

4.2 Fracture Pressure Evaluation

This data was used to provide the basis of a fracture pressure prediction using Daines' minimum tensile strength method. The model has the capacity to resolve and extrapolate the local principle stress regime, subsequent to the first fracture in a compact formation. For further information, please refer to the:

Formation Pressure Evaluation Pore Pressure Evaluation Techniques.

Daines' technique calculates the fracture pressures employing the following equation:

$$P_f = ((S - P_p) * \{u/1-u\}) + ((S - P_p) * B) + P_p$$

Where

P_f = Fracture pressure (psi)

P_p = Pore pressure (psi)

S = Overburden pressure (psi)

u = Poisson's ratio (unitless)

B = Effective stress ratio

During drilling, bulk densities were calculated from cuttings lithology together with data from offset wells. These estimates were adjusted when density data became available from wireline logs.

The Poisson's ratio was derived by comparing the formation type drilled with a list of established values. The effective stress ratio "Beta" was calculated from the results of leak off tests where the fracture gradient is actually measured. Once the ratio had been derived the result was used over the following hole section to calculate the fracture pressure using overburden pressure, estimated pore pressure and Poisson's ratio for each lithology.

It must however be stressed that this method of fracture pressure calculation relies heavily upon the formation being pressured up to the point of fracture. The use in the equation of data from formation integrity tests (in which the formation is pressured to a predetermined point and no further) rather than a full leak off test will underestimate subsequent fracture pressures.

12.25" Hole Section

A leak off test result of 14.49ppg EMW was performed at the Baleen - 3 13.375" casing shoe (320m MD, 319m TVD). On Baleen - 4 after drilling to 390m it was decided to pull the drilling assembly back to the 13 3/8" shoe and conduct a formation integrity test (FIT). The result of the test was noted as 1.86sg EMW (230psi). The results of this test are presented in tabular form at the end of this section.

The ECDs encountered during this section never reached this point, and no significant losses were encountered – with the exception of a temporary complete loss of returns after a pack-off at section TD

8.5" Hole Section

After drilling out the Baleen - 4 9 5/8" casing shoe at 1885.39m, rathole to 1890m and three metres of 8.5" hole to 1893m, a formation integrity test (FIT) was performed. A good test was obtained and the result, using mud weighted at 1.09sg (9.1ppg) recorded an equivalent mud weight (EMW) of 1.34sg (11.1ppg) formation strength at the casing shoe. This FIT result was used for fracture pressure calculations of Baleen-4.

No significant downhole mud losses were recorded whilst drilling Baleen-4. The 8.5" section was drilled with a KCL brine mud system weighted from 1.09sg to 1.18 sg. While drilling, an ECD range of 1.26sg to 1.31sg was recorded. The ECD in this section at no time came close to the 1.34sg fracture pressure recorded at the shoe.

The following is a summary of the leak off test conducted in this well:

Hole Section	Hole MD	Casing	Shoe MD	Pressure	Mud Weight	EMW
12.25"	390m	13.375"	320m	230psi	1.11ppg	1.86sg
8.5"	1893m	9.625"	1885.39m	265psi	1.09sg	1.34sg