Worked Questions and Answers

A Learning Document for prospective Candidates
For the Rotary Drilling Well Control Test Programme

Revision No.1, November 2000

Candidates sitting the IWCF written test papers for the first time are often rather anxious about the structure of the test.

They will frequently ask:

- Are there any trick questions?
- How does the IWCF compose questions?
- Is there more than one answer and so on?

It is not easy to give straightforward answers to these questions. It is for this reason that this publication has been prepared. It aims to assist the candidate by providing a collection of various questions and fully worked-out answers.

IMPORTANT POINTS

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- Read questions first, don't rush or skip words. Then read the question once again, highlighting with a transparent marker (or underline with your pen) important words or phrases.

- If a question has multiple-choice answers you can note your correct answers first (***in the right margin***) and then review the remaining answers before you finally make your selection in the check boxes. Alternatively, you can strike out the incorrect answers first and then review the remaining answers before you finally make your selection in the check boxes. Both methods are perfectly valid.

- Some questions require more than one answer – the candidate must select the requested number of answers. If a candidate does not select the requested number of answers – the answers that have been selected will be ignored and the candidate will not receive any points for the question.

- Check your test paper one final time before handing it to the Invigilator.

The following pages contain some examples with detailed analysis.

Example Question 1

It is planned to perform a leak-off test. Which of the following actions have to be performed before the test is conducted?

(TWO ANSWERS)

- ☑ A. Circulate the mud to obtain a uniform weight and condition.
- ☐ B. Drill 3 ft (1 m) out of the casing shoe and test the BOP-stack against exposed formation and cement.
- ☐ C. Spot a viscous LCM pill on bottom.
- ☑ D. Drill 6 - 15 ft (2 - 5 m) of new formation.
- ☐ E. Run a calliper through casing and open hole.

Comments:

Each set of answers has a few distracters. These might be legitimate answers but in the wrong context or they might be inappropriate answers altogether.

In this question we find the following important words. A candidate could highlight these as follows: -

'plan'	It is planned to perform the test, the test has not yet been performed.
'actions'	The first indication that more than one answer is required.
'before'	Once again stressing that these are activities that happen prior to, not during, the test.
'two correct answers'	Below the question and in **bold** style the number of answers required is stated.

The above suggestions might seem insignificant, but candidates are literally distracted by answers and fail to remember the intent of the question. Highlighting critical words not only improves the focus, it also shortens the time to answer the question.

Detailed Analysis:

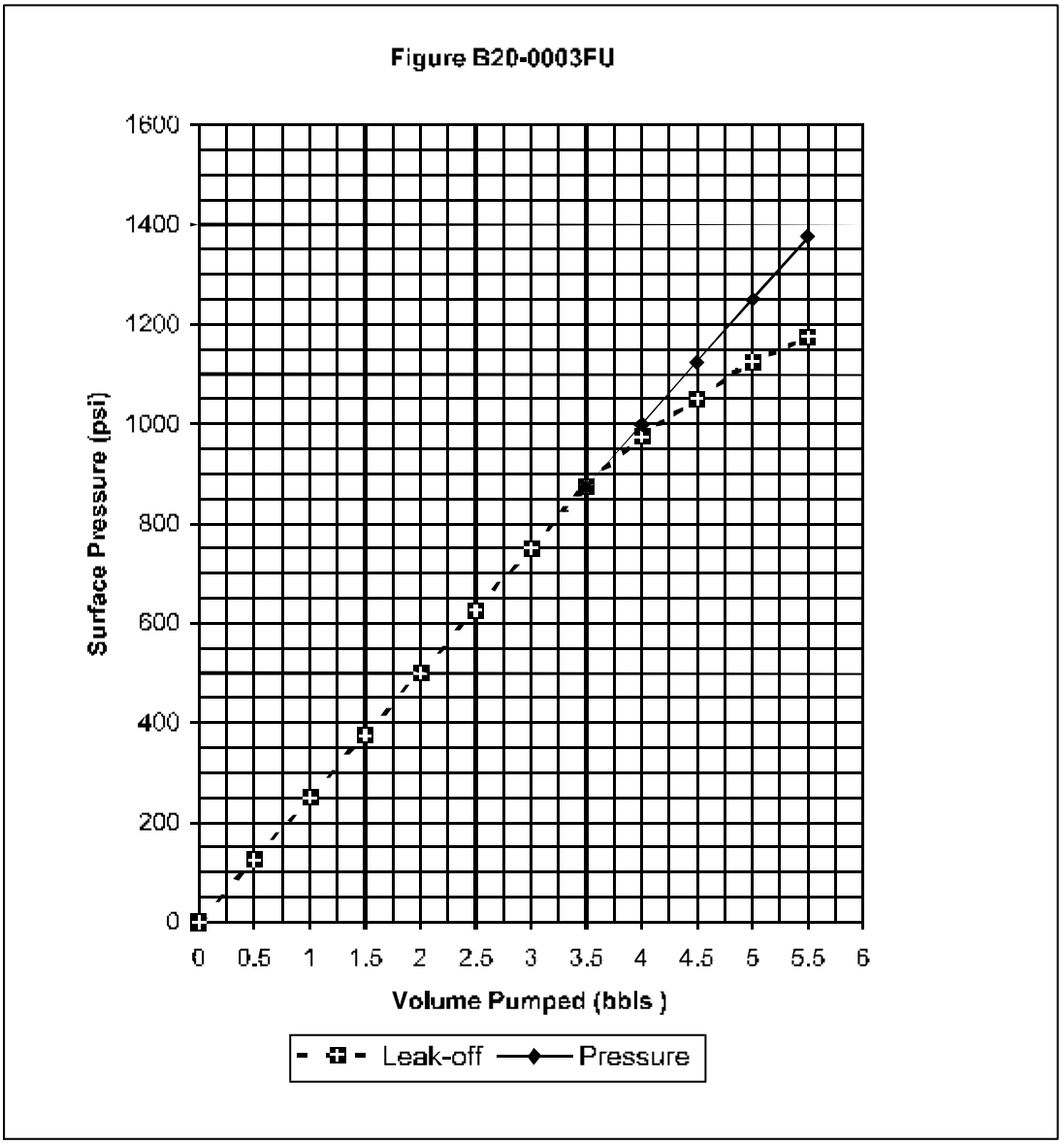
Answers 'A' and 'D' are correct. They are key activities preceding all leak-off tests performed in accordance with good practice.

Answer 'B' is incorrect. Drilling a mere 3 ft (1 m) out of the casing shoe is usually not sufficient to get into new formation. Testing the BOP stack against the exposed formation is totally out of bounds. Nevertheless, it is important to properly read the answer before discounting any inappropriate activity.

Answer 'C' is incorrect. Spotting a viscous LCM pill might have an operational purpose, but it is not the standard action to take before a leak-off test. Use the common sense approach and don't be led by activities, which could be taken, instead of those which need to be taken.

Answer 'E' is incorrect. The volume of drilling fluid is fairly accurately known when the casing has just been set and cemented. It also does not serve any immediate purpose for calculating the formation strength following the leak-off test.

Example Question 2



Determine the leak-off pressure from the leak-off test graph shown above.

- ☑ A. 875 psi.
- ☐ B. 975 psi.
- ☐ C. 1,050 psi.
- ☐ D. 1,125 psi.
- ☐ E. 1,175 psi.

Detailed Analysis:

The correct answer is **875 psi.**

The incorrect answers are 975, 1050, 1125, and 1175 psi. The test should have been terminated at 975psi, the first visible deviation from the straight line. In some weak formations a **breakdown** could result if the test continued beyond this pressure.

The leak-off pressure is here defined as the highest pressure point (875 psi) at which no leak-off has taken place. The volume of mud pumped from surface (3.5 bbls) has only compressed the total fluid volume in the hole and expanded the casing in the process. After another ½ bbl is pumped from surface we have injected a small amount of fluid into a newly created fracture. It is quite conceivable and probably even likely that the leak-off starts somewhere between 875 and 900 psi, but the graph does not allow us to be more accurate than intervals of ¼ bbl volume being pumped. Furthermore, no details are given about the leak-off method.

If the graph is difficult to read, ensure you use a ruler and there will be no doubt about the last pressure point on the straight line.

What can we do with this leak-off pressure?
What other information is required to calculate the formation strength?
Where does MAASP fit in all of this?

The relationship between the leak-off pressure, MAASP and fracture pressure (not breakdown pressure) relies on the fluid column between surface and casing shoe. The fluid column needs to be a uniform and accurately measured density.

The true vertical depth of the casing shoe is information we also require. If the overall fluid density is changed, or if we have two or more different densities between surface and casing shoe, the pressure at surface will change. This is because the fracture pressure is - for practical purposes - considered to be an absolute value and will remain the same as long as we do not initiate a breakdown.

In summary:

- The leak-off pressure is directly related to the fracture pressure with a fluid column of a known density between surface and true vertical casing shoe depth.
- The MAASP allows the user to relate to the fracture pressure during a well control situation, as long as the density of one (or more) fluid columns is accurately known.

Understanding the reasons for performing a leak-off test simplifies the following question.

Example Question 3

The leak-off test results are now recorded.
Which of the following information is essential to calculate the fracture pressure?

(TWO ANSWERS)

- ❑ A. The capacity of the drill string.
- ☒ B. The true vertical depth of the casing shoe.
- ❑ C. The presence of a float sub in the drill string.
- ❑ D. The pore pressure of the formation being tested.
- ☒ E. The mud density.

Comments:

The candidate can highlight the following words: -

'results.....recorded'	The information related to leak-off pressure.
'essential'	It is the essential information that is required, not any other.
'fracture pressure'	This is what we are after....!

Detailed Analysis:

Answers (B) and (E) are correct. **Without** this information no accurate calculation(s) can be made. You could scribble the following formula on a piece of paper, or next to the question itself, to jog your memory.

Pfrac = (MW x TVDepthcsg.shoe) + LOP

Note that the abbreviations (Pfrac, MW, TVDepthcsg.shoe, LOP) are not universal and could be quite different in your company or area!

Answer (A) is incorrect. The capacities or volumes of hole, casing and drill string have **no** impact on the hydrostatic head calculation.

Answer (C) is incorrect. It is a distracter in relation to the leak-off test activity. A float sub in the drill string might have an influence on the value of the leak-off pressure, if the test was performed through the drill string instead of the annulus. However, the validity of the leak-off test result is not part of the question.

We want to calculate the fracture pressure from the information we already have. Note that this (somewhat disputable) distracter has been chosen to illustrate the importance to carefully read the question!

Answer (D) is incorrect. The pore pressure value has no direct relationship with the fracture pressure value. We do not need this information to calculate the fracture pressure.

By now you have probably come to terms with some aspects of the IWCF testing methodology. The following three questions have fully worked answers.

Example Question 4

Which of the following are relevant considerations when selecting a slow circulation rate during a well kill using a surface BOP system?

(THREE ANSWERS)

- ☑ A. Choke control management.
- ☑ B. Annular friction losses.
- ☐ C. Vacuum degasser handling capacity.
- ☐ D. Pressure rating of the Ram Preventer.
- ☑ E. Removal of gas influx in horizontal holes.

Detailed Analysis:

Answers (a), (b) and (e) are correct.

- A reduced or slow circulation rate will simplify choke control management. Pressure fluctuations at the choke will be slower because any decompression of mud and influx will take place at a slower rate. If choke control cannot be managed at any given rate, a further reduction will be beneficial, provided the circulation pressure is adjusted accordingly.

- Annular friction losses will always be affected by the circulation rate, the amount is dependent on many factors, such as annular capacity and mud rheology.

- In horizontal holes it might be more difficult to remove gas trapped in washouts when circulation rate is vastly reduced. If circulation rates *higher than normal* cannot be applied, circulation time might be substantially longer than is commonly experienced in deviated or vertical holes.

Answer (c) is incorrect. The vacuum degasser has no impact on the selection of the reduced circulation rate pressure during the well kill.

Answer (d) is incorrect.

- The well pressure below the Ram Preventer is the same as that of the casing or choke pressure. Any decrease or increase in slow circulation rate while maintaining bottom hole pressure will have an impact on the choke pressure.
- However this choke pressure will always be lower than the shut in casing or well pressure below the Ram Preventer, because with no pump running, no annular friction loss has to be taken into account (static casing pressure = dynamic choke pressure plus dynamic friction loss when bottom hole pressure is kept constant).

When in doubt, sketch a diagram with typical data.

Example Question 5

While running in the hole it is observed that the trip tank level is significantly higher than pre-calculated values. There is a float valve in the drill string. What action should the Driller take?

- ❑ A. Flowcheck. If no flow, pump out of hole and check for plugged nozzles.
- ❑ B. Flowcheck. If no flow, close the well in and spot LCM around the bit to cure seepage losses.
- ❑ C. Continue running in the hole. It is impossible to swab the well while running in. Ignore trip tank levels.
- ❑ D. Shut the well in and reverse circulate to clean the hole.
- ☑ E. Flowcheck. If no flow, continue running in the hole or consider stripping to bottom.

Detailed Analysis

Note the words significantly higher and float valve in the question.

Answer (E) is the only correct answer.

- Whatever procedure you would like to follow, utmost caution needs to be exercised. The string will need to go back to the bottom before circulation can commence, preferably under controlled conditions (consider closing the BOPs and diverting returns through the choke while continually monitoring pit levels).
- If the trip tank level increase is genuine, it is probably caused by a swabbed influx during the trip out of the hole. This influx is migrating and expanding in volume.

Answer (A) is incorrect.

- It is unlikely that any of the nozzles are plugged as we have a float in the string.
- Furthermore, we should not pull out of the hole before investigating the trip tank volume discrepancy.
- Pulling out of the hole will always place you in a disadvantageous situation when an (possible) influx migrates and expands even further up the hole.

Answer (B) is incorrect.

- A significant increase in trip tank level is unlikely to be caused by losses.
- Spotting LCM at random depth would not be a solution in all situations.

Answer (C) is incorrect.

- The statement (it is impossible to swab the well in whilst running in) is probably correct in most common well situations, but the proposed action (continue running in the hole - ignore trip tank levels) is wrong practice.

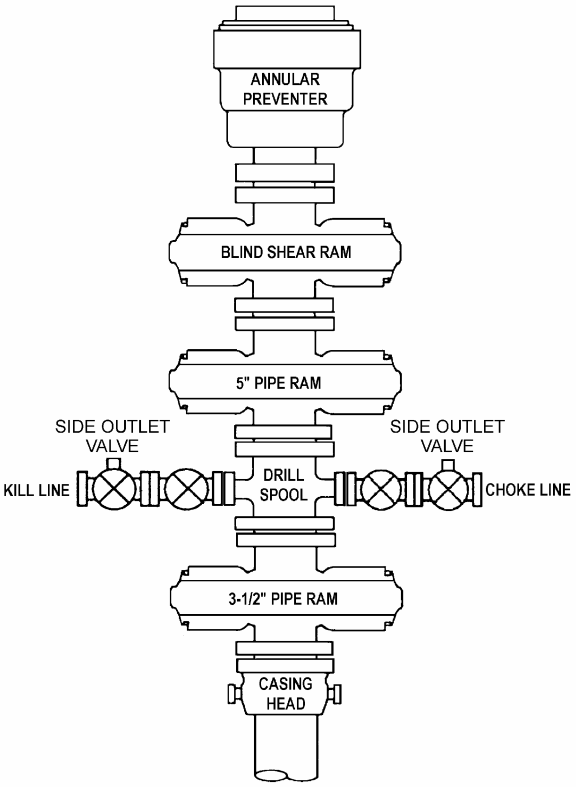
Answer (D) is incorrect.

- It is assumed there is an influx in the well located above the bit.
- The Driller's Method would be the first choice kill method.
- Reverse circulation is not possible as there is a float in the string.
- If it had been possible to reverse circulate it would have created higher annular pressures leading to induced losses.

Example Question 6.

The figure below illustrates a BOP-stack and wellhead.

Figure A10-0005



Indicate if the following activity can take place safely.

With the well shut in under pressure on 5 inch drill pipe, is it possible to repair a leaking flange on the drilling spool?

- ❑ A. Yes.
- ☑ B. No.

The correct answer is B. (No).

- If the well is shut in under pressure, it has been closed using either the Annular Preventer or the '5-inch' Ram Type Preventer.
- Because the lower pipe ram is fitted with 3-1/2 inch pipe rams instead of 5 inch pipe or variable bore rams the well cannot be secured below the drilling spool. Therefore, any attempt to repair the drilling spool would expose it to well pressure.

- With this sort of questions it is important not to be led by situations you might have experienced at the well site. The illustration has been chosen to portray a situation, which allows only one answer to the question. Use your pen to mark the drawing when in doubt and/or to assist you with getting the correct answer.

- Incorrect answers usually stem from hasty decision making or oversight. Be aware.