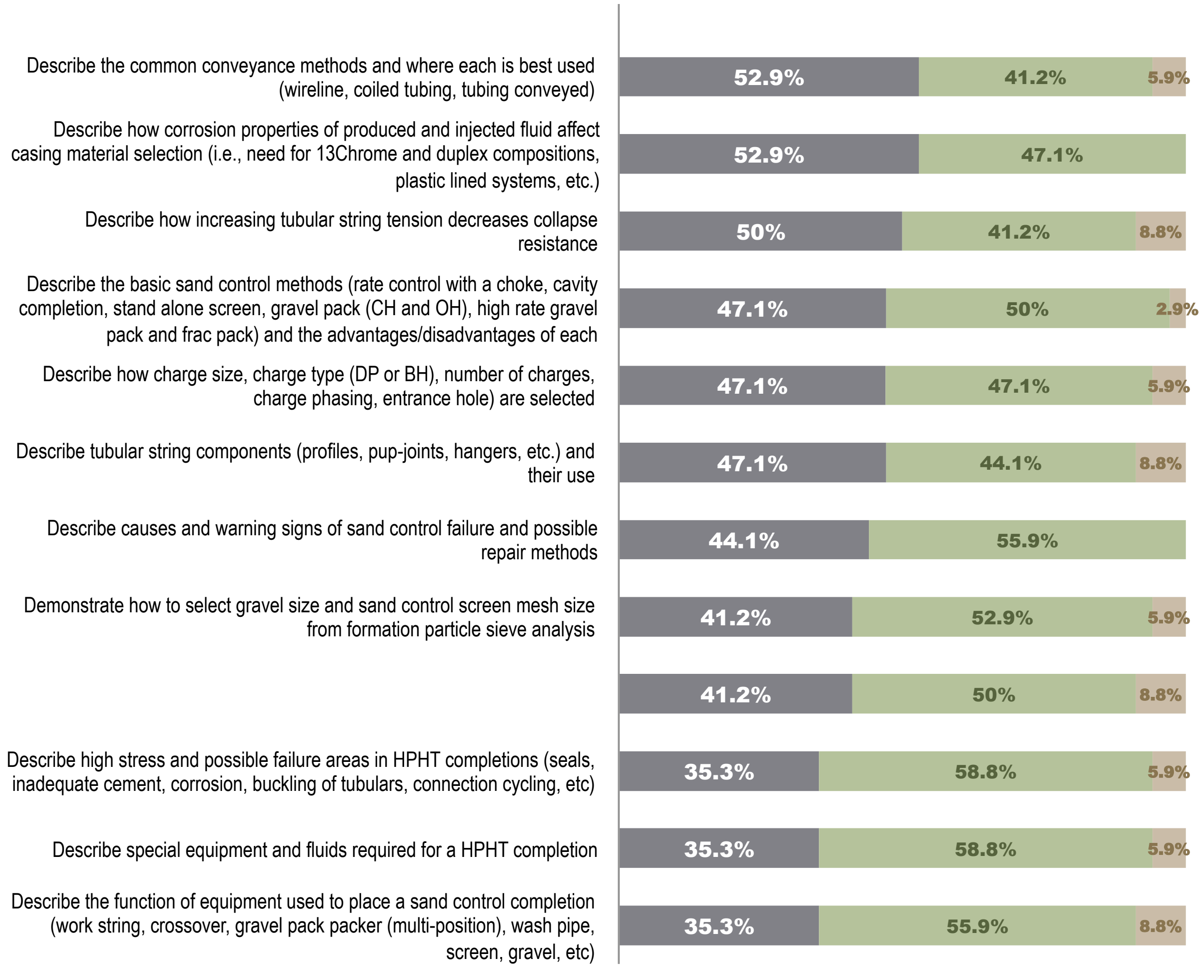


6: Drilling Equipment

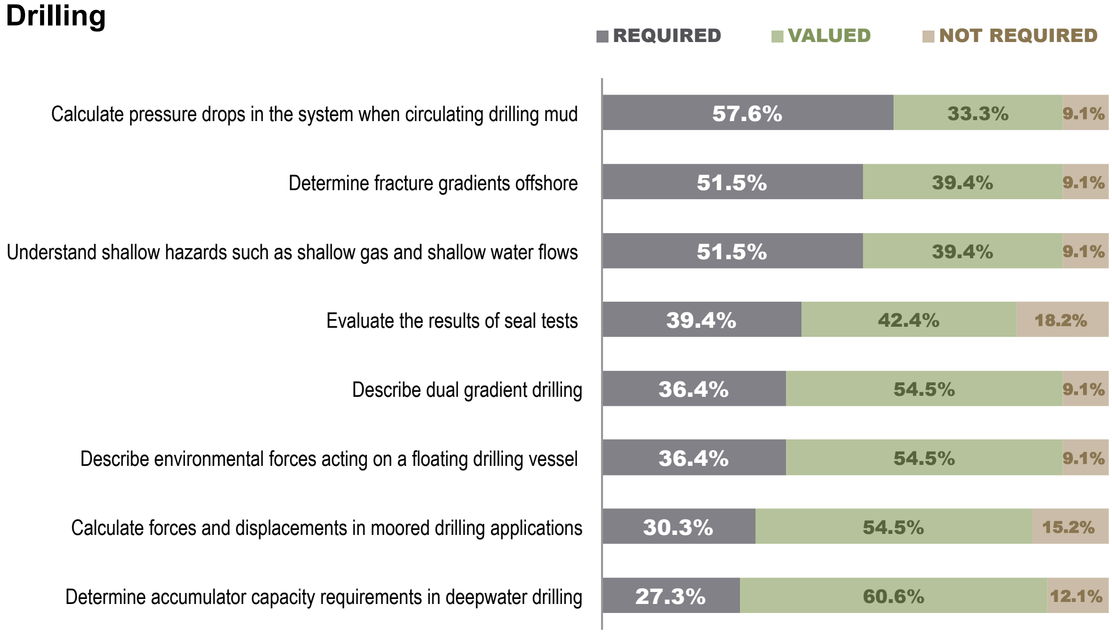


7: WELL COMPLETIONS

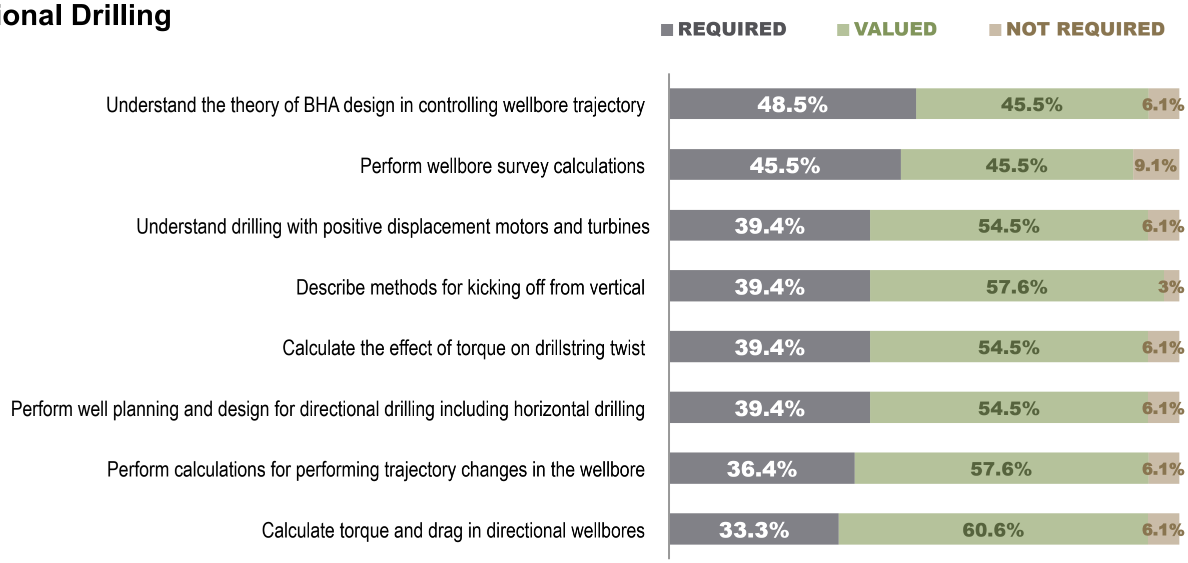




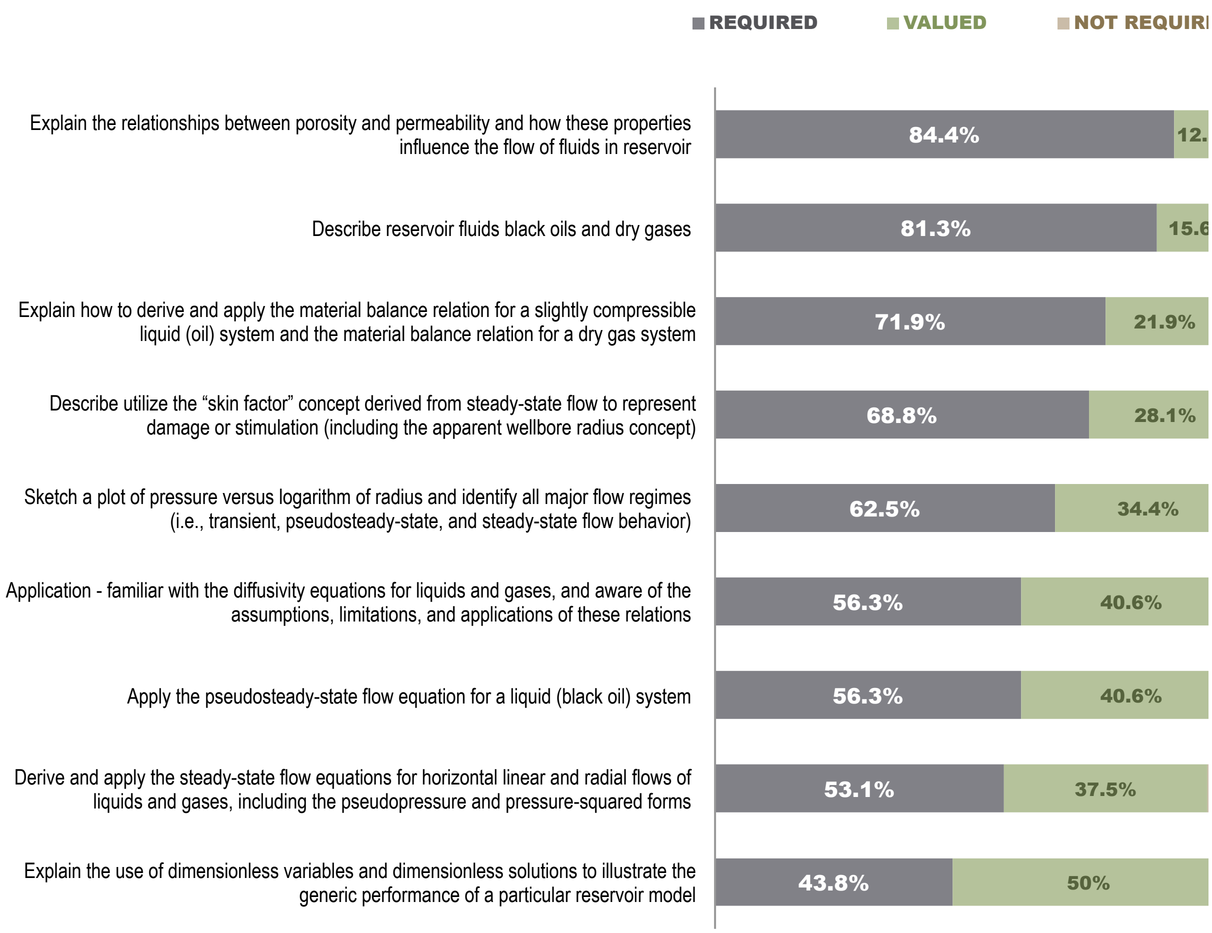
8: Floating Drilling



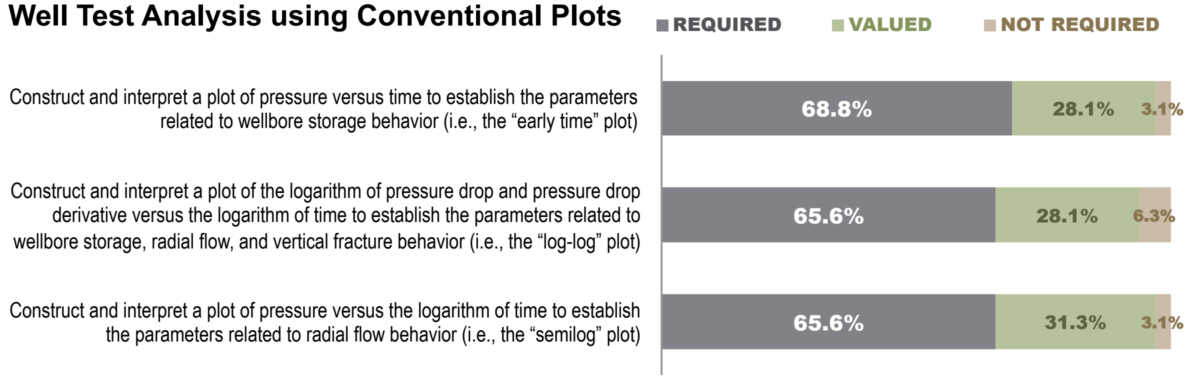
9: Directional Drilling



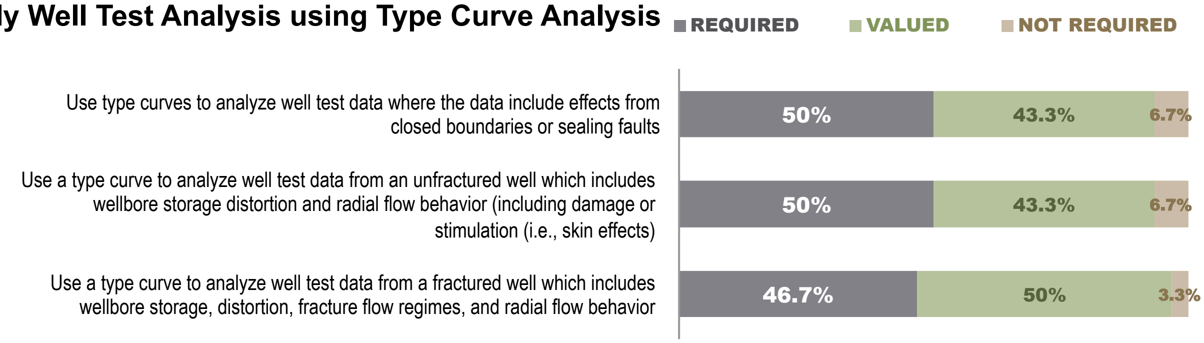
10: Describe terminology and commonly-applied methods for quantifying well performance



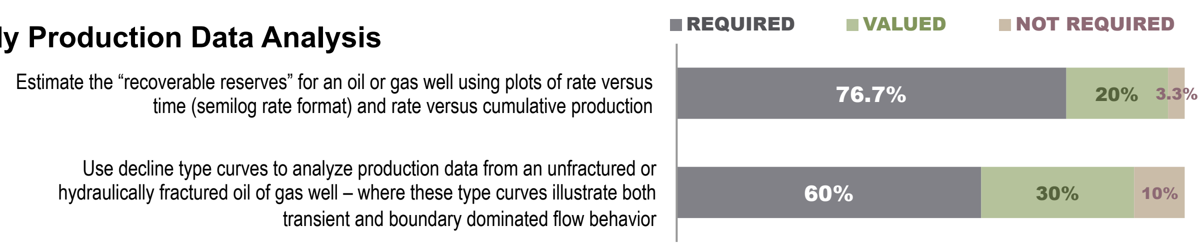
11: Apply Well Test Analysis using Conventional Plots



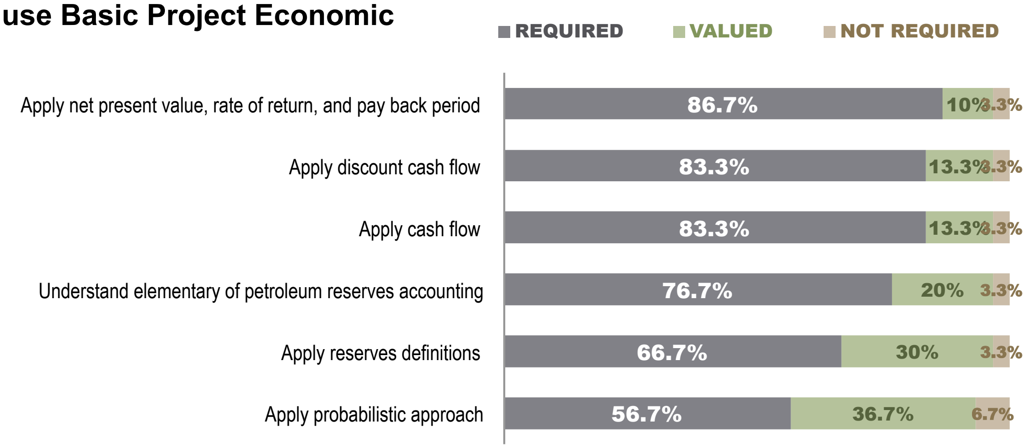
12: Apply Well Test Analysis using Type Curve Analysis



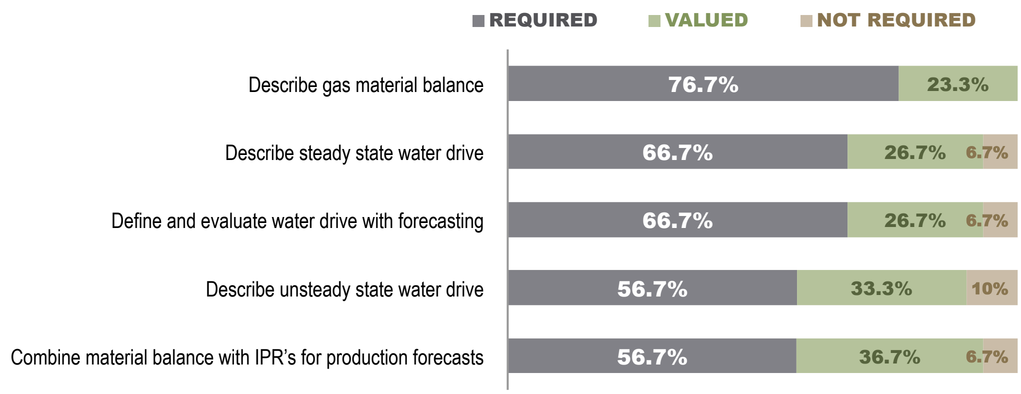
13: Apply Production Data Analysis



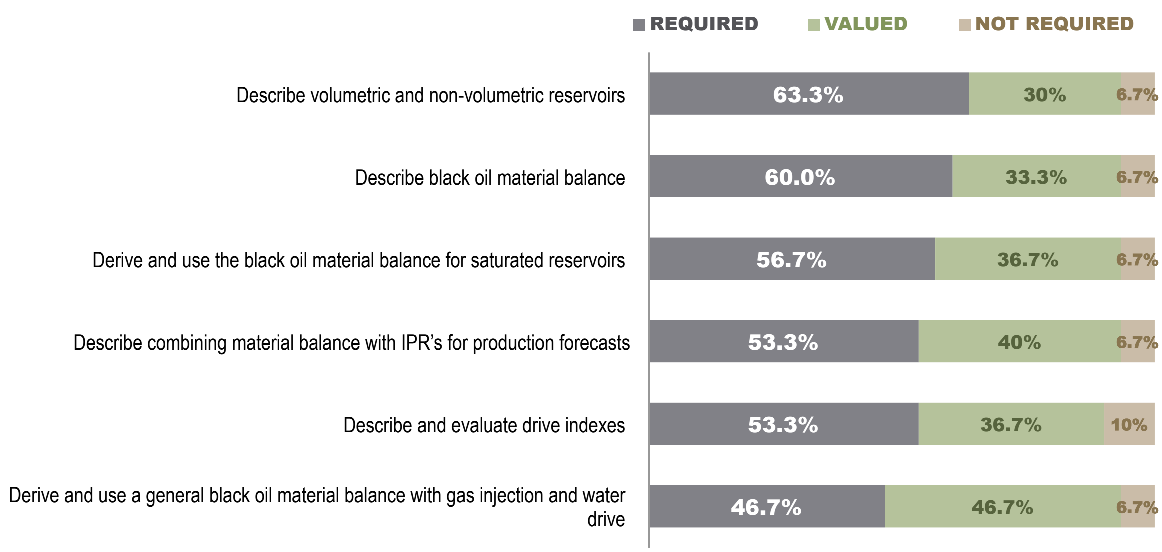
14: Understand and use Basic Project Economic



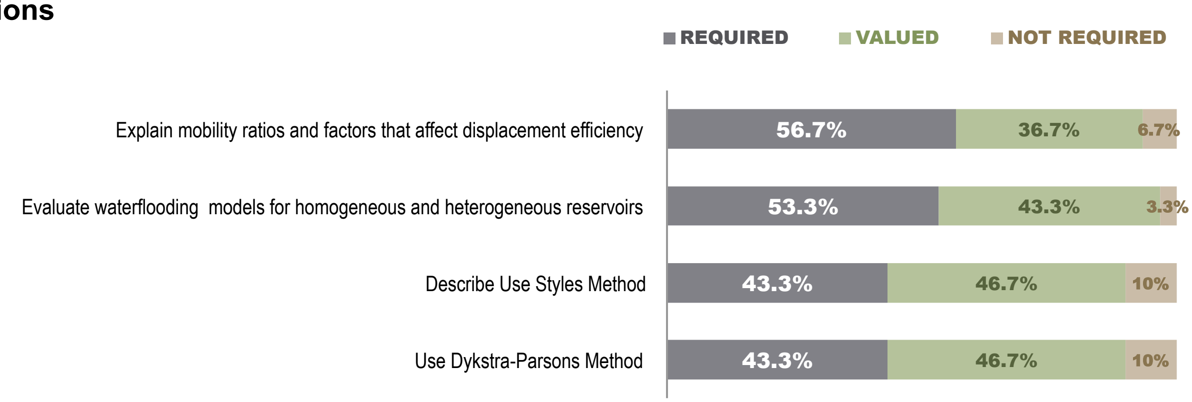
15: Derive and use the Gas Material Balance coupled with Forecasting



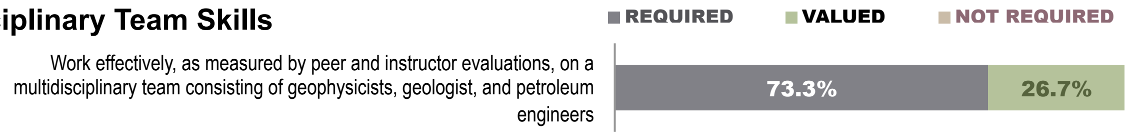
16: Derive and use the Oil Material Balance coupled with Forecasting



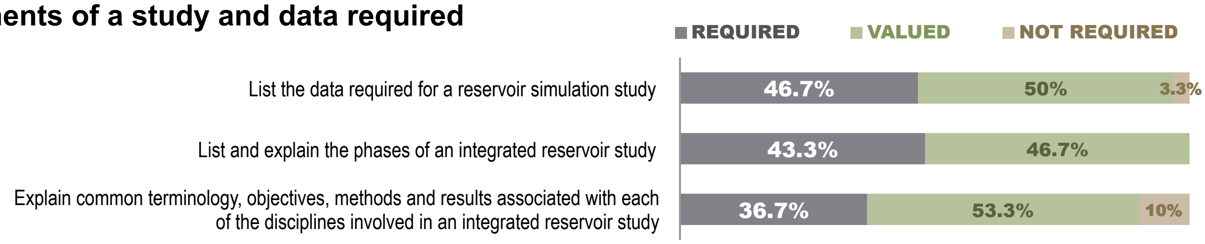
17: Derive and Describe Immiscible Frontal Advance Theory and Applications



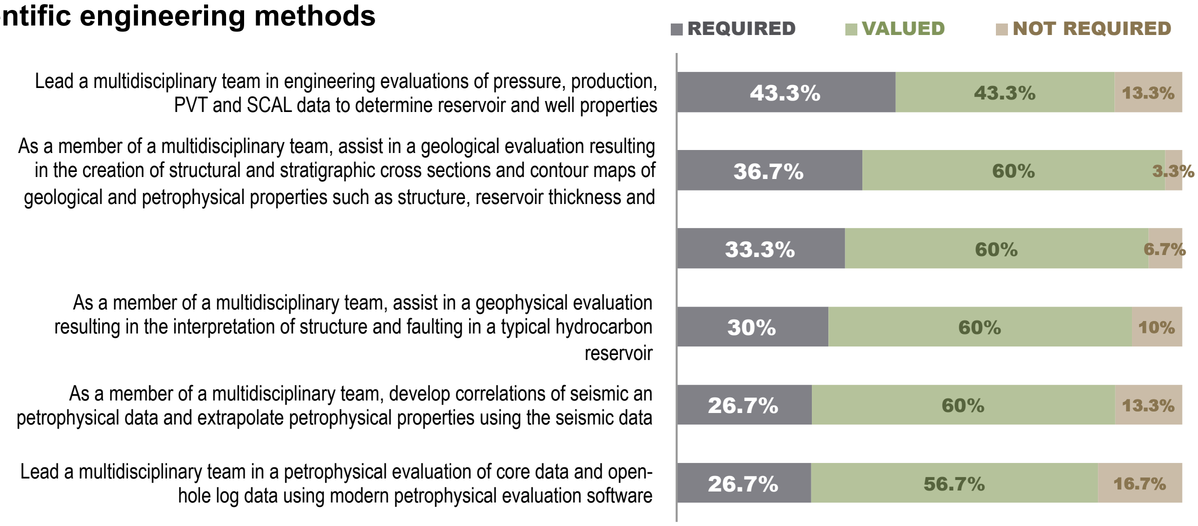
18: Multidisciplinary Team Skills



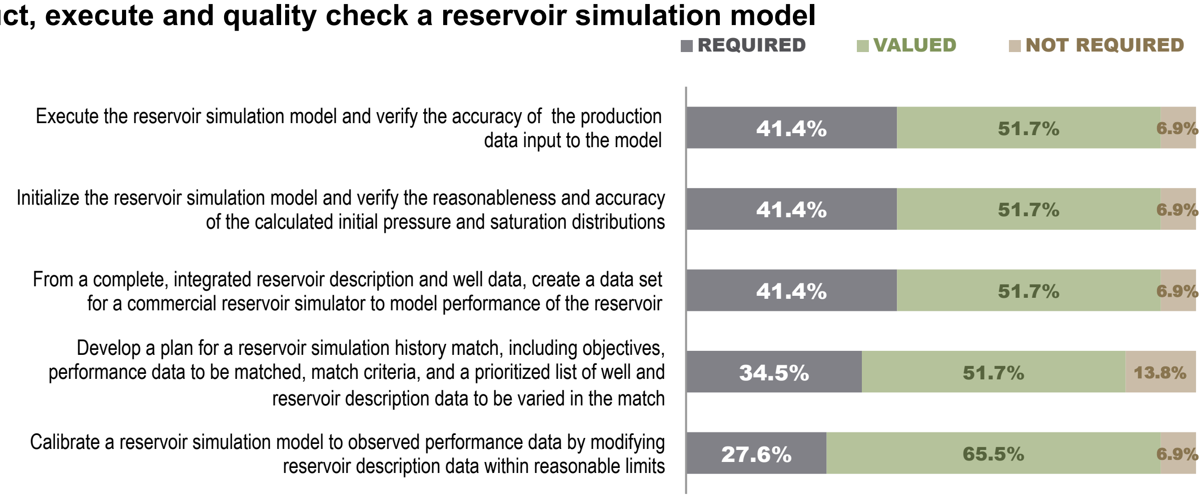
19: Explain how to conduct an Integrated Reservoir Study, including the components of a study and data required



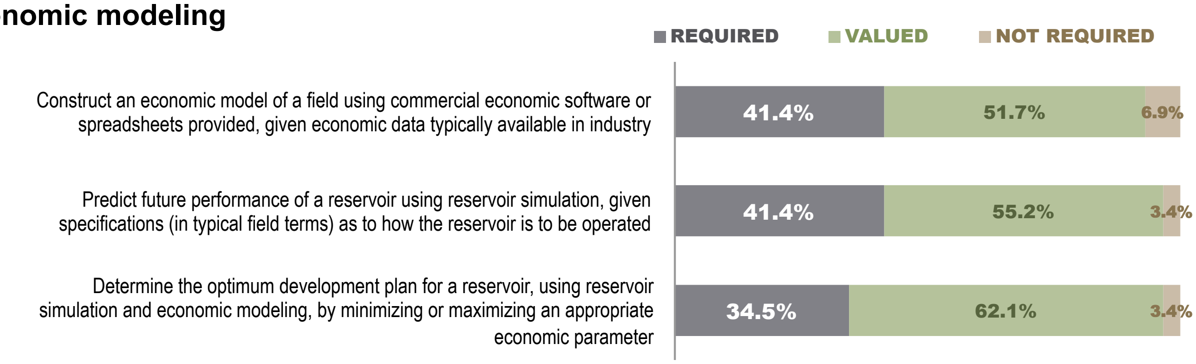
20: Develop a complete description of a Hydrocarbon Reservoir using geoscientific engineering methods



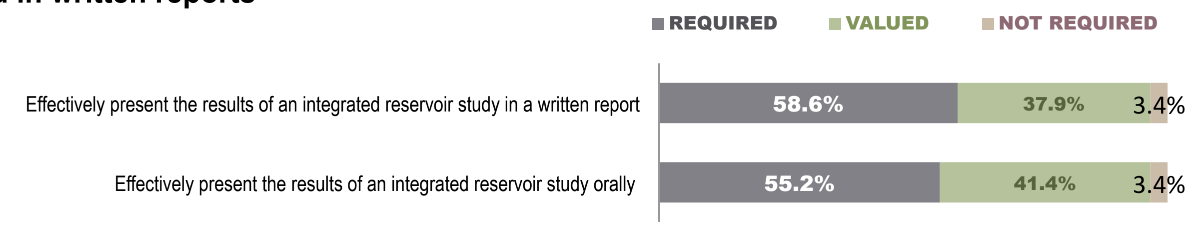
21: Given a complete reservoir description and well data, and design, construct, execute and quality check a reservoir simulation model



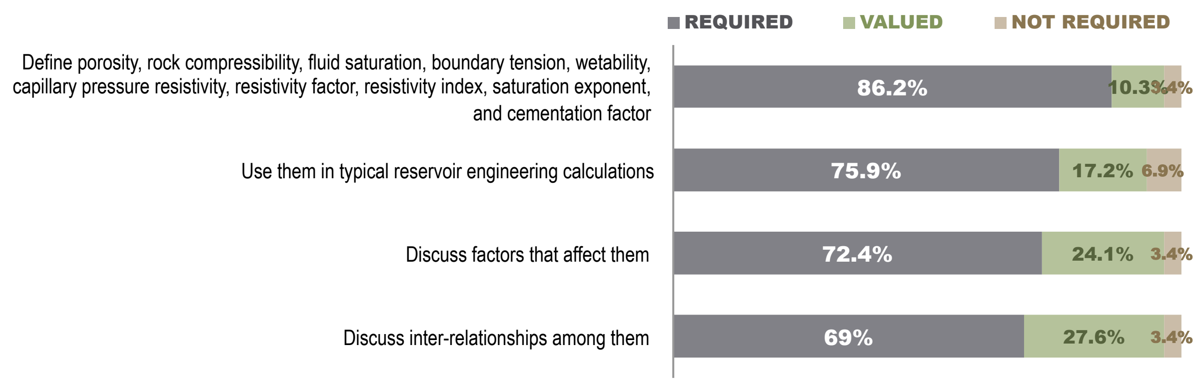
22: Predict and optimize reservoir performance using reservoir simulation and economic modeling



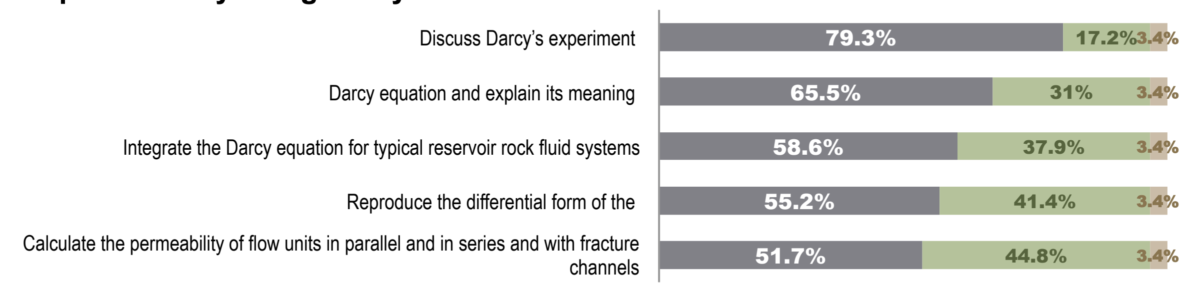
23: Effectively communicate the results of an integrated reservoir study orally and in written reports



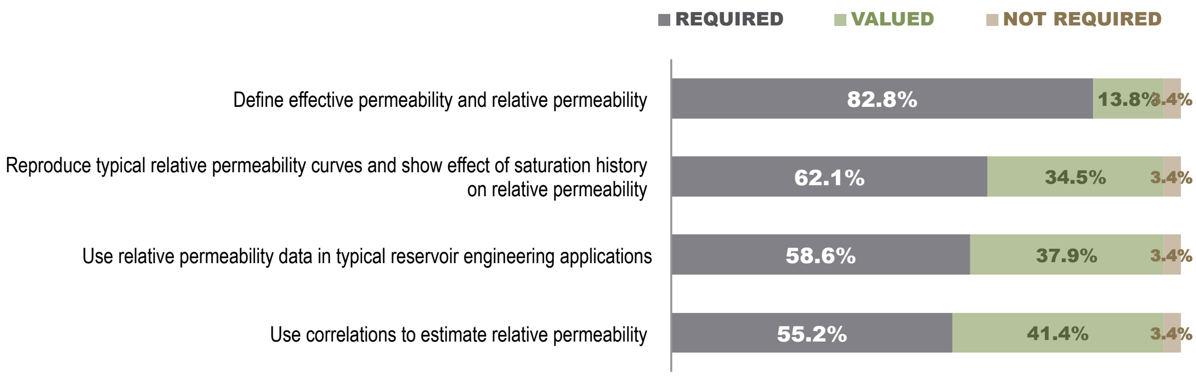
24: Describe and calculate basic properties of the rock fluid system affecting the storage and flow capacity of the system and distribution of fluids with the system



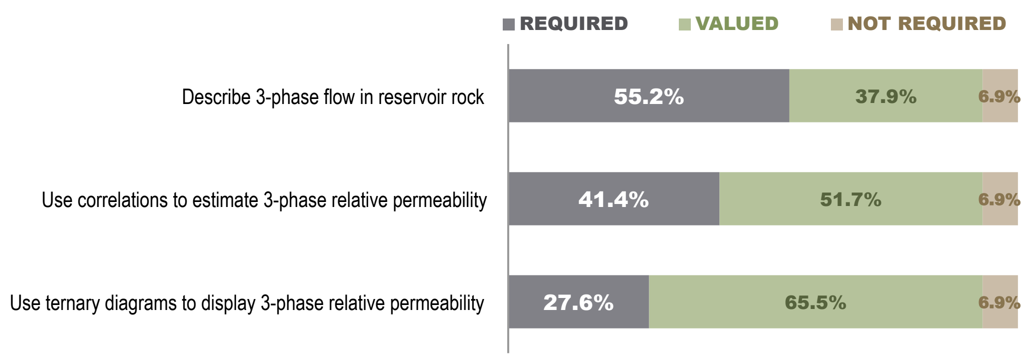
25: Calculate permeability using Darcy's Law



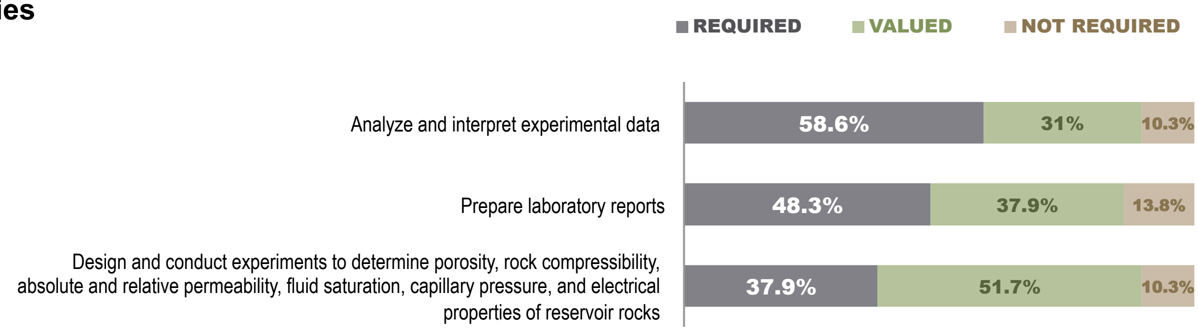
26: Describe and use effective and relative permeability



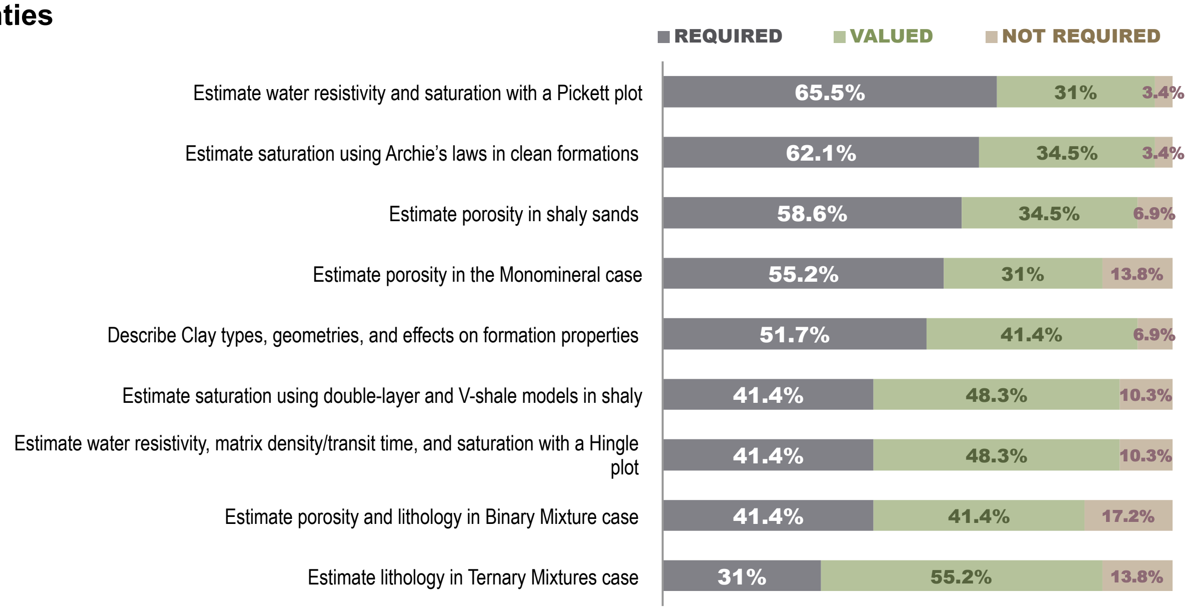
27: Describe and use 3-phase relative permeability



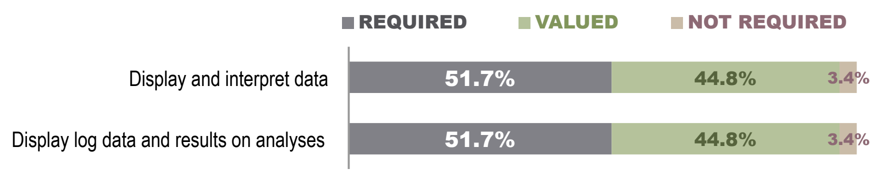
28: Design and conduct experiments to determine basic rock fluid properties



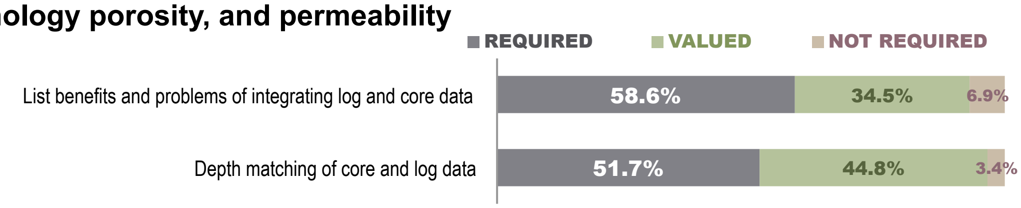
29: Able to interpret common open hole logging measurements for lithology, porosity, and water saturation estimates and their associated uncertainties



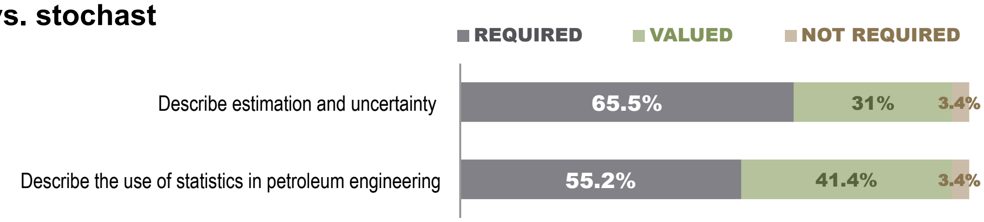
30: Able to perform basic wireline log evaluations on a commercial software package



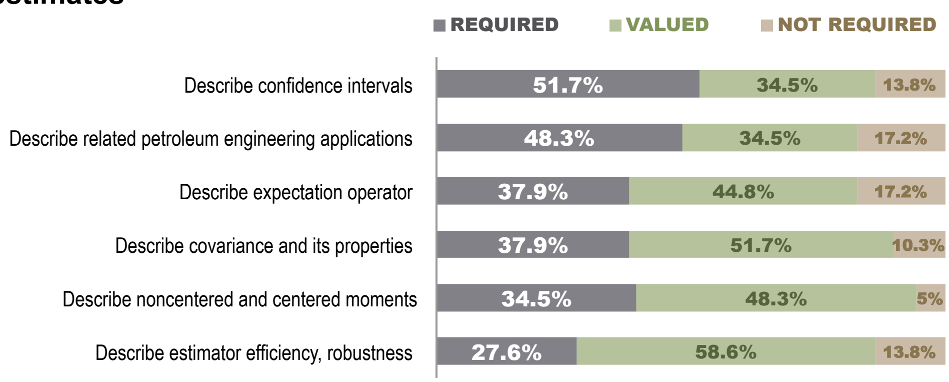
31: Able to integrate wireline logging data with basic core data in order to assess formation lithology porosity, and permeability



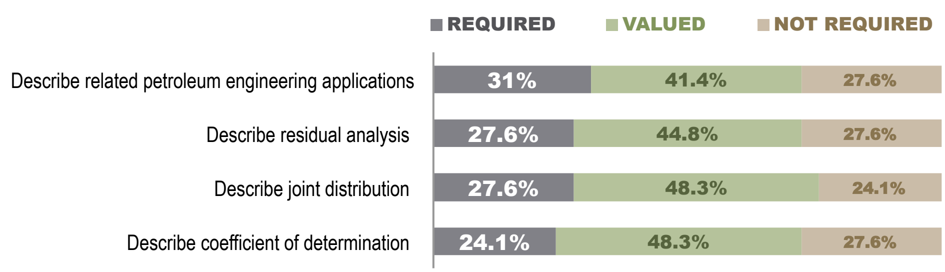
32: Understand various types and forms of reservoir heterogeneity and its role in reservoir performance. Appreciate the uncertainty in reservoir property estimates and the need to quantify it. Understand the difference between deterministic vs. stochast



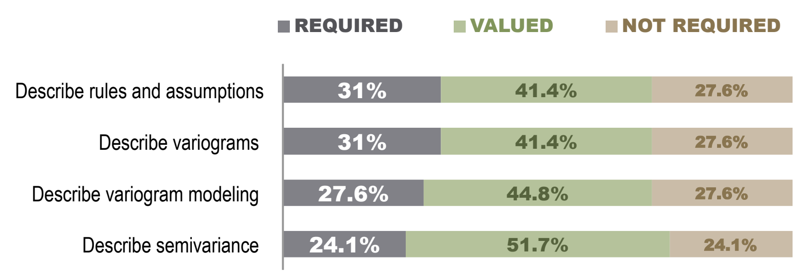
34: Learn about statistical moment and expectations and how to formulate various estimators using these concepts. Learn about estimator bias, efficiency and robustness. Learn about confidence intervals an apply the concept to permeability estimates



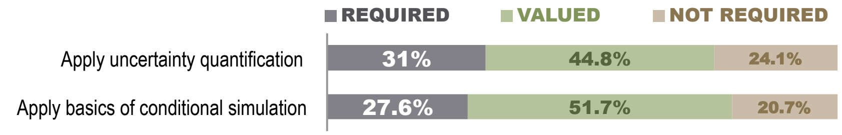
35: Perform exploratory data analysis through transformations and correlation. Learn about coefficient of determination and residual analysis. Use existing software to analyze well log and core data from oil field



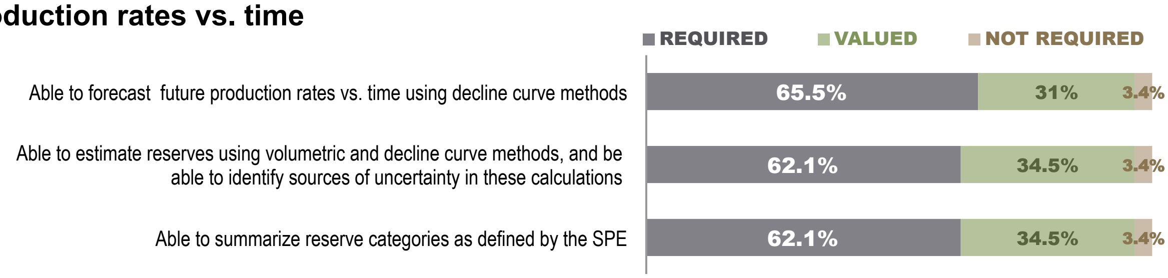
36: Learn about analysis of spatial data using variograms and variogram modeling, rules and physical significance of variogram modeling. Practical applications using the software GEOEAS



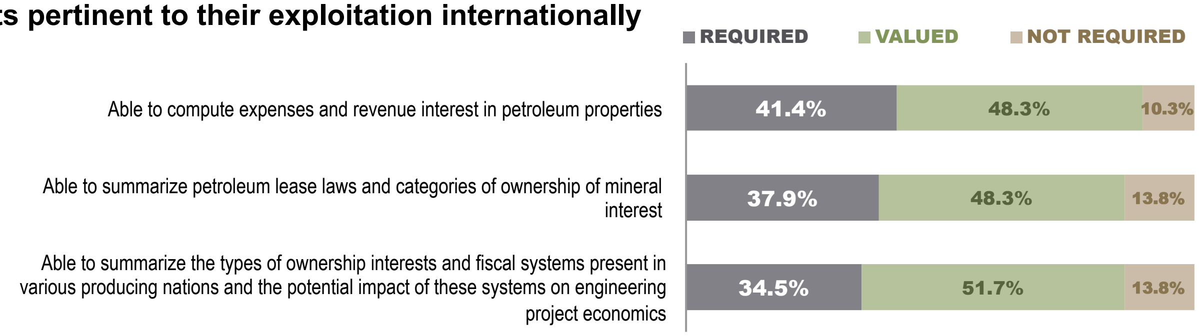
37: Learn about spatial modeling or reservoir properties using kriging and the use of kriging variance as a measure of uncertainty, basic concepts of conditional simulation and the need to study multiple realizations. Solve examples using GEOEAS



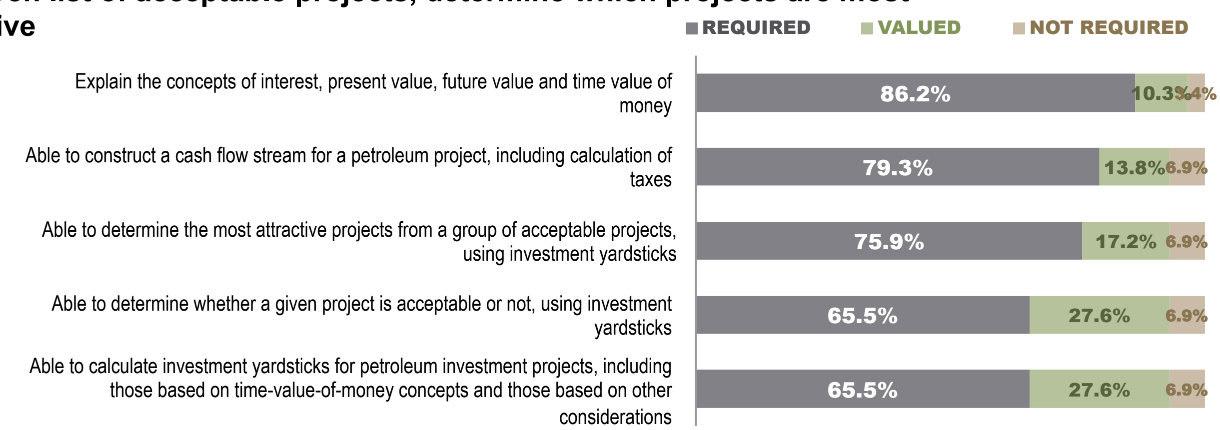
38: Able to categorize petroleum reserves and to estimate proved reserves using volumetric and decline curve methods; also, be able to forecast future production rates vs. time



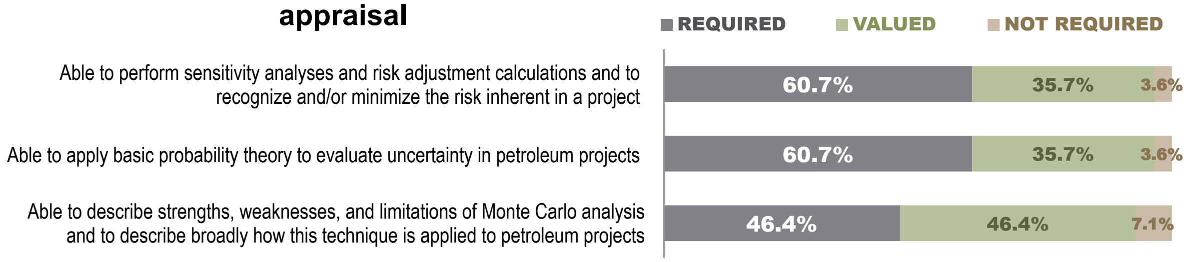
39: Able to state in concise summary form, the fundamental forms of ownership of petroleum resources, and laws, fiscal systems and financial interests pertinent to their exploitation internationally



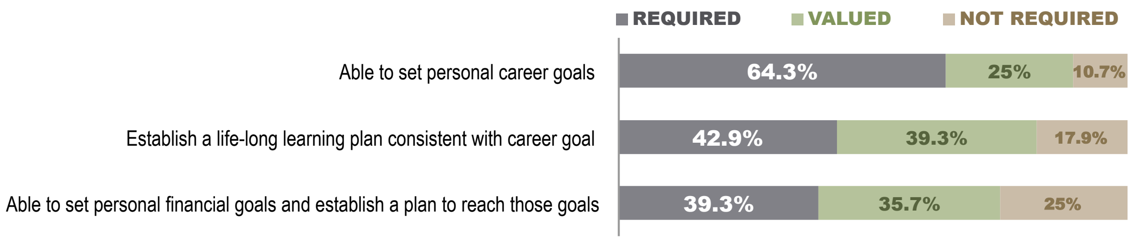
40: Able to perform basic cash flow analysis for petroleum projects and to determine whether proposed projects are acceptable or unacceptable and, in a given list of acceptable projects, determine which projects are most attractive



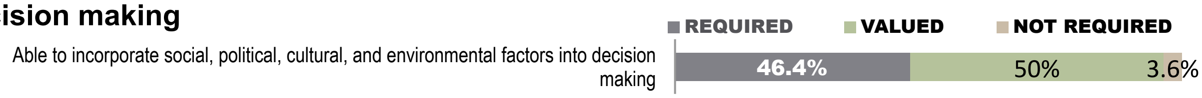
41: Able to evaluate uncertainty in reserve estimates and economic appraisal



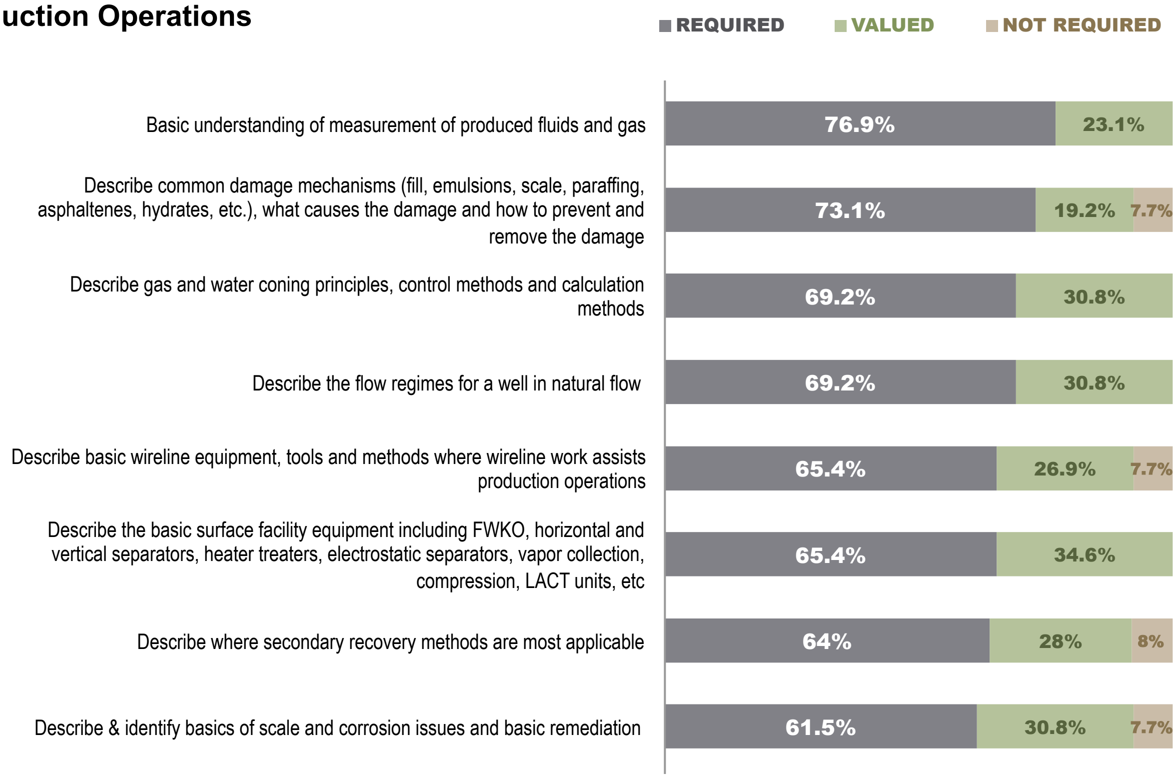
42: Able to set personal career and financial goals, including personal investment, planning, financial management, and a life-long learning plan

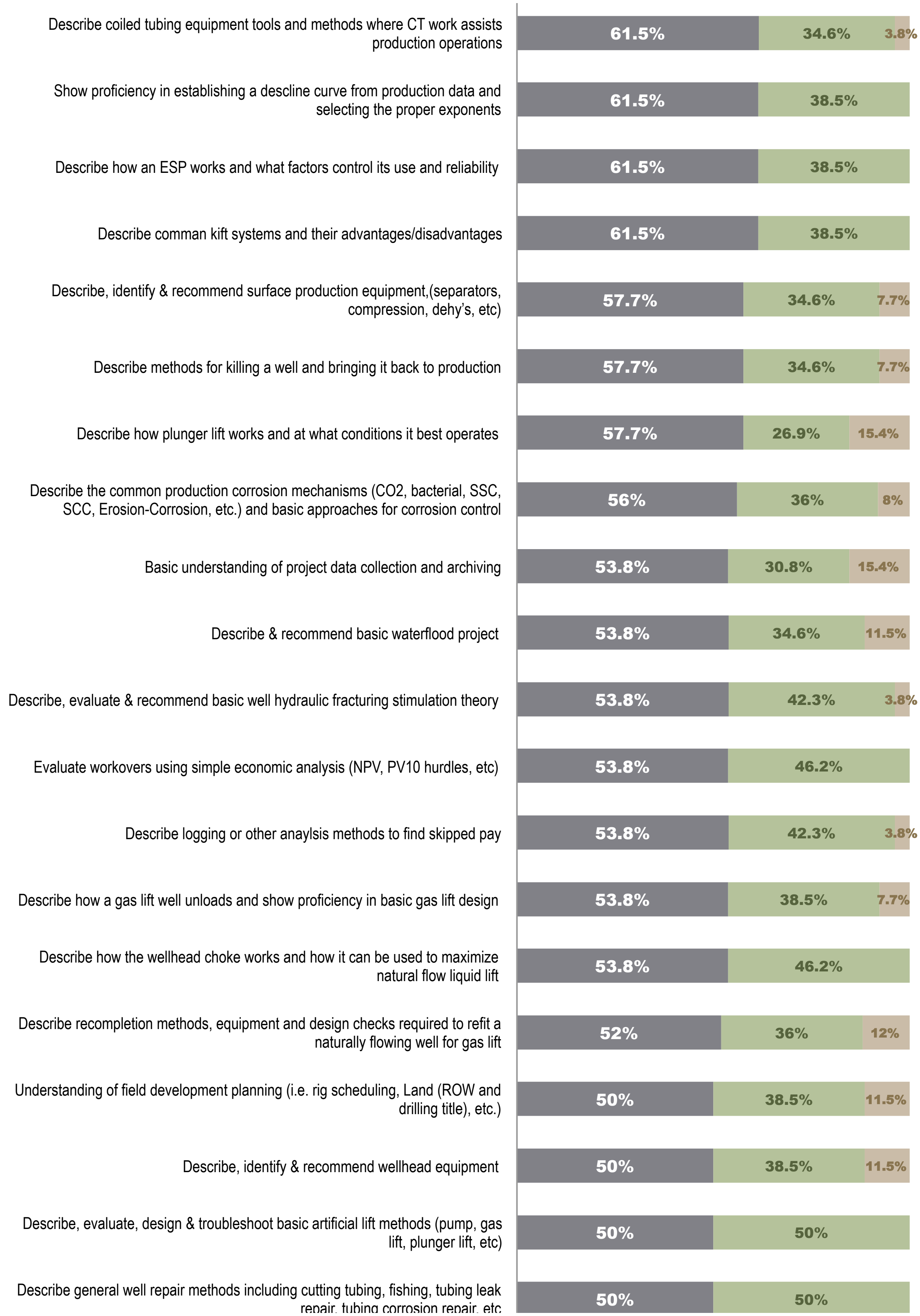


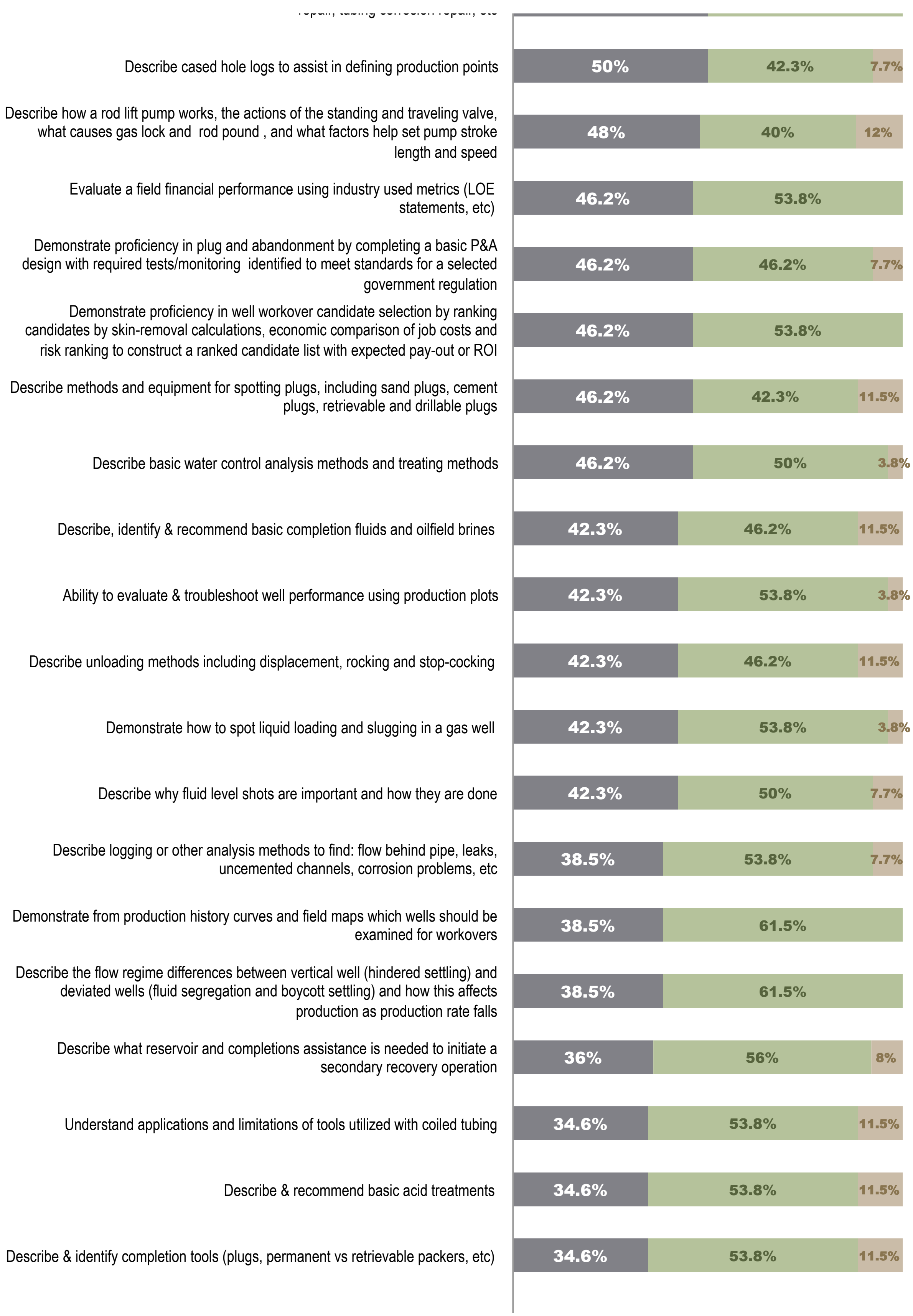
43: Able to incorporate social, political, cultural, and environmental factors into decision making



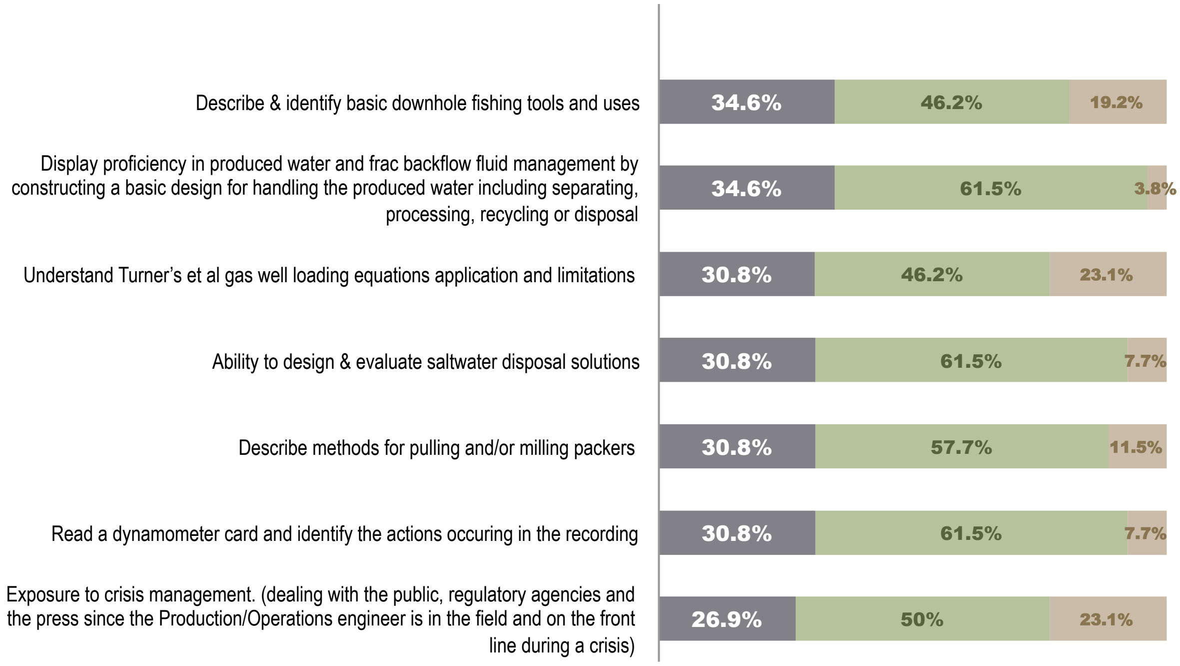
44: Production Operations




Describe coiled tubing equipment tools and methods where CT work assists production operations
61.5%
34.6%
3.8%
Show proficiency in establishing a descline curve from production data and selecting the proper exponents
61.5%
38.5%
Describe how an ESP works and what factors control its use and reliability
61.5%
38.5%
Describe comman kift systems and their advantages/disadvantages
61.5%
38.5%
Describe, identify & recommend surface production equipment,(separators, compression, dehy's, etc)
57.7%
34.6%
7.7%
Describe methods for killing a well and bringing it back to production
57.7%
34.6%
7.7%
Describe how plunger lift works and at what conditions it best operates
57.7%
26.9%
15.4%
Describe the common production corrosion mechanisms (CO2, bacterial, SSC, SCC, Erosion-Corrosion, etc.) and basic approaches for corrosion control
56%
36%
8%
Basic understanding of project data collection and archiving
53.8%
30.8%
15.4%
Describe & recommend basic waterflood project
53.8%
34.6%
11.5%
Describe, evaluate & recommend basic well hydraulic fracturing stimulation theory
53.8%
42.3%
3.8%
Evaluate workovers using simple economic analysis (NPV, PV10 hurdles, etc)
53.8%
46.2%
Describe logging or other anaylsis methods to find skipped pay
53.8%
42.3%
3.8%
Describe how a gas lift well unloads and show proficiency in basic gas lift design
53.8%
38.5%
7.7%
Describe how the wellhead choke works and how it can be used to maximize natural flow liquid lift
53.8%
46.2%
Describe recompletion methods, equipment and design checks required to refit a naturally flowing well for gas lift
52%
36%
12%
Understanding of field development planning (i.e. rig scheduling, Land (ROW and drilling title), etc.)
50%
38.5%
11.5%
Describe, identify & recommend wellhead equipment
50%
38.5%
11.5%
Describe, evaluate, design & troubleshoot basic artificial lift methods (pump, gas lift, plunger lift, etc)
50%
50%
Describe general well repair methods including cutting tubing, fishing, tubing leak repair, tubing corrosion repair, etc
50%
50%



Describe cased hole logs to assist in defining production points
50%
42.3%
7.7%
Describe how a rod lift pump works, the actions of the standing and traveling valve, what causes gas lock and rod pound , and what factors help set pump stroke length and speed
48%
40%
12%
Evaluate a field financial performance using industry used metrics (LOE statements, etc)
46.2%
53.8%
Demonstrate proficiency in plug and abandonment by completing a basic P&A design with required tests/monitoring identified to meet standards for a selected government regulation
46.2%
46.2%
7.7%
Demonstrate proficiency in well workover candidate selection by ranking candidates by skin-removal calculations, economic comparison of job costs and risk ranking to construct a ranked candidate list with expected pay-out or ROI
46.2%
53.8%
Describe methods and equipment for spotting plugs, including sand plugs, cement plugs, retrievable and drillable plugs
46.2%
42.3%
11.5%
Describe basic water control analysis methods and treating methods
46.2%
50%
3.8%
Describe, identify & recommend basic completion fluids and oilfield brines
42.3%
46.2%
11.5%
Ability to evaluate & troubleshoot well performance using production plots
42.3%
53.8%
3.8%
Describe unloading methods including displacement, rocking and stop-cocking
42.3%
46.2%
11.5%
Demonstrate how to spot liquid loading and slugging in a gas well
42.3%
53.8%
3.8%
Describe why fluid level shots are important and how they are done
42.3%
50%
7.7%
Describe logging or other analysis methods to find: flow behind pipe, leaks, uncemented channels, corrosion problems, etc
38.5%
53.8%
7.7%
Demonstrate from production history curves and field maps which wells should be examined for workovers
38.5%
61.5%
Describe the flow regime differences between vertical well (hindered settling) and deviated wells (fluid segregation and boycott settling) and how this affects production as production rate falls
38.5%
61.5%
Describe what reservoir and completions assistance is needed to initiate a secondary recovery operation
36%
56%
8%
Understand applications and limitations of tools utilized with coiled tubing
34.6%
53.8%
11.5%
Describe & recommend basic acid treatments
34.6%
53.8%
11.5%
Describe & identify completion tools (plugs, permanent vs retrievable packers, etc)
34.6%
53.8%
11.5%


Describe & identify basic downhole fishing tools and uses
34.6%
46.2%
19.2%
Display proficiency in produced water and frac backflow fluid management by constructing a basic design for handling the produced water including separating, processing, recycling or disposal
34.6%
61.5%
3.8%
Understand Turner's et al gas well loading equations application and limitations
30.8%
46.2%
23.1%
Ability to design & evaluate saltwater disposal solutions
30.8%
61.5%
7.7%
Describe methods for pulling and/or milling packers
30.8%
57.7%
11.5%
Read a dynamometer card and identify the actions occuring in the recording
30.8%
61.5%
7.7%
Exposure to crisis management. (dealing with the public, regulatory agencies and the press since the Production/Operations engineer is in the field and on the front line during a crisis)
26.9%
50%
23.1%