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AE Carbon Storage - Legacy Well Re-Entry

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October 2020

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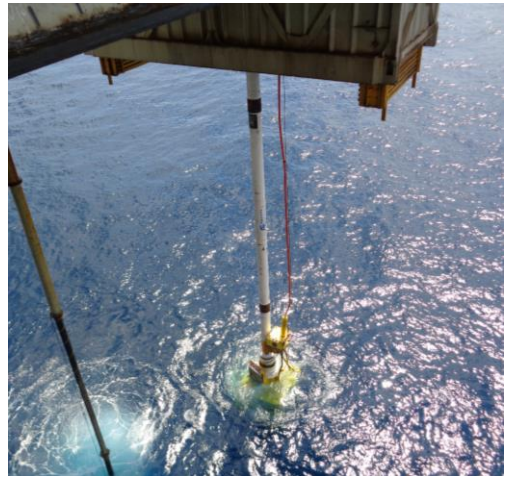
Legacy Well Re-Entry

Legacy oil and gas fields are often considered good carbon storage locations given the proven formation properties and existing infrastructure

- Security of the formation that the CO2 will be stored
- Liability of legacy wells
- Cost to correctly secure legacy wells for CO2 integrity - costly relief/intersection well

Oil and Gas proven well re-entry / tieback techniques can help carbon capture projects eliminate these issues associated with legacy wells but in some cases the technology will need to be expanded to cover below mudline abandonments.



Sink Scenario	Adaptation of existing platform to host injection wells?	Modification of existing wells for CO_2 injection?
CO_2 storage in a depleted gasfield	Estimated at 50% possibility	Estimated at 50% possibility
CO_2 storage in a depleted oilfield	Estimated at 50% possibility	Estimated at 50% possibility
EOR at an oilfield followed by CO_2 storage	Estimated at 50% possibility	Production wells remain in use. New subsea injection template and new wells required (but 50% opportunity to re-use water injection wells if available).
CO_2 storage in a saline aquifer	New platforms required.	New wells required.

Table 5.1 Suitability estimated for existing platform and wells. N.B. Network costs in later chapters assume new infrastructure is used.

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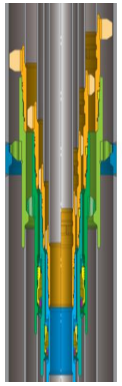
Legacy Well Re-Entry

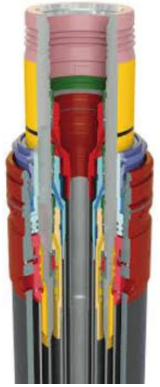
What is tieback / well entry engineering?

- Developed in the 1970's basic casing back off then in the 1980's first stack down hangers
- Disconnection from wells at the mudline during exploration and appraisal drilling
- Provides a means to pre-drill wells to gain first oil faster
- Used for intervention, suspension, abandonment and production (bringing online suspended wells)

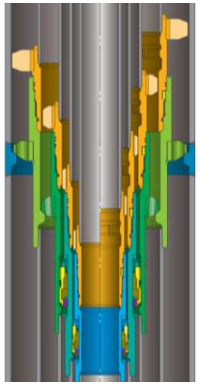
Platform Well (Pre-drill)
Tieback / Well Re-Entry

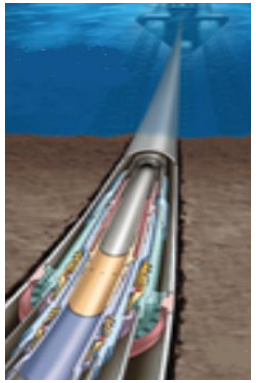


Subsea Well
Tieback / Well Re-Entry



Mudline Suspension Well
Tieback / Well Re-Entry





Platform Well
Tieback / Well Re-Entry

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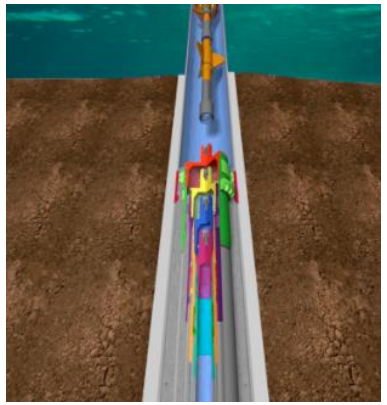
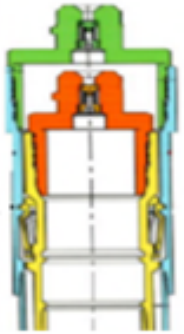
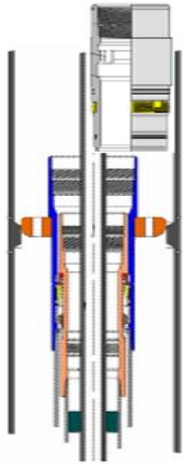
Legacy Well Re-Entry

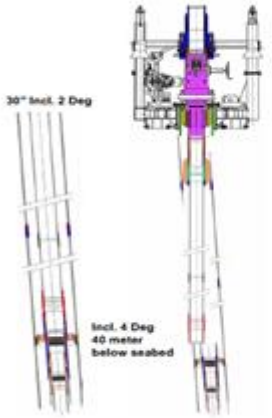
- **Common challenges** – TA caps, seal and thread condition, hanger not set correctly, environmental barrier engagement (stiff inflexible), conductor/LP housing angle, debris

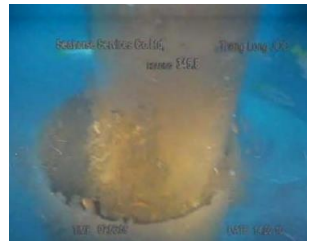
- **Additional challenges** for platform wells – jacket installation alignment, guide tolerances, top side restrictions, tieback not considered

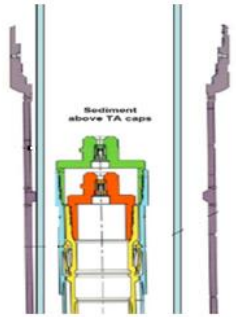


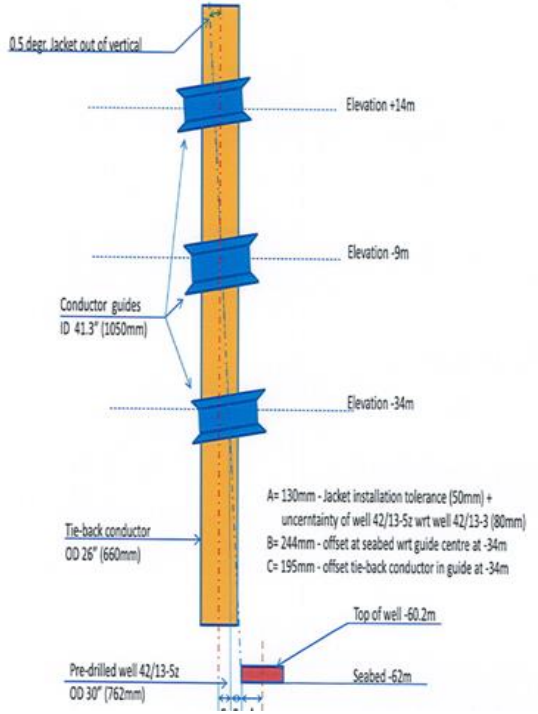












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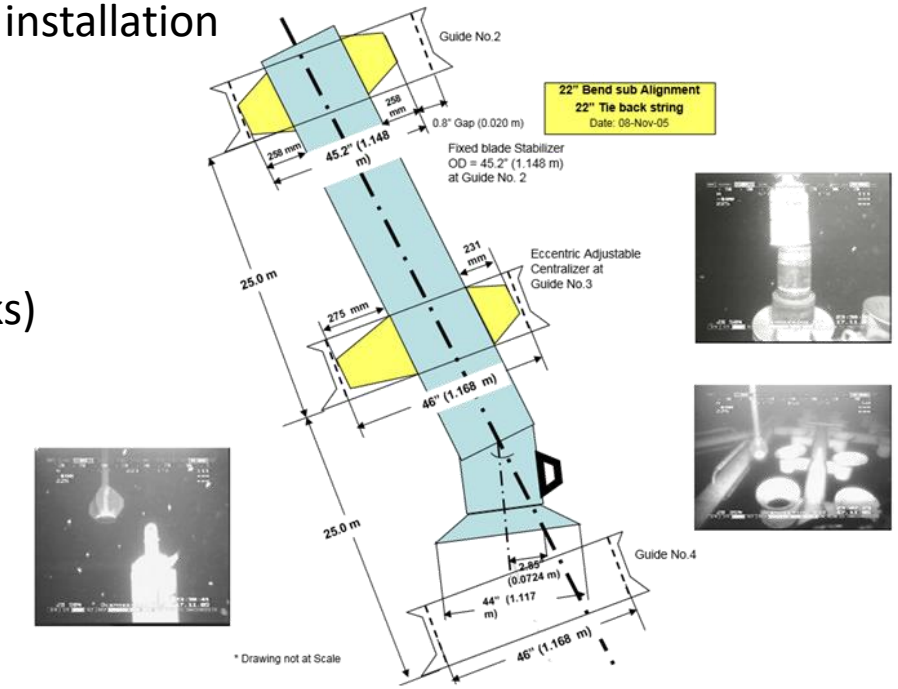
Legacy Well Re-Entry

- **Prevention is better than cure**
  - Advanced planning including current and future scopes (design in the tieback phase)
  - Well suspension/re-entry procedures, equipment selection and preservation (between suspension and re-entry)
  - Platform well (pre-drill) extends to jacket design, manufacture and installation

- **Legacy wells inherited challenges**
  - Early planning and remedial offline work is key
  - Inherited challenges need plan A, B, C (trip time is short for tiebacks)
  - Missing data



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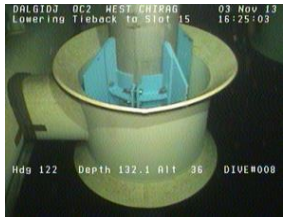
Legacy Well Re-Entry

- **Planning, interface engineering and contingency is key to any tieback well re-entry project**
  - Well data review
  - Riser / tieback analysis
  - Interface requirements and management
  - Well control planning
  - Contingency planning and bespoke equipment
  - Source equipment and design legacy (if required) tooling
  - Tieback procedures as relevant (pre-drilling, jacket installation, suspension, re-entry, contingency)
  - Offshore operations

Plan	Prepare	Interface/Engineer	Contingency	Perform Offshore

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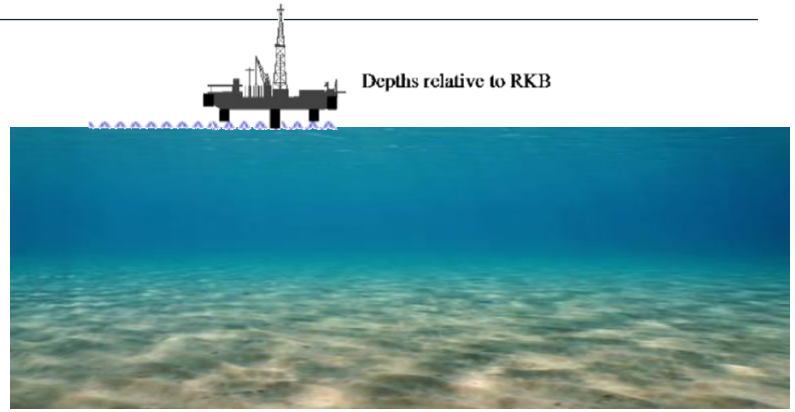
Legacy Well Re-Entry: Abandoned Well (CCS) Tieback / Well Re-Entry

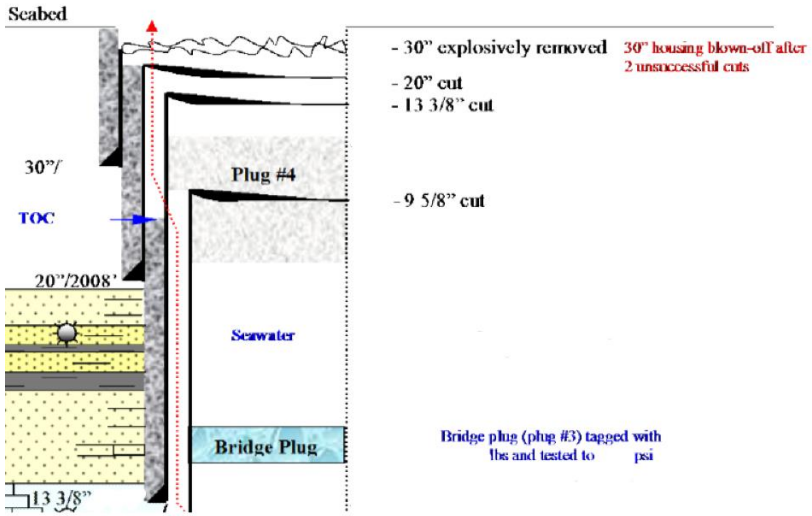
New challenges to overcome for CCS projects: Abandoned Well (CCS) Tieback / Well Re-Entry

Abandoned Well (CCS)
Tieback / Well Re-Entry

Many abandoned wells have conductor and casing cut several meters below mudline, no hanger system and shallow cement plugs covering the strings

- Abandoned wells not designed to be re-entered
- Location of well centre and depth to casing
- Cement and casing pipe clean up (explosively, cement dumped ontop)
- Establishment of below mudline to surface conduit
- No mudline hangers for tieback of pressure retaining conduit





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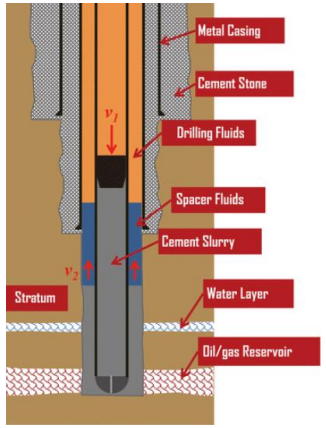
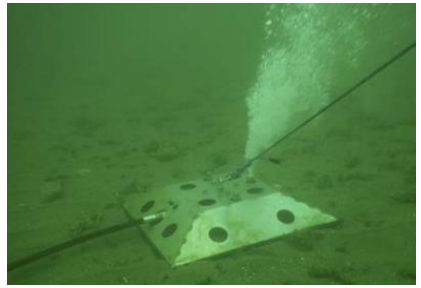
Legacy Well Re-Entry: Abandoned Well (CCS) Tieback / Well Re-Entry

Abandoned wells not designed to be re-entered: Well barrier review, potential testing and monitoring



- **Best case:** Suited the formation, pressure and composition at the time of abandonment
  - Provides an opportunity to review data and possibly approve for CO2 storage projects
  - Consider subsea monitoring of in life CO2 leakage
  - No requirement for well re-entry
- **Worst case:** poorly executed, unsatisfactory abandonment with incomplete barriers and supporting information
  - Likely requires measures to be undertaken to ensure security for CO2 storage
  - Remedial work involving well re-entry via tieback (best case) or relief/intersection well (worst case)



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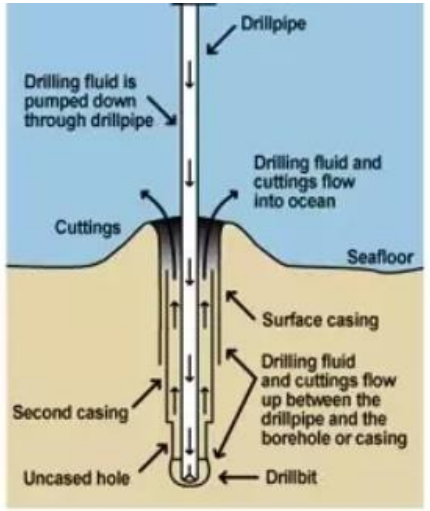
Legacy Well Re-Entry: Abandoned Well (CCS) Tieback / Well Re-Entry

- **Work prior to the jack up being onsite**
  - Locate below mudline well casings accurately. Use same vessel for jack up spud can seabed survey
    - Spud can core samples required between 5m to 100m
    - Add Magnetometer survey
    - Add potential seismic survey
    - Add potential core sample over well target
  - Pre work if any at the worksite – mark location with template

Location of well centre and depth to casing

- **Jack Up On Site – Environmental Barrier**
  - Find the abandoned well stub via template or potential suction can and conductor
  - Drill pilot hole and tag TOC with proximity / range finder BHA
  - Skid drilling package to suit well centre
  - Drill out with hole opener to conductor
- Maybe necessary to trip back in to cut clean up / dress conductor/casing/cement below mudline

Cement and casing clean up



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Legacy Well Re-Entry: Abandoned Well (CCS) Tieback / Well Re-Entry

- **Jack Up On Site – Environmental Barrier**

- Provide a conduit to the first casing string
- Overshot installed over cleaned up conductor OR Internal stinger inside conductor
- Run or washdown overshot or internal stringer, bring conduit back to surface

Establish below mudline to surface conduit

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Legacy Well Re-Entry: Abandoned Well (CCS) Tieback / Well Re-Entry

- **Jack Up On Site – Environmental Barrier Installed**
  - RIH with brushing, flushing and inspection BHA

- **Option 1: Casing Back Off / Re-Connection**
  - CCL log to find upper casing location
  - RIH with hydraulic casing backoff tool and make up tooling, break coupler and recover casing stub
  - RIH with casing string, make up tieback connection with tool hydraulic casing make up tooling
    - Use latch style connection or standard threaded connector
    - Suitability dependent on casing connector type

Casing overshot patches or casing reconnection for well control

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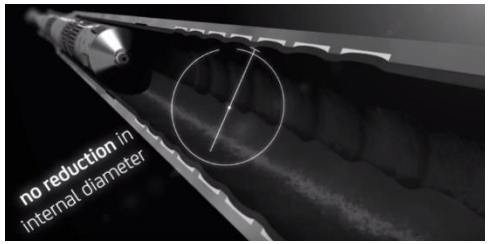
Legacy Well Re-Entry: Abandoned Well (CCS) Tieback / Well Re-Entry

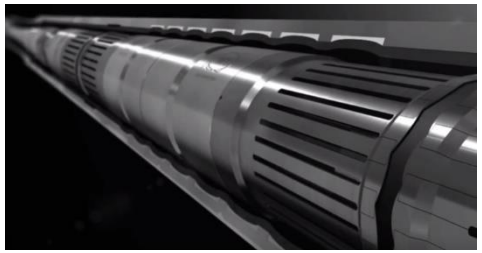
Where casing connectors are not suitable for back off / reconnection

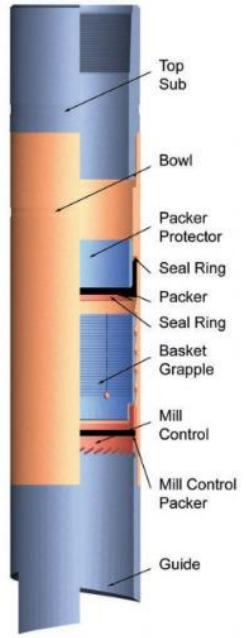
Casing overshot patches or casing reconnection for well control

- **Option 2: Casing Patch - Non-gas tight**
  - Make connection via casing patch – Non-gas tight

- **Option 3: Casing Patch Gas tight**
  - Make connection via metal to metal overshot – Gas tight







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Legacy Well Re-Entry: Abandoned Well (CCS) Tieback / Well Re-Entry

- **Jack Up On Site – Environmental Barrier Installed, Casing Back To Surface**
    - Nipple up surface exploration rental well head (if required) and or surface BOP
    - Well control established
    - Drill out upper cement plug
    - Perform further casing string tiebacks if required
    - Complete CCS enhanced abandonment activities

Once well control established complete improved barrier scope

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Legacy Well Re-Entry: Conclusion

- Legacy oil and gas fields are often considered good carbon storage locations given the proven formation properties and existing infrastructure – legacy wells present a challenge
- Established tieback techniques can offer CO2 storage projects the potential to select existing formations with legacy well issues
- Can remove the need for costly relief/intersection wells
- Expansion of proven tieback techniques
- Abandoned Well (CCS) Tieback / Well Re-Entry (below mudline conductor/casing) requires industry collaboration and early engagement

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