NWT OFFICE OF THE REGULATOR OF OIL AND GAS OPERATIONS

Office of the Regulator of Oil and Gas Operations
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Mr. Lloyd Doyle
Corporate Operating Officer
Paramount Resources Ltd.
4700 Bankers Hall West
888 3 STREET SW
CALGARY AB 42P 5C5

February 9, 2017

Dear Mr. Doyle:

Approval of Amendment - Fort Liard F-36 (ACW-2016-003)

This letter is to confirm my approval of an amendment to the program for the abandonment of the Fort Liard F-36 well. The approval was issued verbally on February 6, 2017. A copy of the approved amended program is attached.

If you have any questions, please contact me at 867-767-9097 or by email at James_Fulford@gov.nt.ca.

Sincerely,

James Fulford
Chief Conservation Officer

Encl.

Bureau de l'organisme de réglementation des opérations pétrolières et gazières
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BUREAU DE L'ORGANISME DE RÉGLEMENTATION DES OPÉRATIONS PÉTROLIÈRES ET GAZIÈRES DES TN-O

Abandonment Program for Paramount Fort Liard F-36

Revision 4- 20170207

Revision to set tubing plug in 60mm string (Mattson) as well can't be killed

Well Name:	Paramount et al Liard F-36		
Area:	60-10-123-15		
Location:	Latitude: 60^0 05' 27"		
	Longitude: 123^0 22' 00"		
UWI:	300F366010123150	WID:	1841
Spud Date:	March 3, 1998		
Rig Release Date:	March 28, 1998 (Suspended drilling for break-up)		
Well Status:	Dually-completed as a Mattson/Fantasque gas producer. Currently shut-in		
Last Workover	March 2006		
KB Elevation:	470.3 m	Ground Elevation:	464.8 m
PBTD:	2092 mKB	TD:	2110 mKB

Casing & Cementing

Surface Hole:	311 mm to 502 mKB		
Surface Casing:	244.5 mm, 48.07 kg/m, H-40, ST&C set at 502 mKB. Cemented with 30 t class 'G' cement plus 2% CaCl2. 3m3 cement returns to surface.		
Intermediate Hole:	222 mm to 1494 mKB		
Intermediate Casing:	177.8 mm, 34.2 kg/m, J-55, LT&C set at 1494 mKB. Cemented with 20t 1:1:2 and 19 t Expandomix+ 0.15% CFL-3 + 0.3% LTR. 2 m3 cement returns to surface		
	Burst (80%) 24MPa	Collapse	18Mpa
Main Hole:	156mm to 2110 mKB		
Liner:	114.3mm, 17.26kg/m,L-80, LT&C, set at 2107.59mKB. Cemented with 15.8t 0:1:0 "G" + 0.4% D-24 salt gel Liner top @ 1387.7m		
	Burst (80%) 42MPa	Collapse (80%)	35Mpa
Tubing #1	60.3mm 6.99kg/m J-55		
	Burst (80%) 42MPa	Collapse (80%)	44Mpa
	Joint Tensile yield (80%)	25,520daN	
Tubing #2	52.4mm 4.84kg/m J-55		
	Burst (80%) 40MPa	Collapse (80%)	42Mpa
	Joint Tensile yield (80%)	17,440daN	

Program Summary

Note: Preparation, road construction and rig up will be handled by a separate document incorporating the requirements of the Operations Authorization and supporting documents (Safety Plan, Environmental Protection Plan, and Emergency Response Plan which are already on file with OROGO). These documents well be onsite for reference by the site supervisor, along with site specific extracts, emergency contact numbers etc.

This document focuses on the describing the operations planned for the well.

Overview:

The Fort Liard F-36 well was drilled in 1998. It was initially completed as a Mattson gas producer (after an unsuccessful test of the Golata). The Fantasque was subsequently perforated and the well re-completed as a dual producer (tubing and annulus) – both zones were sweet gas. Gas production up the annulus from the Fantasque was insufficient to overcome associated water production and in 2005 the well was recompleted again using a dual tubing configuration. Gas production has declined and the well was shut-in in 2007. The field is shut-in with some of the facilities decommissioned. The purpose of this program is to permanently abandon the depleted Mattson and Fantasque zones, and the cut and cap the well.

A wireline plug was dropped on top of the packer @ 1383mKB in 2005 and it appears to have fallen beside the slick-joint. Attempts to retrieve it or to connect to the packer were not successful at that time. Thus it is not possible to latch onto the connector and retrieve the packer. Similarly, the presence of the loose plug on top of the packer makes it impractical to mill around the outside of the packer (a difficult operation with a permanent packer in any case). For this reason, neither the liner top at 1387mKB nor the lower perforations are accessible to be isolated with bridge plugs and cement.

Paramount therefore proposes the abandon the lower zone (Mattson – top perforation 1582) by removing the current tubing strings, and setting a cement retainer immediately above the existing packer. An attempt will be made to squeeze cement into the Mattson perforations. Cement will then be spotted across the Fantasque perforations (on top of the retainer) and a squeeze of the Fantasque attempted. Previous experience indicates that the Fantasque is very tight and little cement is likely to be accepted. The top of the remaining cement plug will be tagged and must be at least 1325mKB (19 meters above the top Fantasque perforation).

During the 2014 and 2016 Shut-in Well Inspections, a surface casing vent flow was noted.
Once the Fantasque is abandoned, the uphole sections will be logged and this information combined with gas and geological analysis will be used to determine a squeeze program to shut off any surface casing vent flow prior to cutting and capping the well.

The wellbore will be left filled with fresh water. An air space will be left at the top of the wellbore to prevent freeze-back of the wellbore fluid (water). Although there is no observed history of permafrost in this well, the NRCAN "permafrost Map" indicates "Sporadic Discontinuous Permafrost" in the area, and none of the boreholes in the area (200-400 km) indicated any permafrost, the air space is considered prudent.

Proposed Operations:

The steps of the operation are listed below. Paramount believes that this is an acceptable abandonment procedure for the Mattson and Fantasque zones, given the current state of the well. As the guidelines for suspension and abandonment of wells in the NWT are currently not finalized, the Alberta Energy Regulator (AER) Directive 20 has been used as a guideline for this operation, in conjunction with communications with representatives from OROGO.

1) Check for surface casing vent flow (bubble test).
   Contact Calgary immediately if there is no flow.
   Report results on AM report.
   The well is anticipated to show flow based on the 2014 and 2016 Shut-in Well Inspections. Measure & record flow rate as per AER Directive 20.

   a) Have technician from AGAT take gas samples from surface casing vent for analysis.
      (This may be done prior to start of operations to expedite results)
      See condition 13 of the AACW.

   b) Install a monitoring device (with recording capability) on the surface casing vent (Vent Nanny or equivalent).

   c) Obtain a stabilized shut-in pressure on the surface casing.
      Monitor to ensure the pressure does not exceed 6,000kPa.
      (L.O.Test 1998 @ 512m 23.05kPa/m – with no breakdown)

   d) Open surface casing vent to flow. Route vented gas so it does not accumulate and cause a hazard. Leave vent open during operations.
      See condition 14 of AACW

      If well does not show any flow via the surface casing vent, it will be steamed after the Fantasque zone is abandoned to ensure that the vent is not just frozen off.

2) Verify that there are no tubing plugs set before releasing slick-line.

   a) Check pressure on 52mm string (11,000kPa in Oct 2016).
      Attempt to bleed down pressure on 50mm tubing.
      Close 52mm tubing and re–check pressure.
      Assuming there are no plugs in the tubing pressure should not bleed down significantly.

   b) Check pressure on 60mm string (11,000kPa in Oct 2016).
      Attempt to bleed down pressure on 50mm tubing.
      Close 60mm tubing and re–check pressure.
      Assuming there are no plugs in the tubing pressure should not bleed down significantly.

   c) If there is any doubt, rig up slick line and run sinker bar to be sure tubing is open.
      (See attached downhole diagram).

3) Kill well with fresh water.
   Do not use produced water -- fresh water is sufficient to kill both zones.
   This will avoid the need to circulate the well to fresh water after plugging operations.

4) As Mattson can't be killed (can't squeeze water into Mattson for "Lubricate & Bleed") set plug in 60mm tubing.

   a) Rig up E-line and run gauge ring to +/- 1385m

   b) Set permanent tubing plug at +/- 1383

   c) Bleed off tubing and confirm both sides of tubing and annulus are dead.

   d) Tubing is not dead, set additional bridge plug higher in tubing string (as low as practical)

5) Rig up service rig and stump test BOPs to 1400 kPa & 21 MPa X 10 minutes.
   Annular is required on this well only (to allow well control with 60mm tubing prior to pulling tubing hanger). (Tubing will be offset till tubing hanger clears the BOP).
   Note: 52mm offset rams are required. (Offset will be 1.86" or 47mm from center)

   a) Ensure well is dead.
      Remove bonnet(s) and master valves (4)

   b) Install 2-way BPV in 60mm and 52mm side of tubing hanger.

   c) Install BOPs.
      Ensure service rig is positioned to allow BOP doors to be opened to change rams, and ram cavities are oriented to allow ram change.
      The alignment pin (typ. Hex key) on the tubing spool should be at the 12 o'clock position and the rig at 6 o'clock. The 60mm tubing string should be on the left (9 o'clock) and the 50mm string on the right.
      The reverse is likely also acceptable – check on location.
      See drawing of wellhead components at the end of this program.
      Remove 52mm BPV

   d) Screw 52mm pup (with X/O and stabbing valve) into 52mm tubing hanger.

   e) Pressure test rams and BOP connection to 1400 kPa & 21 MPa X 10 minutes.

   f) Remove 60mm BPV

6) Pull tubing strings

   a) Pull 52mm tubing from the well and lay down.
      Check for NORM with scintillation detector as tubing is pulled.
      Immediately stop pulling tubing and contact Calgary office if NORM is detected.
      A specialist will be required to supervise pulling tubing if NORM is detected.

   b) Install 2-way BPV in 52mm tubing hanger.
      Land 52mm tubing hanger & BPV in 178mm (main) tubing hanger.
      (a 52mm pup joint may be used below the 52mm mandrel tubing hanger to facilitate installation of the hanger)
      Remove 52mm landing joint.

   c) Change to 60mm pipe rams.
      Offset rams will not be used – as soon as the tubing hanger is pulled the tubing will be essentially centered in the wellbore.)

Install 60mm and 52mm back pressure valves.
Place 60mm pup with collar just below pipe rams – close top with stabbing valve and X/O
Pressure test rams to 1400 kPa & 7 MPa X 10 minutes.

d) Check for pressure and remove 60mm BPV.
Install 60mm lifting joint.
(52mm BPV may be left in place – it will come out with the tubing hanger)

e) Pull 60mm tubing from the well with Baker FH packer @ 1383m KB.
Packer is hydraulic set. Release is straight pull with shear release.
Shear is typically set to 30,000 lbs (15,000 daN) but could be 10-25,000 daN.
Laydown tubing.

If packer will not release, come off On-Off connector at 1379m KB, leaving packer @ 1379m in place.
If not possible to come off On-Off connector, cut tubing as low as practical above On-Off connector.
Check for NORM with scintillation detector as tubing is pulled.
Immediately stop pulling tubing and contact Calgary office if NORM is detected.
A specialist will be required to supervise pulling tubing if NORM is detected.

7) Rig up E-line

a) Run a 158.5mm gauge ring and CCL to +/-1383mKB tagging the top of the slick joint.

b) Set a 178mm (nominal) bridge plug as close as practical on top of the packer at 1383mKB, avoiding a casing collar.
Note this bridge plug cannot be pressure tested due to the open perforations above, and a hydraulic lock with the packer/plug below it would render the test inconclusive in any case. In addition, the cement plug (discussed below) on top of the bridge plug will be squeezed and then pressure tested.

c) Rig down E-line.

8) Pick up 73mm tubing & run in hole.
If the 60mm tubing pulled from the well is in good condition, this may be used instead of the rental 73mm string.

9) Squeeze Fantasque perforations.

a) Spot 150m (3.0m3) cement as a balanced plug on top of the permanent bridge plug.
More may be spotted if in the cement unit/lines to avoid surface disposal.
Take surface cement samples.

b) Pull up to 1230m and reverse circulate the tubing clear with freshwater (minimum 0.3m3).
Pull up 1 joint.

c) Close BOPs and apply squeeze pressure via the annulus.
Maximum squeeze pressure is 14,000kPa.
A minimum squeeze pressure is of 7,000kPa is required. Based on past performance of the

Fantasque this should easily be achieved, but perform a hesitation squeeze if required. Squeeze a maximum of 1.5 m3 cement.

d) Reverse circulate annulus & tubing volume (+/- 28m3) while waiting on cement to ensure tubing is free of cement.
Check returns for salinity with refractometer.
TDS must be below 4000 ppm or well will have to be displaced to fresh water and returns hauled to disposal.
Ensure ticket to confirm acceptance at disposal location is sent to dickheenan@shaw.ca with original sent to Paramount Resources.
Note: If TDS is over 4000 or if water appears cloudy (e.g. from cement or precipitate), water may be filtered through a coffee filter (or several layers of paper towel) and re-checked. (It is the dissolved not the suspended solids that matter.)

10) Pressure test plug and casing

a) Wait on surface cement samples to set.

b) Pressure test plug to 14,000 kPa for 10 minutes.
(Ref: AER Directive 20 5.3.5.2 Option 4)
Note any response to the pressure test on the SCV monitor.
If pressure test fails, pick up packer to locate source of leak.
Contact Calgary Office with pressure test results for remediation.
Note: Tag cement top as below before using packer to locate leak

11) Confirm plug top with tubing (minimum weight is 1800 daN).
(Ref. AER Directive 20 – 6.1 Method 1)
Report depth on the morning report.
Plug top must be at least 1325m (19 meters above the top Fantasque perforation).

12) Pull out all tubing.
If the surface casing vent test has been negative (no flow) during all operations, steam the top 3 meters of the casing overnight to ensure that the casing vent is not frozen and re-check for surface casing vent flow.
If there is no indication of gas flow or pressure after steaming, contact Calgary Office for discussions with OROGO.
Leave surface casing vent open to monitoring device.

13) Rig up electric wireline to locate source of surface casing vent flow.

a) Close surface casing vent overnight and allow temperatures to stabilize.
With surface casing vent closed, run a baseline temperature log (running into the well) from surface to plug back depth (approximately 1325mKB).
Note: Well must have been shut-in (no tripping of tubing, wireline tools etc. for a minimum of 12 hours) prior to running temperature log.

b) Run a noise log with stops at for 1 minute every 10m from PBTD @ 1325mKB to surface.
Evaluate and take additional measurements as/if indicated in potential areas of interest.

c) Run a radially segmented cement evaluation log from plug back depth (approximately 1325mKB to surface).

d) Leave well (SCV) shut-in overnight to allow temperature to stabilize.
Open the surface casing and allow to flow.
Run a temperature log (running into the well) from surface to back depth (approximately 1325mKB).

e) With well flowing, run a noise log with stops at for 1 minute every 10m from PBTD @ 1325mKB to surface.
Evaluate and take additional measurements as/if indicated in potential areas of interest.
Leave well flowing (still through monitoring device).

f) Have logs and interpretation sent to Calgary and wait on orders for interval(s) to be perforated and squeezed.
Logs will be combined with an evaluation of the geology above the Fantasque and the results of gas samples from the surface casing vent to determine the optimum depth for a squeeze attempt to shut off gas flow.

14) Perforate to squeeze well (leave SCV monitoring device on and well open)

a) Perforate a 2 meter interval @ 13 shots be meter (60 degree phasing) over _____.
(depth determined from noise/temperature/cement evaluation logs)
Note any response on the SCV monitor.

b) Pressure up on surface and attempt to achieve circulation to surface (or at a minimum obtain a feed rate through the perforations) with fresh water.
Connect the open surface casing vent to a tank (e.g. rig tank) and monitor for returns.
Maximum squeeze pressure is 30 MPa.
Note any response on the SCV monitor.
The injection rate must be at least 10 liters per minute to be successful.

15) If injection is unsuccessful (less than 10 liters per minute) squeeze acid into perforations

a) Run tubing to _____ (just below perforations).

b) Circulate 1m3 of 15% HCl to the bottom of the tubing.

c) Attempt to squeeze the HCL into the perforations.
Maximum squeeze pressure is 30MPa.
Record surface squeeze pressure, Vs acid volume squeezed and time.
Note any response on the SCV monitor.

d) When acid is squeezed away or if squeeze is unsuccessful, reverse circulate the remaining acid out to tank truck for disposal.
Neutralize any unspent acid with soda ash or equivalent prior to transport.

16) Set cement retainer

a) Run a 161.7mm gauge ring to _____(as determined from logging runs)

b) Set a cement retainer at _____(as determined from logging runs).

17) Squeeze cement

a) Run in hole with 73mm tubing and sting into the cement retainer.
Pull out of cement retainer to ensure release.

b) Mix +/- 1.0 m3 of cement and circulate to the base of the tubing.
Cement properties (additives) to be determined based upon injection test results

c) Sting into the cement retainer and attempt to squeeze cement.
maximum squeezed pressure is 30MPa.
Monitor production casing to ensure cement retainer is holding

d) When 0.8m3 of cement have been squeezed away – or if unable to squeeze the cement away, pull out of the retainer and spot the remaining cement (minimum 0.2 m3) on top of it.

e) Pull out of the plug and backwash twice the tubing volume with fresh water.
For reference:
1.0m3 cement = 50m of hole fill in 178mm casing
0.2m3 cement = 10m of hole fill in 178mm casing
1000m of 60mm tubing capacity is 2.0m3
a minimum of 8 meters of cement must be placed on top of the cement retainer

f) Pull out of hole and lay down tubing.
Do not fill the hole when pulling last 12 joints of tubing.
This will leave approximately 5 meters of air filled borehole.

18) Monitor surface casing vent for a minimum of 12 hours to determine if cement squeeze has shut off gas flow

a) If test is positive (continued flow) further squeeze operations may be needed.
Contact Calgary office for further instructions.
If test is negative, report results to Calgary and include on morning report, with time and date of test.
Leave vent open with SCV monitor installed and rig down service rig and equipment.
Move to next location.

b) Leave well for at least 72 hours with SCV monitor installed after the squeeze was completed.
Confirm "no flow" results to Calgary office.
Do not proceed with cut and cap if results are not negative (no flow).

19) Cut and cap well

a) Excavate around wellbore approximately 1.5 meters (or more) below ground level).
Slope sides 1:1 or shallower.

b) Cut and remove rathole/mousehole 1m below ground if present.
Backfill rathole /mousehole with 1 m cement plug if required.

c) Cut and remove conductor pipe at least 1.2 meters below ground level.
(not ice-pad level)

d) Support casing bowl with picker or similar.

e) Cut three 60 degree windows in surface casing just below the bowl. Then rough cut production casing. Production casing may drop.

f) Cut surface and production casing at least 1 meter below ground level. (not ice-pad level)

g) Stitch weld a 6mm steel plate over the casing stubs (do not seal).

20) Prepare and install well sign

a) Bead weld well coordinates and date on 5mm plate (500mm X 300mm) as follows:

F-36 60-10-123-15
PARAMOUNT RESOURCES LTD
YYYY-MM-DD
60.0908° -123.3667° NAD 83

(where YYYY-MM-DD is the date of abandonment)

b) Install abandoned well sign on a piece of 60mm tubing (or equivalent). Signpost to be located 1 meter north of the well and set in a suitable cement plug (e.g. a 22 liter pail or a section of 244mm surface casing full of cement at least 1 meter below ground level.
Finished sign should be approximately 1.5 m above ground level, set at a 45 degree to the vertical, and painted iridescent orange.

c) Backfill the hole with a 0.3m crown to allow for possible subsidence.
Note: Re-use of excavated backfill material is contingent on a satisfactory result of test from environmental consultant. If material around well center is contaminated (e.g. with diesel from previous operations), new fill material will be required.

21) Rig down and remove all equipment and material used in the operations from the lease. Haul any remain fluid to an approved waste disposal location.
Ensure ticket to confirm acceptance at disposal location is sent to dickheenan@shaw.ca with original sent to Paramount Resources.

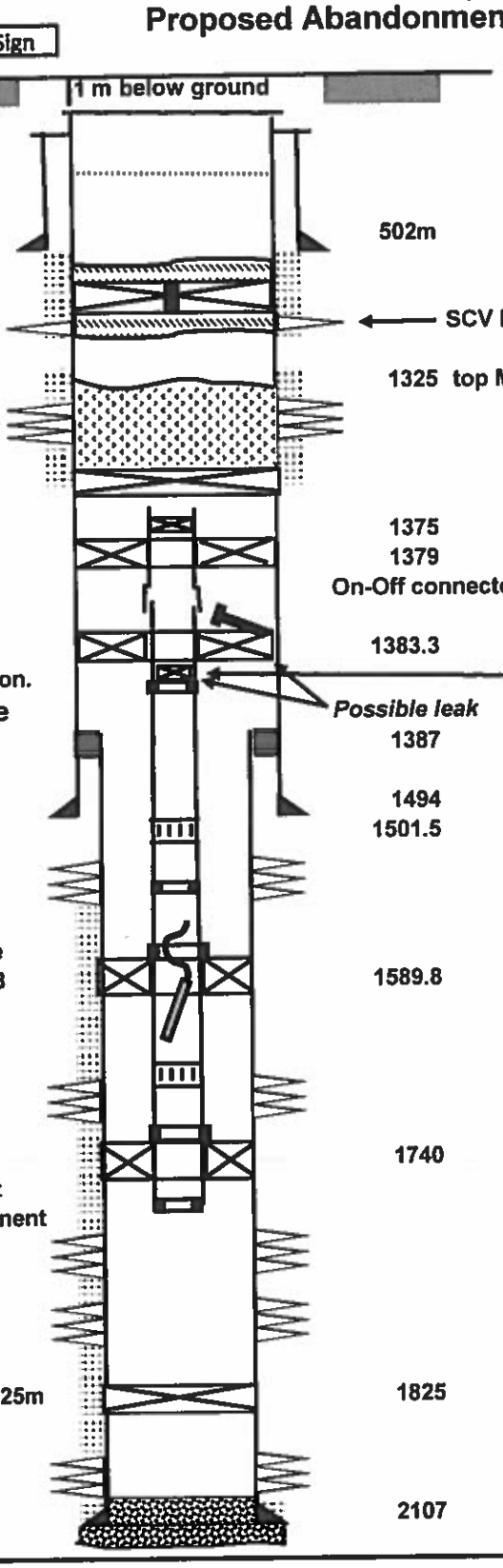
END

R Heenan - 20170207

REGISTERED PROFESSIONAL ENGINEER
R.H.HEENAN
LICENSEE
NT/NU

PERMIT TO PRACTICE
HEENAN ENERGY SERVICES LTD.
Signature R Heenan
Date 2017/02/08
PERMIT NUMBER: P 827
NT/NU Association of Professional Engineers and Geoscientists

PARAMOUNT ET AL FT. LIARD F-36 (20170207 revision)
Proposed Abandonment



Non-sealing steel plate
1m north of well
1.5m high - set in cement

502m — 244mm Surface casing

SCV Flow remediation (typ)

Fantasque top
1225mKB
Fantasque Perforations
1344-1347m

1325 top MIMIMUM (feel with tubing)
NEW Cement plug (squeezed)

Permanent bridge plug

1375 — Permanent tubing bridge plug
1379 — Hydraulic Set Packer
On-Off connector not latched
On-Off connector 47.6mm profile
1383.3 — Hydraulic Set Packer
Permanent tubing bridge plug

FSG Plug dropped
stuck on & blocking on/off con.
Packer is not retrievable

Possible leak

1387 — 114mm liner top

Mattson top 1400mKB

1494 — 178mm Intermediate csg shoe
1501.5 — Sliding Sleeve
8 jts 60mm tbg
F nipple
3.07m 60mm pup
On-Off connector 47.6mm profile

1514-1582mKB
Mattson Perforations

Recorders, sinker bar & wire
betweem 1592 and 1720mKB
(reports not clear)
Lost March 2006

1589.8 — Packer

Mattson Perforations
1644-1724mKB

1740 — Baker WL Packer

See Baker drawing for exact
details on downhole component

Numerous Mattson
Perforations
Above & below the BP @ 1825m
1751-2046mKB

1825 — Baker 43A WSRBP Bridge plug

Not to scale:
DH 20161213

2107 — 114mm liner shoe