EXAM PART A - Well Integrity (45p)

In 2000, an oil producing well was drilled and completed in the Norwegian sector of North Sea. The well was in production status for 14 years and in 2014, due to the low oil price, low productivity, and well integrity issues, the well owner decided to put the well in temporarily abandoned status. The initial reservoir pressure was 160 bar, and the current reservoir pressure is 100 bar. Gas lift technique was applied to produce from the well. The wellbore schematic and well information is provided in Appendix A. Considering the provided information, answer the questions of Part A.

A.1. Define the fundamental concept of "Well Integrity Management System" in your own words. (**5p**)

A.2. During well construction and completion, primary and secondary well barrier envelopes are established to control flow from formation fluid(s). A well barrier envelope can consist of different well barrier elements. Generally, drilling fluid(s) is not an acceptable well barrier element; however, during drilling, it is accepted. What is the reasoning for selecting drilling fluid as well barrier element during drilling of wells? (**5p**)

A.3. List 5 well integrity issues and failures in well design, created during construction and production from this well. (**5p**)

A.4. In order to put the well in temporary abandoned status, primary and secondary well barrier envelopes shall be established. Mark the primary envelope with "Blue" and secondary with "Red", in Appendix A. List the selected elements for each envelope. Write your solution(s), if well intervention activities to be conducted for establishing the envelopes. (**15p**)

A.5. Based on the selected well barrier elements, in previous question, create a well barrier diagram (WBD). Why is a well barrier diagram created? (**15p**)

EXAM PART B – Permanent P&A (55p)

Due to COVID19 pandemic situation, the well owner decided to permanently plug and abandon the well. This is a platform well and the rig (installed during well construction) is out of service and it is not qualified to be operational. Review the provided appendix and answer the questions in Part B of this exam.

B.1. Explain Phase 0 of P&A operations and list activities that can be done on this well during this phase. (**5p**)

B.2. Calculate the minimum setting depth for establishing the permanent barriers. (**10p**)

B.3. List the activities to be conducted to permanently plug the reservoir. How many permanent plugs are required to be installed? How the permanent plugs will be verified and qualified (i.e., what type of testing shall be conducted)? (**10p**)

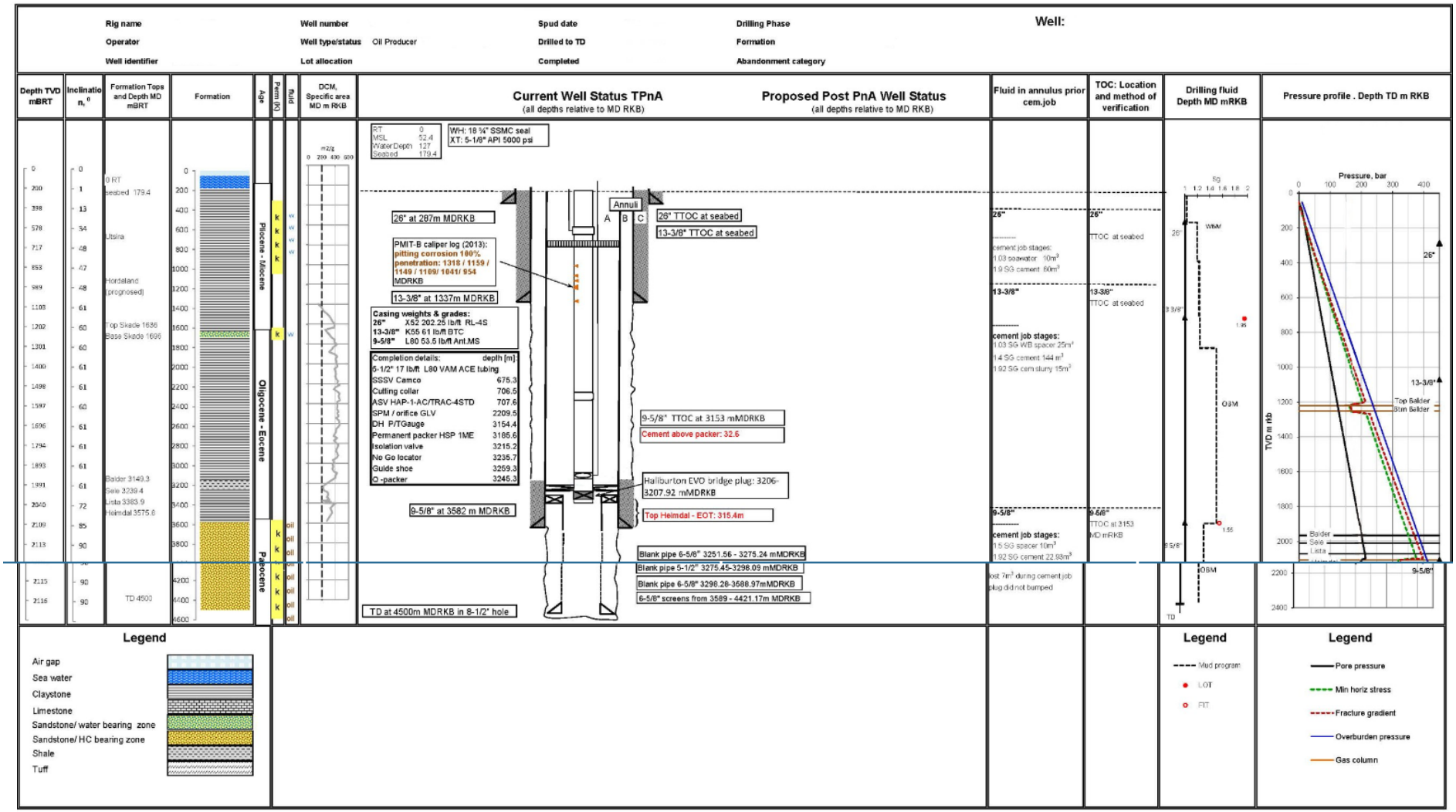
B.4. To establish the permanent well envelopes, cross sectional barriers (known as rock-to-rock) shall be installed. Therefore, the 9 5/8-in. casing is a challenge as there is not cement behind it. List three techniques to solve the issue with casing for establishing a rock-to-rock barrier. List advantages and challenges of each technique. (**10p**)

B.5. How many plug(s) are necessary to be installed for the overburden? Write your reasoning for the proposed depth(s). List the operational sequences until the barrier(s) are in place. How are you going to verify the plugs after placement? (**5p**)

B.6. Why it is necessary to establish an environmental plug for this well? Why should we call the plug as “Environmental Plug” but not as “Environmental Barrier”? (**5p**)

B.7. If you were drilling and constructing the well, what source of modification would you do to minimize the risk of well integrity issues and ease the P&A operation? (**10p**)

Good Luck!


Rig name
Operator
Well identifier
Well number
Well type/status Oil Producer
Lot allocation
Spud date
Drilled to TD
Completed
Drilling Phase
Formation
Abandonment category
Well:
Depth TVD mBRT
Inclination, °
Formation Tops and Depth MD mBRT
Formation
Age
Perm (K)
fluid
DCM, Specific area MD m RKB
Current Well Status TPnA
(all depths relative to MD RKB)
Proposed Post PnA Well Status
(all depths relative to MD RKB)
Fluid in annulus prior cem.job
TOC: Location and method of verification
Drilling fluid Depth MD mRKB
Pressure profile . Depth TD m RKB
RT 0
MSL 52.4
Water Depth 127
Seabed 179.4
WH: 18 ¾" SSMC seal
XT: 5-1/8" API 5000 psi
0 RT
seabed 179.4
Utsira
Hordaland (prognosed)
Top Skade 1636
Base Skade 1698
Balder 3149.3
Sele 3239.4
Lista 3383.9
Helmdal 3575.8
TD 4500
Pliocene - Miocene
Oligocene - Eocene
Paleocene
26" at 287m MDRKB
PMIT-B caliper log (2013):
pitting corrosion 100%
penetration: 1318 / 1159 /
1149 / 1109/ 1041/ 954
MDRKB
13-3/8" at 1337m MDRKB
Casing weights & grades:
26" X52 202.25 lb/ft RL-4S
13-3/8" K55 61 lb/ft BTC
9-5/8" L80 53.5 lb/ft Ant.MS
Completion details: depth [m]
5-1/2" 17 lb/ft L80 VAM ACE tubing
SSSV Camco 675.3
Cutting collar 706.5
ASV HAP-1-AC/TRAC-4STD 707.6
SPM / orifice GLV 2209.5
DH P/TGauge 3154.4
Permanent packer HSP 1ME 3185.6
Isolation valve 3215.2
No Go locator 3235.7
Guide shoe 3259.3
O -packer 3245.3
9-5/8" at 3582 m MDRKB
TD at 4500m MDRKB in 8-1/2" hole
Annuli
A
B
C
26" TTOC at seabed
13-3/8" TTOC at seabed
9-5/8" TTOC at 3153 mMDRKB
Cement above packer: 32.6
Halliburton EVO bridge plug: 3206-3207.92 mMDRKB
Top Helmdal - EOT: 315.4m
Blank pipe 6-5/8" 3251.56 - 3275.24 mMDRKB
Blank pipe 5-1/2" 3275.45-3296.09 mMDRKB
Blank pipe 6-5/8" 3296.28-3588.97mMDRKB
6-5/8" screens from 3589 - 4421.17m MDRKB
26"
cement job stages:
1.03 seawater 10m³
1.9 SG cement 60m³
13-3/8"
cement job stages:
1.03 SG WB spacer 25m³
1.4 SG cement 144 m³
1.92 SG cem slurry 15m³
9-5/8"
cement job stages:
1.5 SG spacer 10m³
1.92 SG cement 22.98m³
lost 7m³ during cement job
plug did not bumped
26" TTOC at seabed
13-3/8" TTOC at seabed
9-5/8" TTOC at 3153 MD mRKB
WBM
OBM
Pressure, bar
TVD m rkb
Top Balder
Strm Balder
Balder
Sele
Lista
Legend
Air gap
Sea water
Claystone
Limestone
Sandstone/ water bearing zone
Sandstone/ HC bearing zone
Shale
Tuff
Mud program
LOT
FIT
Pore pressure
Min horiz stress
Fracture gradient
Overburden pressure
Gas column