# ANADARKO'S OFFSET WELL FRAC PREP GUIDELINES

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ABSTRACT:
With the increase in activity in the Delaware Basin, preparing wells for the surface pressures seen from offset fracs is crucial in order to maintain safe operations and well integrity. It is important to take risk and economics into account when deciding how to prep a well. Most importantly, historical data should be factored into the decision making process and used to build the program guidelines. Factors that should be accounted for are artificial lift type, surface equipment ratings, producing interval, frac azimuth, and relative distance and position to the well being fractured.

BACKGROUND:
An offset frac hit is defined as a change cause to the well in question related to the frac activity of a nearby well. This is most commonly seen as a surface pressure response, but can also be identified through a change in production trend. This paper will focus primarily on the surface pressure response and how it relates to wellbore and surface equipment integrity. The deferred production should also be considered, but the safety side should be taken as the most conservative case.

HIT DATA:
A lookback was performed to review hits that occurred in 2018 as a function of distance from the frac. The lookback only focuses on the impact of Anadarko fracs on Anadarko operated wells as it is difficult to get the data for offset operators. The dataset (*Table 1*) includes 183 wells that were prepped (which will be defined in the next section) for 69 offset fracs. The prepped wells targeted the Bone Spring 3 and Wolfcamp A and varied in lifting methods which included: free flow, gas lift, rod pump, and jet pump. Bone Spring 2 and Wolfcamp B wells were excluded because they did not experience hits due to the vertical offset from WCA/BS3. The max distance this dataset includes is 2600' aerial horizontal distance.

*Figures 1-5* visually represent the data collected. Two major observations can be made. The first is that the data shows that within 1200' from the offset frac, rod pump wells could have the potential to exceed surface equipment pressure ratings, for most wells is 3,000psi. The second is that inside this distance, a well is roughly 70% likely to get hit.

FRAC PREP RULES:
This lookback is the second iteration of Anadarko's frac prep rules. The first pass used a smaller dataset and took a more conservative approach in anticipation that more data would help tighten up the prep radiuses in the future. These "rules" should only be taken as a starting point as geology varies throughout the field and risk profile varies by operator. It is important for an operator to do their due diligence and gather data that applies specifically to their asset.

The initial pass confirmed that Avalon and Penn wells do not experience pressure impacts and thus do not require frac preparation due to a Wolfcamp or Bone Spring frac. It also showed that only direct (parallel) offsets needed to be prepped (*Figure 6*).

Each category, driven by distance from offset frac activity, involves a specific set of recommendations for preparing the well for offset frac (*Table 3-5*).

Other criteria recommended to consider includes:

- Lateral azimuth of the offset frac well in relation lateral azimuth of the producing well in question.
- Geological features that indicate fracs may travel beyond the specified cutoff distances. (Ex. Natural Fractures, faults, etc.)
- Area history and associated frac hits (database)

Since frac schedule sharing/notification are not required in the state of Texas, field cooperation is critical to ensure the success of the program. Planning is a major component of this, but cannot replace eyes on location. If a frac crew is in an area, it is important to communicate this with the team to investigate further in order to mitigate potential risks to safety.

Risk Level: Come and Go (*Table 3)*

A come and go well is defined as any well that will have any work on pad (drilling or completion) which will require deconstruction of the wellhead. Though this well might or might not get hit by frac, depending on well orientation, special consideration is give due to the nature of having personnel on location at all times. The drilling or frac crews will ultimately dictate how the wellhead is set up.

Risk Level: Low (*Table 4)*
Anadarko's low risk category applies to Bone Spring 3 wells that are between 2,500'-1,200' from the offset frac. The main concern in this category is the Rod Pump wells. It is important to note, that the minimum BOP ratings on Rod Pump Wells is 3,000psi, however there is an initiative to upgrade all rod BOP's to 5,000psi in 2019. The other wells are shut in to reduce the potential negative reservoir degradation effects versus for safety as the surface equipment is rated to 10,000psi. With these guidelines a well can be safely shut in and the risk of exceeding, max allowable surface pressure ratings can be mitigated.

Risk Level: High (*Table 5)*
Anadarko's high risk category applies to Bone Spring 3 wells that are less than 1,200' and Wolfcamp A wells within 2,500' from an offset frac. Frac hits have caused surface pressures to exceed 5,000psi in wells that are within this distance, thus Anadarko takes extra precautions for Rod Pump wells. By pulling downhole equipment, the wells can be converted to free flow if the hit is strong enough to sustain free flowing production. This also avoids having to use heavier, more costly fluid to kill the well to run back in hole.

ECONOMIC IMPACT:
The main drawbacks to preparing a well are the cost associated and the deferred production, which could lead to a more aggressive risk tolerance. It is costly to pull rods (and have to rerun rods) and putting a well offline for 1-2 weeks is a large impact to production. It is crucial to stick to the defined rules, even if there are external circumstances. Anadarko has had instances where wells that were offset to active fracs, were not prepped, got hit. These situations can lead to surface leaks or major fishing operations. When operations like this occur, it is fairly easy to justify sticking to the rules and accepting the associated costs.

IDENTIFICATION OF OFFSETS:
Rules are not effective if there is not a diligent effort to identify the wells impacted by offset fracs. Identification is challenging due to frac schedule changes and offset companies operating in adjacent acreage.

Keeping an up to date frac schedule is easy to do when it is your own company, but difficult when there are over 30 companies operating simultaneously in the Basin. A solution to this was the formation of the Delaware Basin Frac Consortium. This is a network of over 20 companies that share monthly frac schedules to fellow operators. This allows time for operators to prepare wells in lieu of waiting to see a frac crew rig up on location. Currently this is done via emails, but a website is in the works that will streamline the process.

Once a frac is known, it is important to map and determine the distance to any offset wells. A public way to find this information is through the Texas Rail Road Commission website. This is a great, but basic tool to visually identify offsets. In an effort to make this process more efficient, Anadarko's GIS Analysist created a map that loads frac schedules (APC and offset operators) and highlights the affected wells that

fall within an ellipsoid defined by the frac risk parameters (Anadarko uses 2,500' as seen in *Figure 7*). This tool has cut down on surveillance time by 75% and reduces the possibility of human error.

## CONCLUSION:

Offset well frac protection is important for operators to maintain both safety and environmental excellence. As activity continues to pick up and more wells are drilled, it is critical to identify and prepare wells that are expected to be hit by an offset frac. It is important for a company to develop guidelines based on their allowable risk tolerance and stick to them. The values provided can be used as a starting point for program development, but due to geologic differences throughout the Basin, a company should gather data that is applicable to their specific acreage position. It is also of note that these "rules" are going to evolve as more data is collected. The final piece of the puzzle is identification, and though there are free tools out there, it is worth developing an efficient solution specifically for your company.

## ACRONYMS

BS3- Bone Spring 3

WCA- Wolfcamp A

FF- Free Flow

JP- Jet Pump

RP- Rod Pump

GL- Gas Lift

IOC- Integrated Operations Center

LOTO- Lock out Tag Out

ESD- Emergency Shutdown

MAOP- Maximum Allowable Operating Pressure

TAC- Tubing Anchor Catcher

BOP- Blow Out Preventer

*Table 1: Offset Frac Hit Dataset*

| | Hit? | | | |
|---|---|---|---|---|
| | **Maybe** | **No** | **Yes** | **Not Applicable**** |
| **BS3 FF** | - | 1 | 8 | - |
| **BS3 JP** | - | - | - | 1 |
| **BS3 RP** | 1 | 16 | 32 | 14 |
| **WCA FF** | 1 | 16 | 36 | 9 |
| **WCA JP** | - | 4 | 2 | - |
| **WCA RP** | - | 1 | 4 | - |
| **WCA GL** | - | 17 | 16 | 2 |

*2 BS3/WCB Wells not listed since they were not hit
** Not Applicable- Pressures were not able to be read at surface

*Figure 1: Max Surface Pressure Observed on Free Flow Wells as a Function of Distance from Offset Frac*

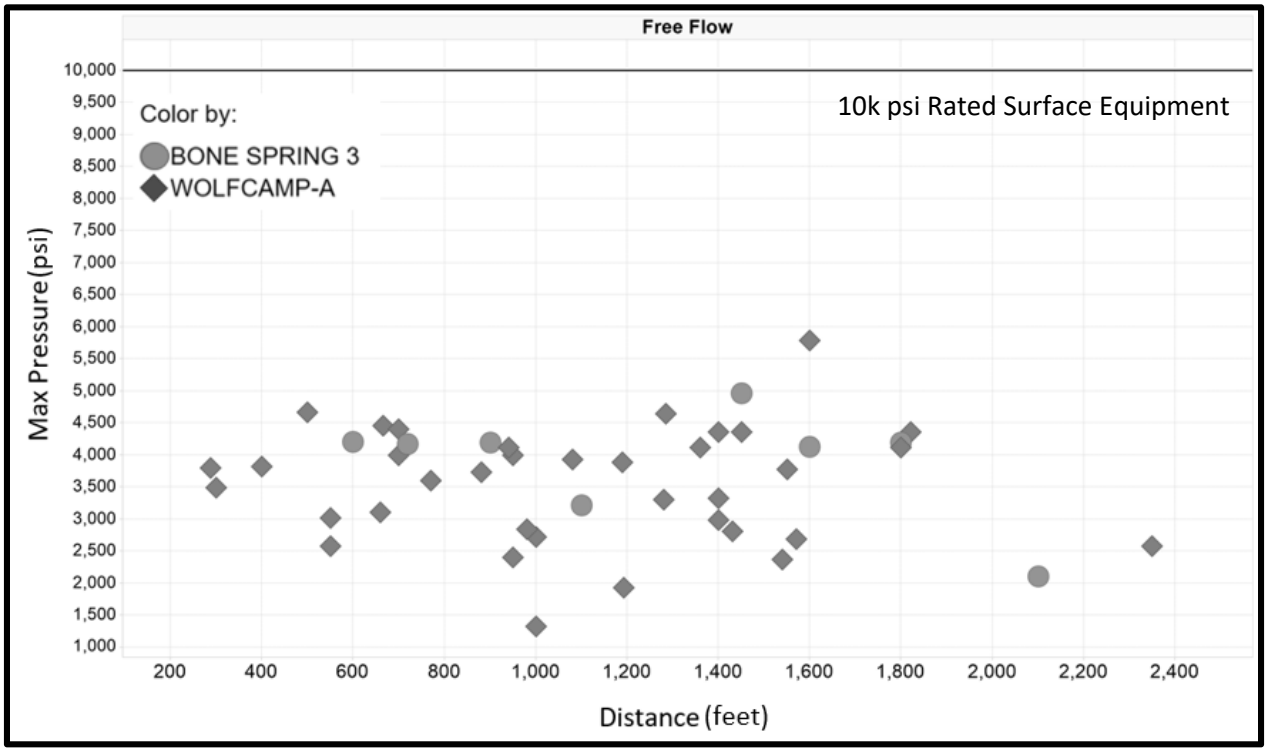


*Figure 2: Max Surface Pressure Observed on Gas Lift Wells as a Function of Distance from Offset Frac*

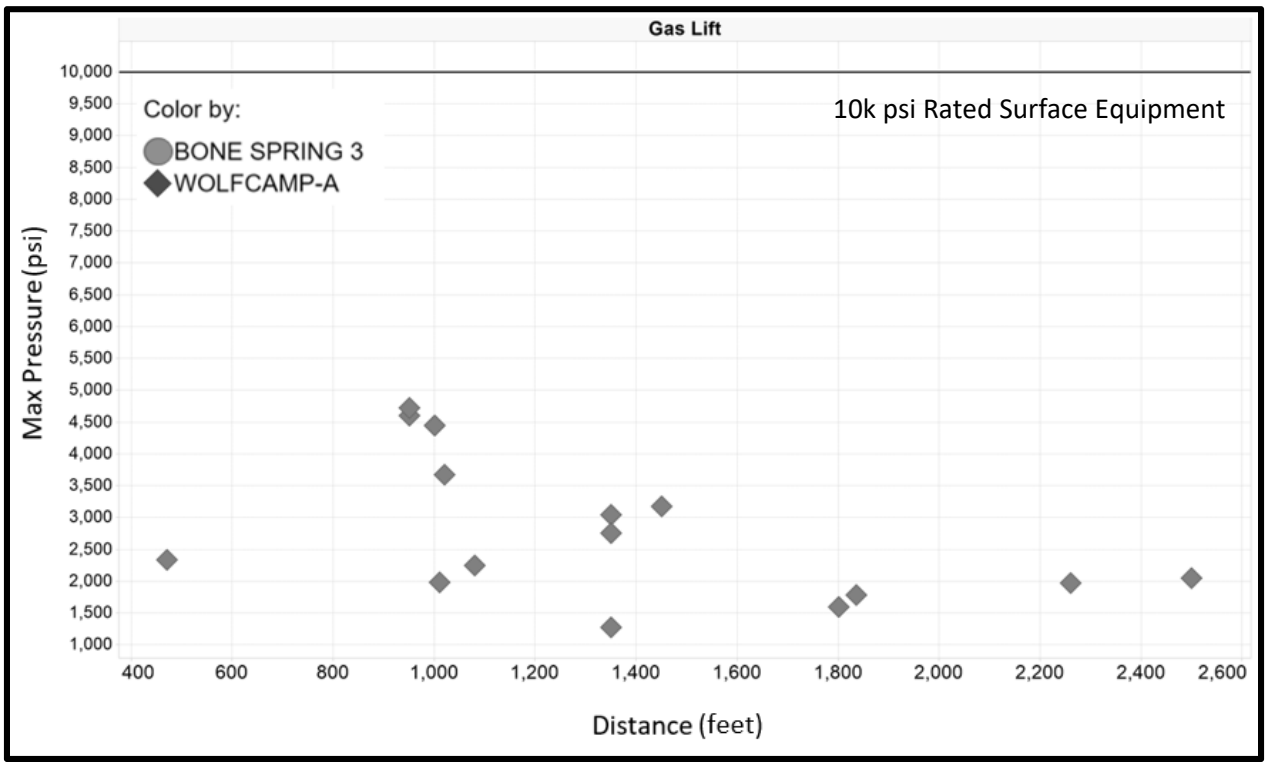



*Figure 3: Max Surface Pressure Observed on Jet Pump Wells as a Function of Distance from Offset Frac*

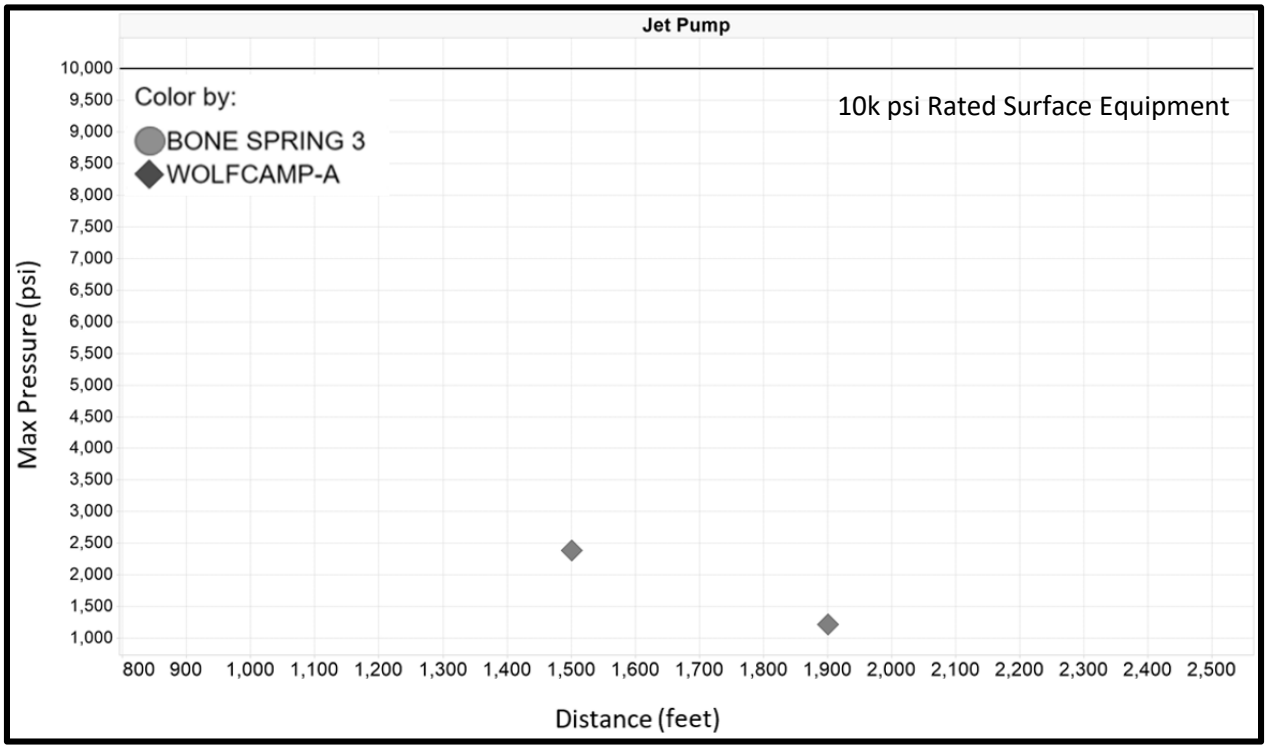


*Figure 4: Max Surface Pressure Observed on Rod Pump Wells as a Function of Distance from Offset Frac*

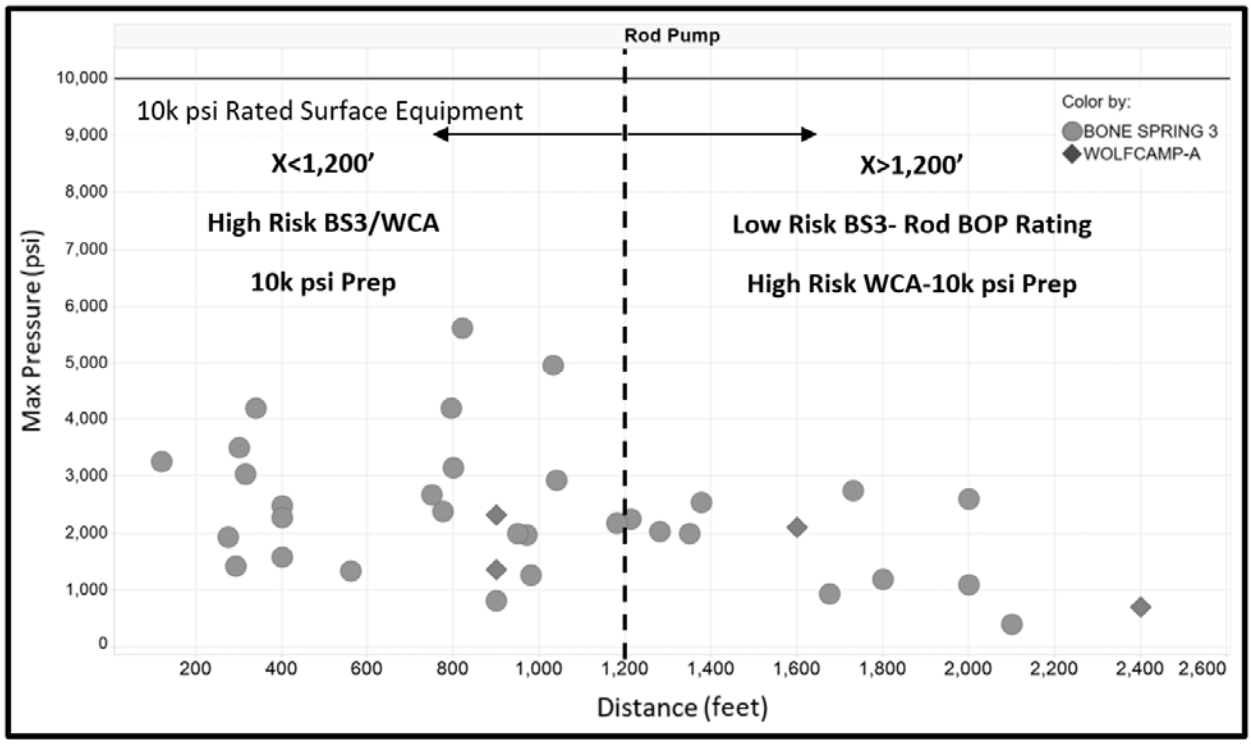
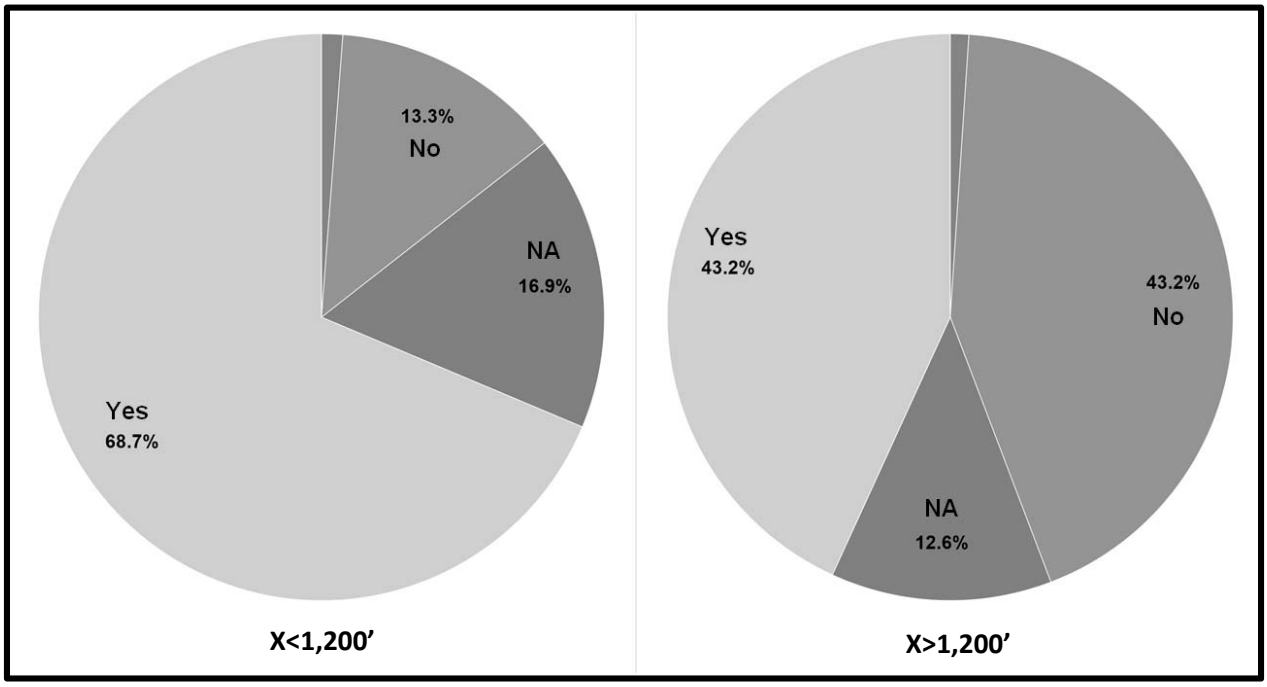



*Figure 5: Likelihood of Frac Hit at a Given Distance*




*Blue- Inconclusive to say if hit or not

*Figure 6: Direct vs. Indirect Offset Wells*


*Table 2: Anadarko's Risk Level vs. Distance Guidelines*

| Wolfcamp to Bone Springs Offset Frac Distance | Risk Level | Wolfcamp to Wolfcamp Offset Frac |
|---|---|---|
| Same Pad | **Come and Go** | Same Pad |
| > 2,500 ft | **Minimal** | > 2,500 ft |
| 1,200 ft – 2,500 ft | **Low** | - |
| < 1,200 ft | **High** | < 2,500 ft |

*Table 3: Come and Go Prep Guidelines*

| Status of Producing Well | Preventative Measure Based on Primary Risk Indicator |
|---|---|
| Rod Pump | • Pull rods and pump<br>• Leave TAC set at depth<br>• Rig down surface pumping equipment (including pumping unit if for drilling)<br>• Drill Prep: Install one 10k gate valve and a BPV<br>• Frac Prep: Install two 10k gate valves and PIT on top<br>• Install cage over tree- remove casing valves if need be |
| Jet Pump | • Circulate out or pull nozzle carrier<br>• Pull out standing valve below jet pump assembly<br>• Deconstruct tree and surface equipment (remove Jet Pump)<br>• Drill Prep: Leave one 10k gate valve and lube in BPV<br>• Frac Prep: Leave two 10k gate valves and PIT on top<br>• Install cage over tree- remove casing valves if need be |
| Plunger | • Catch and retrieve plunger<br>• Deconstruct tree and surface equipment<br>• Drill Prep: Leave one 10k gate valve and lube in BPV<br>• Frac Prep: Leave two 10k gate valves and PIT on top<br>• Install cage over tree- remove casing valves if need be |
| Gas Lift | • Deconstruct tree and surface equipment<br>• Drill Prep: Leave one 10k gate valve and lube in BPV<br>• Frac Prep: Leave two 10k gate valves and PIT on top<br>• Install cage over tree- remove casing valves if need be |
| Free Flowing | • Deconstruct tree and surface equipment<br>• Drill Prep: Leave one 10k gate valve and lube in BPV<br>• Frac Prep: Leave two 10k gate valves and PIT on top<br>• Install cage over tree- remove casing valves if need be |

*Table 4: Low Risk Prep Guidelines*

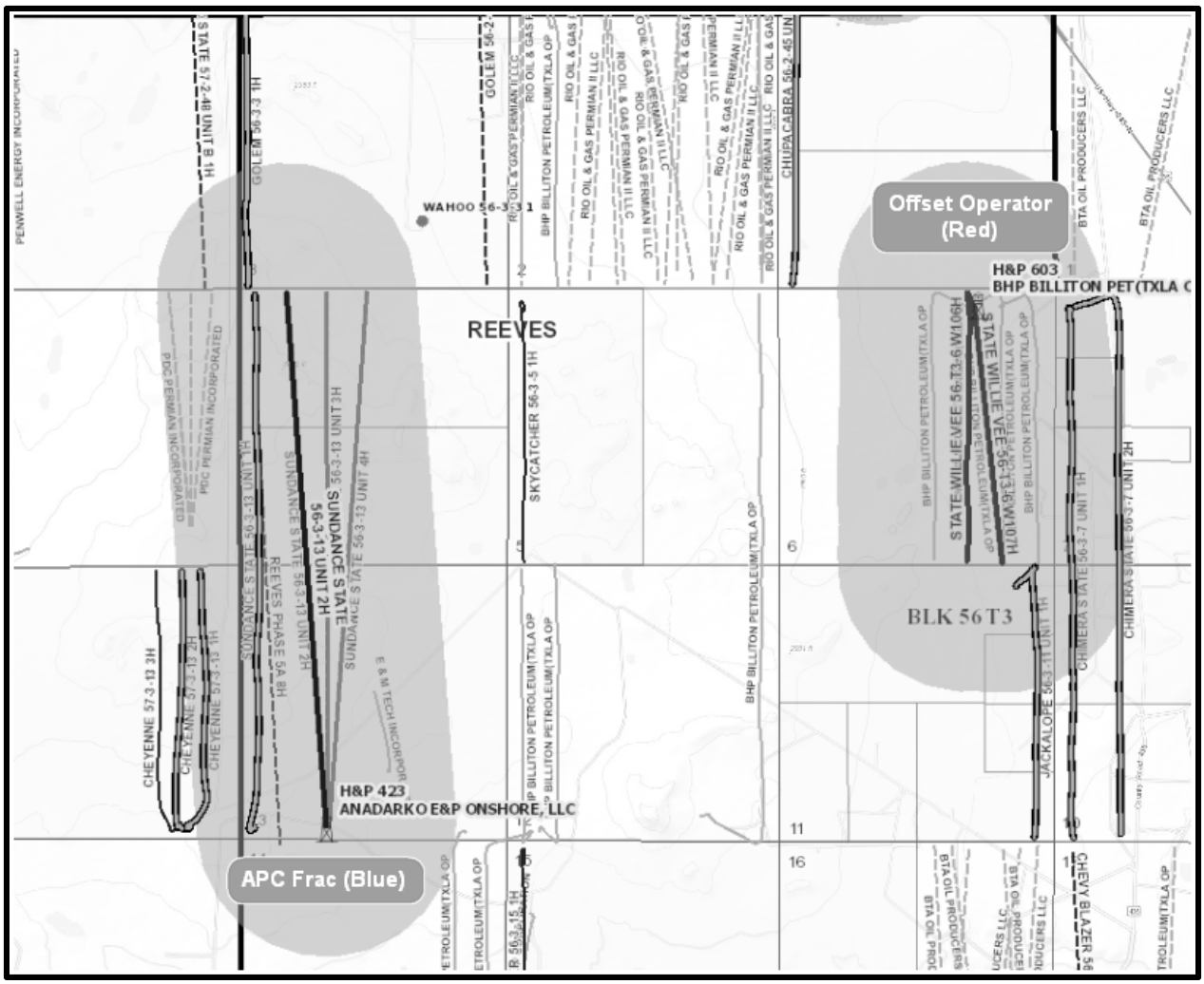
| Status of Producing Well | Preventative Measure Based on Primary Risk Indicator |
|---|---|
| Rod Pump | • Replace stuffing box packing<br>• Close and test rod BOP's on polish rod<br>• Pressure up to 50% of Rod BOP rating below bottom BOP<br>• Grease and test casing valves if possible<br>• Remove casing riser if necessary (MAOP)<br>• Ensure SDV is on well<br>• Shut in well<br>• IOC to Monitor tubing & casing pressure |
| Jet Pump | • Circulate out or pull nozzle carrier<br>• Pull out standing valve below jet pump assembly<br>• Close and LOTO all wing and ESD valves upstream of choke on both sides of flowcross<br>• Leave only two master and crown valve open<br>• Close and LOTO casing valves on both sides<br>• Monitor tubing pressure |
| Plunger | • Catch and retrieve plunger<br>• Close and LOTO wing and ESD valves<br>• Close and LOTO injection line at casing valve. Block and bleed injection line<br>• Monitor casing and tubing pressure |
| Gas Lift | • Close and LOTO wing and ESD valves<br>• Close and LOTO injection line at casing valve. Block and bleed injection line<br>• Monitor casing and tubing pressure |
| Free Flowing | • Close and LOTO wing and ESD valves<br>• Monitor casing and tubing pressure |

*Table 5: High Risk Prep Guidelines*

| Status of Producing Well | Preventative Measure Based on Primary Risk Indicator |
|---|---|
| Rod Pump | • Pull rods and pump<br>• Leave TAC set at depth<br>• Rig down surface pumping equipment<br>• Install two 10k gate valves (flanged)<br>• Monitor tubing and casing pressure<br>• Grease and test casing valves if possible |
| Jet Pump | • Circulate out or pull nozzle carrier<br>• Pull out standing valve below jet pump assembly<br>• Close and LOTO all wing and ESD valves upstream of choke on both sides of flowcross<br>• Leave two master and crown valve open<br>• Close and LOTO casing valves on both sides<br>• Monitor tubing pressure |
| Plunger | • Catch and retrieve plunger<br>• Retrieve bumper spring and tubing stop<br>• Install BPV in tubing head if needed<br>• Close and LOTO wing and ESD valves<br>• Close and LOTO injection line at casing valve. Block and bleed injection line<br>• Monitor tubing and casing pressure |
| Gas Lift | • Close and LOTO wing and ESD valves<br>• Close and LOTO injection line at casing valve. Block and bleed injection line<br>• Monitor tubing and casing pressure |
| Free Flowing | • Close and LOTO wing and ESD valves<br>• Monitor tubing and casing pressure |

In addition to these preventative measures, it is also necessary for the area foreman to verify all surface equipment ratings including piping downstream of the casing outlet.

*Figure 7: Anadarko's Frac Surveillance Map*




*Wells effected are highlighted in green.