COGCC RULES RELATED TO BLOWOUT PREVENTER EQUIPMENT

Garfield County Energy Advisory Board
Thursday, December 2, 2010

David Andrews, P.E., P.G.
Western Colorado Engineering Supervisor
Blowout Preventers (BOP’s) are used to manage “kicks” and prevent “blowouts”

• **kick:** Influx of formation liquids or gas into the wellbore that results in an increase in pit volume. Without corrective measures, this condition can result in a blowout.

• **blowout:** An uncontrolled flow of well fluids and/or formation fluids from the wellbore
Gas Kick Frequency in Garfield County

• Gas kicks occur periodically in Garfield County as operators drill with balanced to slightly underbalanced mud systems.

• A Garfield County COGCC policy requires that operators report “significant” gas kicks, which are managed by shutting in the well to circulate the kick out of the wellbore by going on choke and requiring an increase of mud weight exceeding 0.3 pounds per gallon (ppg).

• During 2009 and 2010, COGCC received 42 kick reports on Form 23: Garfield (34), Rio Blanco (4), Mesa (2), Gunnison (1), and Weld (1).
Causes of Gas Kicks

- Insufficient mud weight. Example:
  - MW x 0.052 x TVD = HP
  - 9.0 ppg x 0.052 x 8,000 ft = 3,744 psi
- Swabbing effect or not keeping the hole full of drilling mud while tripping drill string out of the hole
- Lost circulation
- Abnormal formation pressure ("normal" pressure gradient is 0.43 psi/ft [reservoir with saline water])
- Kicks must be controlled through well control procedures, or they may result in a blowout.
Blowout Frequency in Garfield County

- Garfield County active well count, 11/7/2006 = 3,529
- Garfield County active well count, 11/8/2010 = 7,708
- Average wells added to active well count per year in Garfield County from 2006 to 2010 = 1,045
- Blowouts during drilling resulting in rig fires:
  - 2/1/2004, PA 324-33, Parachute Field
  - 8/27/2008, RWF 334-29, Rulison Field
- Post-completion loss of well control: 11/25/2008, McPherson A3, Mamm Creek Field
Potential Risks from Blowouts

- Personal injury
- Fires
- Significant equipment damage
- Release of drilling and other wellbore fluids to the environment
- Significant loss of mineral reserves
- Potential regulatory enforcement if acts are negligent
Blowout Response

• Adequate site access and communication
• Quick response by local fire and emergency services
• Quick response by expert well control companies
• Quick response by environmental investigation and remediation contractors
Definitions

- **blowout preventer (BOP):** A device attached to the casinghead that allows the well to be sealed to confine the well fluids in the wellbore.

- **choke manifold:** An assembly of valves, chokes, gauges, and lines used to control the rate of flow from the well when the BOPs are closed.
What is the purpose of Blowout Prevention Equipment ("BOPE")?

- BOPE consists of the BOP, choke manifolds, choke lines, kill lines, control systems, accumulators, pumps, valves, fittings, tanks, separators, degassers, and flare lines.

- Primary functions of BOPE:
  - confine well fluids to the wellbore
  - provide means to add fluid to the wellbore (kill line)
  - allow controlled volumes to be withdrawn from the wellbore (choke)
Blowout Preventer

- Annular Preventer
- Double Ram Set: Pipe Ram
  - Blind/Shear Ram
- Kill Line/Choke Line
- Single Pipe Ram
- Spool & Well Head
WELL BORE DIAGRAM
BOP OPEN DURING NORMAL OPERATIONS
INFLOW CONTROLLED BY DRILLING FLUID WEIGHT

GROUND SURFACE

AQUIFER(S)

CEMENT SURFACE CASING

DRILLING FLUID (MUD)

PRODUCTIVE FORMATIONS

WELLBORE

DRILL STRING or PRODUCTION CASING

AQUIFER(S)
WELL BORE DIAGRAM
BOP OPEN
AT THE START OF A GAS KICK
FLUID LEVEL RISE IN PIT OR GAS
DETECTION

GROUND SURFACE

AQUIFER(S)

CEMENT SURFACE CASING

DRILLING FLUID (MUD)

PRODUCTIVE FORMATIONS

WELLBORE DRILL STRING or PRODUCTION CASING

AQUIFER(S)
Well Control Procedures

- Pull off bottom
- Shut down pump
- Check for flow (may be a false alarm)
- Close BOP rams and circulate kick through choke with kill mud (specific procedures vary)
- Shut down pump
- Check for flow
WELL BORE DIAGRAM
BOP CLOSED
SHUT-IN IMMEDIATELY AFTER INITIATION OF WELL CONTROL PROCEDURES TO GAUGE PRESSURES
WELL BORE DIAGRAM
BOP CLOSED
WELL CONTROL PROCEDURES IN PROGRESS TO
CIRCULATE GAS KICK

GAS –CUT MUD FLOW TO SURFACE
SEPARATION EQUIPMENT AND FLARE

GROUND SURFACE

AQUIFER(S)

CEMENT

SURFACE CASING

DRILLING FLUID (MUD)

PRODUCTIVE FORMATIONS

WELLBORE
DRILL STRING or PRODUCTION CASING

15
WELL BORE DIAGRAM
CEMENT PLACED OVER HYDROCARBON ZONE
WELL READY FOR COMPLETION WORK
DOUBLE RAM
COLORADO AREAS OF KNOWN HIGH FORMATION PRESSURES

- MAMM CREEK
- TEEPEE BUTTES
- RULISON
COLORADO AREAS OF KNOWN LOW PRESSURES

- RANGELY MANCOS FM
- FLORENCE – CANON CITY PIERRE SHALE FM
- YUMA COUNTY NIØBRARA FM
- RATON BASIN CBM WELLS

COLORADO AREAS OF KNOWN LOW PRESSURES
COGCC Rules Related to BOPE

• 317.a. General Drilling Rules
• 603 Drilling and Well Servicing Operations and High Density Area Rules
317.a.: Blowout prevention equipment ("BOPE")

a. The operator shall take all necessary precautions for keeping a well under control while being drilled or deepened. BOPE, if any, shall be indicated on the Application for Permit to Drill, Deepen, Re-enter, or Recomplete and Operate (Form 2), as well as any known subsurface conditions (e.g. under or over-pressured formations). The working pressure of any BOPE shall exceed the anticipated surface pressure to which it may be subjected...

(1) COGCC may designate specific areas, fields or formations as requiring certain BOPE....

(2) COGCC may condition approval of any application for permit to drill by requiring BOPE ....
Application to Drill
BOPE Notification

---

### DRILLING PLANS AND PROCEDURES

<table>
<thead>
<tr>
<th>String</th>
<th>Size of Hole</th>
<th>Size of Casing</th>
<th>Weight Per Foot</th>
<th>Setting Depth</th>
<th>Sacks Cement</th>
<th>Cement Bottom</th>
<th>Cement Top</th>
<th>Cement Top</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>12-1/4&quot;</td>
<td>8-5/8&quot;</td>
<td>24#, J-55</td>
<td>500'</td>
<td>300</td>
<td>500'</td>
<td>Surface</td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>7-7/8&quot;</td>
<td>5-1/2&quot;</td>
<td>17#/N80</td>
<td>7900'</td>
<td>830</td>
<td>7900'</td>
<td>Surface</td>
<td></td>
</tr>
</tbody>
</table>

**32. BOP Equipment Type:**
- [ ] Annular Preventor
- [x] Double Ram
- [x] Rotating Head
- [ ] None

**33. Comments**
603.i. Statewide well control equipment and other safety requirements

Well control equipment and other safety requirements are:

1. Use BOPE when there is any indication that a well will flow.
2. BOPE shall be in accordance with API RP 53: Recommended Practices for Blowout Prevention Equipment Systems.
3. While in service, BOPE shall be inspected daily, with operating tests each round trip.
4. All equipment placed on or connected to BOPE shall be in good working order with a working pressure rating suitable for the maximum anticipated surface pressure.
5. BOPEs shall contain pipe rams. The choke line and kill line shall be secured.
603.i. Statewide well control equipment and other safety requirements

6. Pressure testing of casing and BOPE components 500 psi for 15 minutes.

7. If blind rams are closed for any purpose except operational testing, the valves on the choke lines or relief lines below the blind rams should be opened prior to opening the rams to bleed off any pressure.

8. All rig employees shall have adequate understanding and training for operation of the BOPE.

9. Rig signs shall be placed at intersection of the public road and rig access road.

10. The rig location and emergency numbers shall be posted on the rig.
603.e.: BOPEs in High Density Areas

• Double ram with blind ram and pipe ram required. Annular preventer or rotating head also required with kelly.

• One person at the wellsite shall be certified by Mineral Management Service.

• BOPE testing shall be at initial rig-up and once every 30 days.

• Pressure testing shall be 70% of working pressure or 70% of the internal yield of casing, whichever is less.
603.e.: BOPEs in High Density Areas

- Pressure testing shall be documented, with records retained for 1 year.
- Pipe rams function tested daily
- Pit level indicators shall be used.
- BOPE shall be used on all well servicing operations.
- Backup valves shall be required on well servicing operations during reverse circulation. Valves shall be pressure tested before each well servicing operation.
API RP 53 – Incorporated by Reference

- BOP stack arrangement
- Installation and maintenance guidelines for choke manifolds, choke lines, kill lines, control systems, accumulators, pumps, valves, fittings, tanks, separators, degassers, and flare lines
- Recommended spare parts lists
- Testing guidelines for inspection tests, function tests, hydraulic operator tests, and pressure tests.
- Low pressure tests and high pressure tests are specified prior to spud, after disconnection or repair, and at a minimum 21 day frequency.
Rule 317.o.: Cement Bond Logs

...A cement bond log shall be run on all production casing or, in the case of a production liner, the intermediate casing...
COGCC’s Recent Staff Training and Field Inspections

• Engineering staff and Field Inspection staff training
  – Well Control Class, November 2009
  – Well Safety and H₂S Awareness, April 2010

• Random field inspections performed for BOP tests. Operators must notify COGCC staff prior to conducting BOP tests in northwest Colorado.