

Guidelines for Well Abandonment.

WELL ABANDONMENT

Well abandonment shall prevent pressure build-up, or cross flow, in the well and its surroundings by isolating all permeable hydrocarbon zones and water zones of different pressure regimes from each other. Abandonment shall also prevent contamination of freshwater aquifers, block leakage of any wellbore fluids to the surface, and minimize the consequential effects of well operations on the environment. The abandonment procedure given in this section applies to a well that

1. Is completed as a non-productive well;
2. ceases to produce oil or natural gas;
3. Is no longer operated for the purpose for which the well is drilled.

Cement top, cement bond behind the intermediate and production casings shall be reviewed before planning well abandonment. Cement behind casing above porous intervals shall have good cement bonding (both formation to cement and cement to casing) at least 100 meters above and below the interval. If there are porous intervals not covered by the primary cementation of intermediate casings, remedial cementing must be conducted to isolate these intervals. It shall be ensured from cementing operation records (volume of cement slurry pumped, returns during cementing, cement plug top tagged inside casing) that surface casing is cemented up to surface and fresh water zones behind it are isolated. Well shall be stabilized before abandonment process.

The requirement of cement bond repair may not be applicable in cases where gas or hydrocarbon presence and migration through annulus cement & subsequent pressure build up in annulus were not observed.

For placement of plug, the requirements given in section 4.2 shall be fulfilled.

Permanent Abandonment

The process of abandonment essentially consists of down hole abandon plug(s), and surface abandon plug.

1. Down hole abandon plug

1.1 Open hole down hole abandonment

1. In uncased portion of well, cement plug shall be set to extend from a minimum of 30 m below the bottom to 30 m above the top of any oil, gas, or freshwater zones.
2. ***In addition, minimum 30 meters of cement shall be set above and below the previous casing shoe. This cement plug will also be considered as back up to the plug placed against the hydrocarbon bearing zone. The bottom of this back up plug shall be positioned such that the formation fracture strength at the base of the plug is in excess of the expected potential internal pressure. (Expected potential internal pressure refers to the pressure developed by the formation fluid at the base of the plug due to failure or leakage of the plug below it).***
3. ***For longer drilled intervals and multi porous zones in the open hole, where with one cement plug to cover all porous zones is difficult, two or more cement plugs shall be placed. The lower most cement plug shall extend 30 meters below the bottom most porous zone and the upper most plug shall extend 30 meters above the upper most porous zone.***
4. The plug(s) in the open hole shall be tagged after WOC by applying weight of at least 8 MT on the plug.

5. In case there is no oil, gas, or freshwater zone, the open hole shall be isolated by placing one cement plug of minimum 60 meters (30 m below and 30 m inside deepest casing shoe).
6. **Casing patch, casing failure point, cement squeezed intervals shall be covered by cement plugs, 30 meters above and below the extremities.**
7. For expected or known lost circulation conditions, a mechanical barrier device like bridge plug/retainer should be set 15 to 30 m above the casing shoe with minimum of 15 m of cement on top of the device. Alternatively lightweight slurry designed for adequate compressive strength may be used.
8. **Low plug(s) shall be build up and high plug(s) shall be drilled out until good hard cement plug is still within the deep-set target. .**

2. Cased hole down hole abandonment

- 2.1. Cement plug shall be set at least 30 m above to 30 m below the perforated interval, or down to a casing plug, whichever is less. When abandoning multiple permeable zones, due consideration shall be given to the number of permeable zones and whether isolation of all the zones is required or not. If multiple zones are not required to be isolated from one another, isolation of all zones from the rest of the well can be achieved by squeezing & plugging the shallowest zone.
- 2.2 **To ensure good quality cement plug, it would be preferable to provide a platform (bridge plug or cementing retainer) for placement of the cement plug. This will be compulsory for known loss circulation situations.**
- 2.3 **Bridge plug / cementing retainer mentioned above without cement plug on the top of it shall not be accepted as a barrier.**
- 2.4. **The second 30 meter cement plug, back up to the first plug shall be placed if permeable zone is hydrocarbon bearing or over pressured water bearing. The backup plug shall be positioned such that the formation fracture strength at the base of the plug is in excess of the expected potential internal pressure.**
- 2.5. When there is completion packer(s) in the hole that will not be retrieved, the perforated interval below the packers should be isolated by squeezing cement through the packer or spotting cement across the perforations. Cement should then be spotted above the packer.
- 2.6 The liner laps, if any, shall be isolated by setting a cement plug across the top of the liner, which shall extend at least 30 m into the liner. This can be omitted for the liner lap only if the liner lap was confirmed to have good cement bonding by logs and has been successfully pressure/inflow tested earlier.
- 2.7 In offshore exploratory locations, an intermediate cement plug of minimum 60 m length shall be placed in production casing at 1000-1500 m depth.
- 2.8 If casing(s) are cut and retrieved thereby leaving a stub inside the next larger string, abandonment cement plug(s) shall be set so as to extend a minimum of 30 m inside deepest stub and 30 m above largest stub covering all the annuli.
- 2.9 **Low plug(s) shall be build up and high plug(s) shall be drilled out until good hard cement plug is still within the deep-set target.**

While placing abandon plug in open hole or cased hole stated above it shall be ensured that the wellbore including the space between the cement plugs is filled with drilling fluid of sufficient specific gravity and other properties so as to enable it to withstand any subsequent pressure which may develop in the wellbore.

3. Surface abandon plug

3.1 Onshore wells

- 3.1.1 Before placing surface plug, all annuli shall be checked for any activity by opening wellhead valve.

- 3.1.2. Surface cement plug of at least 60 m length shall be placed in such a manner that the top of the plug is within 60 m below the mean ground level in the smallest string of casing.
- 3.1.33. **All the casing annulus should be pressure tested to verify isolation and annulus integrity above TOC. (The test pressure should not exceed LOT value at shoe of outer casing of the annulus).**
- 3.1.4. Capping and marking of the abandoned well shall be done to the satisfaction of the local authorities.

3.2 Offshore wells

3.2.1 Platform wells

1. Before placing surface plug, all annuli shall be checked for any activity by opening wellhead valve. All the casing annulus should be pressure tested to verify isolation and annulus integrity above TOC. **(The test pressure should not exceed LOT value at shoe of outer casing of the annulus).In case of pressure in the annulus, it shall be brought to zero by bulldozing, bleeding & lubrication etc.**
2. Surface cement plug of at least 60 m length shall be placed in such a manner that the top of the plug is within **100 m** below the mud line level in the smallest string of casing. The well shall be capped.

[The above procedure is applicable when the platform is not to be decommissioned and removed for site restoration. In case of platform decommissioning and removal, permanent well abandonment shall follow procedure given in the following section].

3.2.2 Exploratory wells with jack up rig

Procedure to be followed for a typical case of an exploratory well drilled from a jack up having 20" x 13-3/8" x 9-5/8" casings and 30" conductor is given here.

1. **Place a cement plug of 60 meters (or bridge plug with minimum of 15 meters of cement above it) at maximum possible depth.**
2. Check 20" x 13.3/8" annulus and 13.3/8" x 9.5/8" annulus for any activity. Fill both annuli with mud.
3. Perforate 9.5/8" & 13.3/8" casings simultaneously 25 m above 20" shoe with high density perforation gun. Open 20" x 13-3/8" annulus and 13-3/8" x 9-5/8" annulus valve one by one and try to establish circulation individually. Limiting pressure should be LOT value of corresponding shoe or 70% of collapse/ burst pressure rating of casings. Place cement slurry of calculated volume. Close BOP. Open outer annulus first and raise 50 m cement slurry into annulus. Raise cement slurry in inner annulus by same height following above procedure. Close both the annuli and squeeze cement slurry up to 1000 psi
4. Cut and retrieve 9.5/8", 13.3/8" and 20" casing or open and retrieve casings from MLS if used.
5. Place a balanced plug of at least 30 m below the 9.5/8" casing cut point up to 4 to 5 m below the mud line to cover all casing stubs as per 11.1.2.5.
6. The plug placed as per point 5 should be tagged after W.O.C by applying a wt of at least 8 tons.
7. Cut and retrieve 30" conductor at least 1 m below seabed.
8. All casing and protective structures shall be removed to the satisfaction of the governing authority for the clearance of **location**.

In line with the above, surface abandon plug procedure shall be formulated well wise.

3.2.3 Sub-sea wells

Surface abandon plug of minimum 60 m length shall be placed in such a manner that top of the cement plug is at about 200 – 250 meters below wellhead.

Besides the surface abandon plug, there shall be the requirement of a permanent well barrier, at an appropriate depth, that must include all annuli, extending to the full cross section of the well and seal both vertically and horizontally (often referred to as rock to rock / restoring the cap rock).

4. Temporary abandonment

The temporary abandonment must be carried out such that the well can be re-entered safely and then secured using pressure control equipment without compromising the barriers in place.

- 1. Two cement plugs (minimum 30 meters length each) shall be placed if a permeable zone is hydrocarbon bearing or over pressured water bearing. The second plug is back up to the first plug.*
- 2. These two cement plugs shall be placed as close to the potential source of inflow as possible, covering all possible leak paths.*
- 3. Both cement plugs shall be lapped by annular cement of at least length equal to that of the plugs.*
- 4. Cement plug shall be set on a bridge plug or cementing retainer as a suitable base compulsorily where is possibility of cement plug slippage down hole due to cement slurry density or losses, well activity or high gas content in formation fluid. It would be preferable in normal situations.*
- 5. Cement plug(s) shall be tagged after WOC by applying weight of at least 8 MT and pressure tested at 1000 psi or up to LOT value at shoe, whichever is less.*
- 6. A cemented shoe track shall not be accepted as a plug unless it is specifically designed and proved by adequate pressure testing at least 2.0 ppg above the expected LOT. (For situations where the rig has to be skidded between the slots during batch drilling, the weight and pressure tested shoe track with mechanical top plug can be treated as a plug for temporary abandonment)*
- 7. A permanent bridge plug or cementing retainer (not activated) with minimum 15 meters cement plug on it will be accepted as an alternate to the first cement plug. Bridge plug / cementing retainer alone shall not be accepted as a barrier.*
- 8. The production liner lap shall be isolated by setting a cement plug across the lap of the production liner which shall extend at least 30 meters into the liner.*
- 9. For subsea producing or development wells, integrity shall be monitored during the abandonment / shut-in period six monthly.*
- 10. Cement plug of at least 60 meter in length shall be set in the casing with top of the plug no more than 300 meter below the mud line.*
- 11. For offshore wells drilled by jack up rigs without platform, dual seal type T/A caps shall be installed on MLS (Mud Line Suspension System). The dual seal type T/A caps are installed through BOP. A single temporary abandonment cap shall cover both production bore as well as annulus, locking the hangers in place.*