

The well control methods and procedures require that the rig pressure control system specifications (Blow Out Preventer, surface lines, manifold, manifold choke, tanks, separators, and flares) are predefined to withstand well pressure and temperature maximum parameters during operations and that the well control methods are pre-established during the well planning phase including the casing design parameters, cementing programs, and the drilling fluid program. For the execution phase the PIs together with the company man will coordinate and review assigned tasks of the established procedure. The experience of the 'Company Man' at the rig site is fundamental to lead efficient and safe operations during the decision-making process.

### Integrated workflows

Many well-planning and engineering software packages today offer a tight integration with other software applications, running on one data management infrastructure. Thereby a common data management environment is essential for multidisciplinary teams of geoscientists and drilling engineers who plan and monitor wells to ensure optimal wellbore design and drilling progress. In figure 4.2.15 such integrated workflow is depicted.

A two-way link with seismic interpretation applications could be integrated for interactive well-design and trajectory monitoring workflows in a 3D interpretation environment, which interconnects the well database into combined well-planning, engineering and geo-steering workflows.

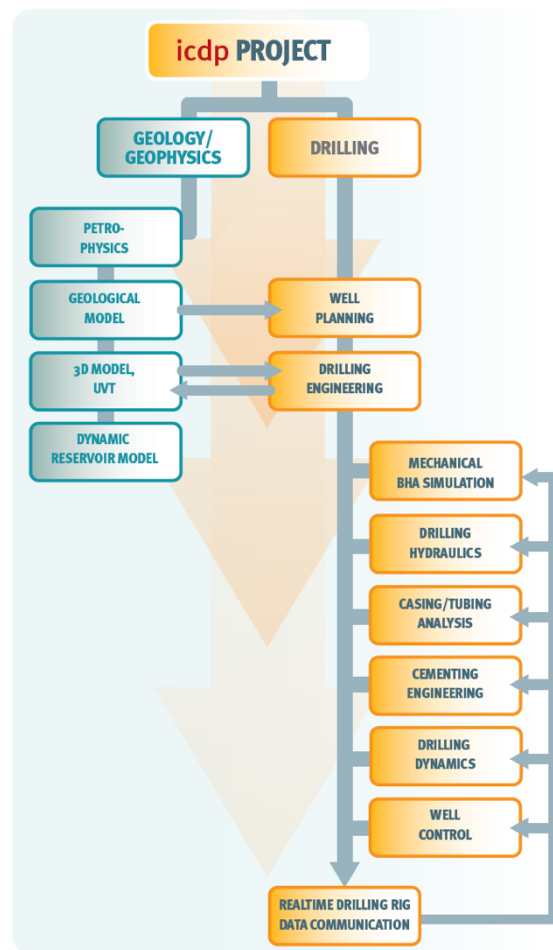


Fig. 4.2.15: ICDP well engineering flow chart

### Abandonment and Decommissioning

The final step of scientific drilling field operations is the proper management of well abandonment and surface facilities decommissioning to shut downfield operations.

Abandonment and decommissioning expenses including all capital and operational expenditures have to be accounted for early on in the project budget calculation. Scientific drilling projects often evolve during the operations when new open science question arise. This results in changing research objectives and more ambitious operational targets such as deeper wells using high-technology applications and long-term utilization of the well that may

interfere with the budget set aside for well abandonment.

What has to be done with the well and surface facilities at the end of the drilling phase will depend to a large extent on governmental and local regulations. All surface facilities installed during drilling operations regularly need to be removed at the end of the project. The decommissioning plan must include the removal of all existing equipment or facilities from the drilling location. The removed equipment should be disposed by certified companies at qualified locations with supervision of accredited inspectors. Often, the location must be handed back to the landowner or state in the same (natural) conditions as at the time the project started. Accordingly, drilling site remedial and recultivation is an important and legally binding duty and liability.

Once all planned scientific on-site observations and measurements are done and related experiments and tests have been performed, the well needs to be plugged and abandoned. This is achieved by plugging open reservoir horizons and fresh water zones from bottom to surface. Reliable independent barriers are set downhole to avoid leakages or contamination by e.g., salty formation water or gas migration to freshwater zones or even to surface. From the engineering point of view plug and abandonment (P&A) means shutting down a well permanently to avoid influxes to the wellbore and surface. For this purpose, so-called bridge plugs of e.g., cement and viscous fluid pills are pumped into reservoir sections and wellbore to create reliable independent barriers. In this way contamination of aquifers or leakages from opened hydrocarbons reservoirs to surface and biosphere will be excluded. The individual length and position of the cement plugs

has to be planned in accordance to legislation and in cooperation with permitting authorities to exclude any health, safety and environmental risk.

The UK and Norwegian national oil and gas P&A guidelines are recommended for guidance and can be applied in scientific drilling projects. Their program can be used for single or multiple well plugging and abandonment:

- Design or preparatory work: evaluate well integrity, identify well sections to be plugged, select equipment and skilled personnel, find out local liability and regulations
- Reservoir (horizons) abandonment: select and install primary and secondary barriers to test or produce from selected geological horizons or reservoirs
- Intermediate abandonment: select and install primary and secondary barriers towards upper flowing zones like aquifers or perforated horizons
- Wellhead and conductor casing cut and removal: cut casing and retrieve it and also remove the wellhead to proceed to cement the cellar

Designing the P&A job involves calculation of cementing pumping pressures combined with slurry densities and displacement fluids. In order to fulfill local regulations and warrant a safe working environment engineering consultant support will often be needed.

In many cases, as mentioned above, the natural preexisting vegetation has to be rehabilitated after the equipment and facilities deinstallation is completed. It may also be necessary to involve an environmental project supervisor for external inspection and audit. Local authorities or environmental agencies will need to evaluate the location to confirm that the original conditions are re-

established in conformity with local regulations. The surface facilities removing plan together with the P&A plan and the location environmental evaluation report

shall be documented together in the Abandonment and Decommissioning Master Plan in order to hand it to the corresponding authorities.

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