Date of Issue: November 2015
Affected Publication: API Recommended Practice 92U, *Underbalanced Drilling Operations*, First Edition, November 2008

ADDENDUM 1

Page 21, *replace* **Section 5.4**, *including* **Table 1**, *with the following:*

5.4 Drilling Matrix

5.4.1 A drilling matrix, as shown in Table 1, or similar device should be used to graphically illustrate and communicate to the UBO crews when action is required to return the well parameters of pressure and flow rate back into the optimum operating envelope (Cell A1). The drilling matrix effectively highlights when contingency operations are required; i.e., conditions outside of Cell A1 in Table 1. The drilling matrix is for "bit-on-bottom" drilling parameters and excludes any other operations including, but not limited to, leak repairs, tripping, connections and circulating out of the hole.

Table 1—Drilling Matrix

Surface Flow Rate	Surface Flowing Pressure		
	P1 – P2 (A)	P2 – P3 (B)	> P3 (C)
0 – Q1 (1)	Continue drilling.	Continuing drilling; adjust system to decrease WHP.	Secure well; evaluate next planned action.
Q1 – Q2 (2)	Continue drilling; adjust system to increase BHP.	Cease drilling; pick up, space out; adjust system to increase BHP and decrease WHP.	Secure well; evaluate next planned action.
> Q2 (3)	Secure well; evaluate next planned action.	Secure well; evaluate next planned action.	Secure well; evaluate next planned action.
NOTE In this example table P1 is assumed to be zero.			

5.4.2 The yellow regions in Table 1 (Cells B1, B2, and A2) are established to allow safe reaction time to return operations to a green condition (A1). The red regions (A3, B3, C1, C2, and C3) indicate that maximum planned parameters have been exceeded and appropriate action shall be taken.

5.4.3 The pressure and flow rate values used in UB drilling shall be project-specific and based on the design limitations of the actual equipment that will be used during project execution.

5.4.4 The drilling matrix shall contain the following design parameters.

a) Surface flowing pressure.

— P1 is the minimum operating pressure. Consideration shall be given to, but not limited to, the following:

1) friction through surface equipment;

2) minimum pressure required to vent gas;

3) minimum separator pressure to ensure effective dumping of fluids;

— P2 is the maximum pressure under which normal operations will continue. To establish this continuous operating pressure, consideration shall be given to, but not limited to, the following.

1) Pressure rating on the UBD flow control equipment.

— Stripping pressure is typically the lowest pressure rating of the RCD. Note that RCD seal elements are expendable items and their pressure capability may decrease with usage. Fit for purpose testing may be required to establish operating pressure values.

NOTE Rig alignment, pipe condition, drilling fluid, flowing temperature, type of sealing element, etc. can further reduce pressure capability.

— Erosion rates of the surface flowlines and manifolds (typically governed by the maximum drilling gas rate).

2) Casing design limits – MASP as a function of the planned mud density, casing shoe depth and formation integrity.

3) For offshore applications, consideration shall be given to the riser system.

— P3 is the pressure at which the well is secured – evaluate next planned action.

An appropriate safety factor should be applied to the maximum pressure rating of the weakest component of UBD flow control equipment, formation integrity, and casing design. Appropriate safety factor should be determined in a HAZOP/HAZID (or equivalent). Condition and failure mechanism of the equipment, field experience with the proposed equipment, and hole conditions should be considered.

b) Surface flow rates.

— Q1 is the maximum flow rate under which normal operations will continue. To establish this continuous operating flow rate, consideration shall be given to, but not limited to, the following.

1) Handling capacity of surface equipment (liquid and/or gas)

2) Erosional effects of the material being circulated (surface and downhole)

3) Mandated daily flare limits, flare heat radiation concerns

4) Surface equipment configuration

— Q2 is the flow rate at which the well is secured – evaluate next planned action.

1) An appropriate safety factor should be applied to the maximum flow rating of the least capable component of UBD flow control equipment and formation integrity. Appropriate safety factor should be determined in a HAZOP/HAZID (or equivalent). Condition and failure mechanism of the equipment, field experience with the proposed equipment, and hole conditions should be considered.

2) Mandated environmental discharge limits (volume, heat, noise, composition, etc.)

5.4.5 If the well is shut-in with the rig BOPs according to the well control matrix, subsequent operations will depend on whether the well can continue to be drilled in underbalanced mode.

5.4.6 The operator shall determine if the circulation system or drill string configuration can be modified to safely reduce the wellhead pressure or flow rates to manageable levels.