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INCIDENT INVESTIGATION REPORT

Gregory Pad Fire

Castle 7 Pump House

JACKSON COUNTY, COLORADO

OCTOBER 3, 2018

PREPARED FOR:

SANDRIDGE ENERGY

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CASTLE -7 PUMP HOUSE FIRE
CASTLE WELLPAD, JACKSON COUNTY, COLORADO

1.0 General Information

Mr. Adam Cole, Sandridge, Oklahoma City, retained Contek Solutions, LLC (Contek) to lead an incident investigation of a well pad fire incident that occurred on the Castle Well Pad located in Jackson County, Colorado.

On September 1, 2018 at approximately 4:20 A.M. Mountain Time, a fire occurred at the Castle 7 Pump House. The small fire was witnessed by personnel on an adjacent pad who responded with a fire extinguisher. The flames grew to greater than 300 feet in height prior to their arrival and the Jackson County Fire Department was called and responded. There was a loss of power, and the automated Motor Operated Valve shut in Castle 7 wellhead and wellpad operations. This also resulted in simultaneously shutting down power to the PLC data collection.

There were no injuries. Property damage was extensive to pump houses, cable trays, insulation, and instrumentation. Loss of hydrocarbons was limited to approximately 5 bbls or less, but Sandridge reported that 5 bbls were release to the Colorado Oil and Gas Commission.

The incident occurred shortly after the Castle 7 Triplex pump, the pump house skid, and associated horizontal separator, Power Fluid Vessel, were put into service for the first time. The Triplex pump is used to return water to the wellhead under high pressure for recovery of oil from the formation.

The pump was shutdown after approximately one hour of operation to assess its condition. The pump and motor were visually and hand checked, it was determined it was running normally and returned to operation. Vibration meter and all operating data indicated normal operations. After operations resumed for a total running time of approximately 12 hours on the Triplex pump, the fire occurred.

Sandridge relies heavily on this Triplex pump and skid system in their operations. They have over 12 similar pump and skid systems in place. Sandridge is concerned about finding the root cause and contributing factors to this event and to apply any findings to other locations to prevent a recurrence of the same event.

The onsite investigation was conducted by Contek Solutions, LLC starting on September 5th, immediately following the Labor Day Holiday. It is suspected that faulty grounding may have contributed to the fire. Additional assessments were continued after Contek personnel left to identify additional cause-related information pertaining to the C7 Pump House skid grounding.

2.0 Scope of the Investigation

The scope of the investigation was to document the extent of damage that occurred, and to identify the root cause of the fire that occurred during the morning of September 1, 2018.

This work included:

1. Documentation of the activities and events leading up to the incident.
2. Photo documentation of damages from the fire incident.
3. Identification of the sources or potential sources for the initial and larger fire.
4. Determination of the root cause and contributing factors for the cause and severity of the incident.

3.0 Investigation Team

The investigation team members were selected by Sandridge from their corporate office in Oklahoma City (OKC), Oklahoma. One goal was to ensure that the investigation leader and significant participants would be independent from the plant's day to day operations. The table below lists the team members. Attachment I contains a copy of the team sign-in list that met on September 5, 2018.

Name	Company	Title/ Job
Hadley Bedbury	Contek Solutions	Investigation Lead
Grant Hewins	Sandridge	Field Operations Manager
Braden Hail	Sandridge OKC	Facility Engineering Supervisor
Nathan Harbin	Sandridge OKC	Project Manager
Grady Camper	Sandridge	Site Production Superintendent
Andrew Bormann	Sandridge	Field Engineer
Shon Crabtree	Sandridge OKC	Instrumentation/Electrical Technician

Additional contacts that were interviewed are also found in Attachment I.

4.0 Purpose of the Investigation

The purpose of the investigation was to:

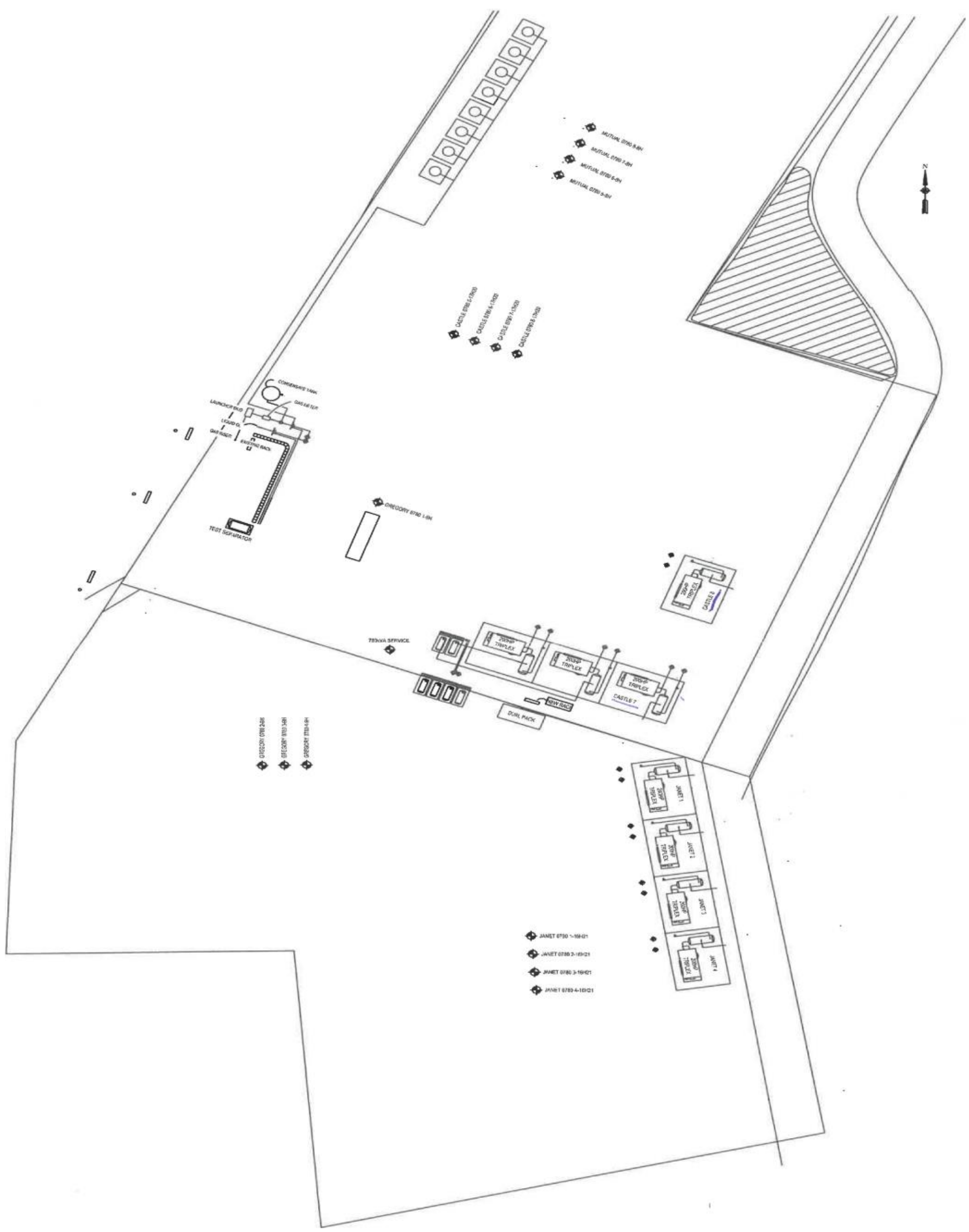
1. Develop a sequence of events and timeline.
2. Obtain information from witnesses at the scene of the incident and others involved for background, incident and post-incident inspection information.
3. Determine operating conditions at the time of the incident.
4. Determine root cause or causes and other contributing factors to the incident.

5.0 Equipment and Processes

5.1 Well and Pump House Layout

The Castle Well Pad is located on the north section of the property and the Janet Pad is located on the south section of property as shown below. The Sandridge wellpad drawing is attached as Attachment II.

Castle and Janet Well Pad Layout



Castle Wells 5-8

Castle Pump House Skids 5-8

Janet Wells 1-4 and Pumps

Four Castle Pump Houses are in place with only C7 Pump House in operation at the time of the incident. Wellhead C8 was free flowing and construction was complete on the Triplex Jet Pump. The C8 pump was not in service. Wellheads C5 and C6 were ordered shut by Sandridge Corporate Office prior to startup of C7.

Pump House skids C7 and C8 were moved to the north further away from Pump House skid C6. This leaves a corner gap between Pump House skid 6 and 7. Pump House skids 7 and 8 are better aligned to face the wellheads with the change.

5.2 Castle 7 Wellhead

Castle 7 Wellhead flows to and from the C7 Pump House. All produced fluids from the C7 Wellhead flow to the C7 Pump House skid area horizontal separator called the Power Fluid Vessel. Prior to the separator, a choke at the wellhead reduces pressure below the 300 psig MAWP of the separator. The C7 wellhead is second from the east end of the four Castle Wells shown on the well pad layout. Specification break dictates ANSI 2500 on discharge of the Triplex pumps and ANSI 900 on wellhead returns.

5.3 C7 Horizontal Separator – Power Fluid Vessel

This separator is called the Power Fluid Vessel. This separator receives all the fluids containing crude oil, produced water and gas from the C7 Wellhead. It is an elevated vessel, approximately 50 bbls in capacity. It is used to separate the three phases. This vessel operates under pressure but below 300 psig with a 300 psig safety valve on top.

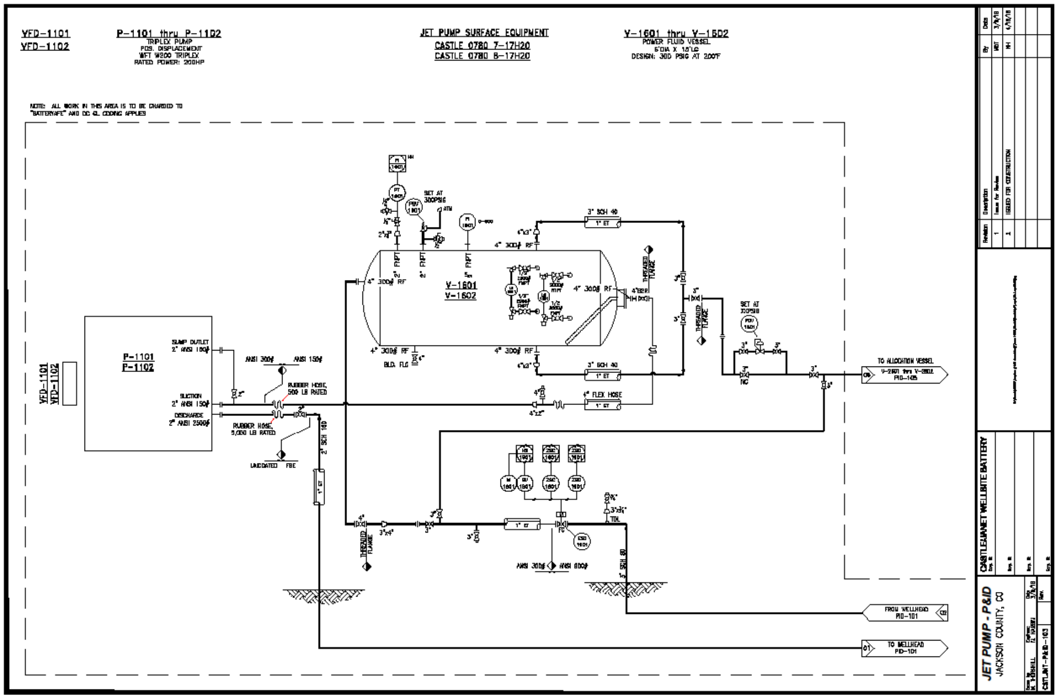
The water discharges from the vessel bottom through a connection at approximately the center tangent line of the front head of the vessel. This water under pressure flows initially through a flex hose rated at 500 psig to provide vibration and flow variability flexing before connecting to 4” steel piping. This 4” piping connects to the connection flange on the outside of the Pump House supplied with the Triplex Pump skid.

The Power Fluid Vessel hydrocarbon liquid flow to one of the Allocation Vessels, V2601 through V2606, for metering, storage and sales distribution.

The gas phase exits the top of the Power Fluid Vessel horizontal separator and goes to the row of vapor combustors located on the north end of the Gregory/Castle wellpad.

The Motor Operated Valve on the line for wellhead production to the Power Fluid Vessel is designed to shut down the wellhead and associated wellpad operations for loss of power to the Triplex pump. This is an important safety device to reduce potential hydrocarbon sources for ignition and to reduce electrical ignition sources.

The drawing below shows the C7 Pump House, Power Fluid Vessel and piping inside the containment area. Attachment III has a larger size drawing.



5.4 Triplex Pump

The Triplex Pump receives water flow from the separator and increases the pressure of this water phase as needed up to a limit of 4,400 psig for return to the C7 Wellhead for hydrocarbon recovery. This is a reciprocating plunger pump with a 200hp 480-volt motor.

Attachment IV provides an overview of the Triplex pump, motor, and variable speed drive.

5.5 Triplex Pump Skid

The Triplex pump is used to return water to the wellhead under high pressure for recovery of oil from the formation at less than 300 psig pressure. The pump suction receives produced water from the Power Fluid Vessel separator and it is increased in pressure up to 4,400 psig as needed for well recovery.

The high-pressure water flows back to the Castle 7 wellhead for increased recovery rates. There is a 5,000 psig flex hose connecting the discharge flange of the C7 Pump House to the Sch 160 piping returning water to the C7 wellhead.

See the Triplex overhead layout view in Attachment IV.

6.0 Incident

6.1 Events Leading Up to the Incident

There were several activities that occurred prior to C7 going into service on August 31, 2018, about 12 hours prior to the incident.

- Sandridge changed the orientation and location of Pump Houses Castle 7 (C7) and Castle 8 (C8) from the original drawing. Pump House C7 was moved next to C8 to be closer to the wellhead and to more directly face the wellhead.

- Weatherford provided the C7 Triplex pump skid that was crane lifted in place. Crane lifting is a safe practice that also minimizes potential damage to the pump skid and skid wiring.

- Sandridge provided the power connections to the Power Panel Box on the outside of the south wall of the Pump House to connections provided by Weatherford. This power was provided from the cable trays located behind the Pump House.

- Sandridge has a site power grounding system that is based on high lightning strike potential from their Oklahoma operations which is considered more than adequate for this area. The grounding was tested after the incident and confirmed that this system provided less than 25 ohms resistance based on its 7 ohm resistance test result.

- Sandridge provided the water suction and discharge piping to the Triplex pump flange connections on the north wall of the Pump House. The C7 Pump House skid and skid contents including the Power Panel, PLC, and low power breaker boxes on the outside south wall were provided by Weatherford.

- The C7 Triplex pump was first put into service and started about 4pm Mountain Time on 8/31/18. The initial run was limited to one hour. At that time there was a walk-through inspection that found normal equipment temperatures, normal operating conditions and no obvious deviations. The Triplex pump was restarted with a 12+ hour schedule to slowly increase pressure up to its target. There was a stabilization time period between increases in pressure to the wellhead. The pump discharge pressure was up to 3,100 psig at the time the power was lost on the skid.

- The pump was shut down after approximately one hour of operation to assess its condition. The pump and motor were visually, and hand checked. It was determined it was running normally and returned to operation. After operations resumed for a total running time of approximately 12 hours on the Triplex pump, the fire occurred.

6.2 Timeline/events, starting about 4pm Mountain Time, August 31, 2018:

August 31
16:00 approx. - starting up the Triplex Pump for the first time with wellhead flow that put level into the Power Fluid Vessel

17:00 approx. - shutdown C7 Triplex pump for visual inspection, hand check for temperature and restarted based on normal conditions on instrumentation and observation

17:00 to 04:00 on September 1 - all process conditions, instrumentation, running normal per trend lines. Slowly increasing Triplex discharge pressure periodically for flow stabilization for target around 3,300 psig.

September 1
04:20 - power loss to pump skid motor occurred, tripping all Castle pumps and wellhead operations. C7 wellhead and C7 Triplex pumps had simultaneous shutoffs. The loss of power also tripped the PLC, so no further data information was collected.

04:25 approx. – Flowhands witnessed small fire from Janet wells, just south of the C7 Pump House.

04:25 approx. - Well hand started towards the fire with a fire extinguisher. Prior to arrival the small fire suddenly grew into a 300+ foot tall fire ball based on comparisons to the flare height.

Walden fire department was called and responded. Total Safety representative Mark Scott arrived behind the fire trucks.

Post Fire Initial Inspection: Initial entry into the C7 Pump House required SCBA or airline supplied air due to the high concentrations of smoke from insulation (fiberglass), insulation protective coverings on the suction and discharge piping to the Pump House, instrument heat and damaged and burned wiring. All instrumentation, lighting and other low voltage wiring were damaged or destroyed. Pump motor wiring was bare, missing insulation, and two Triplex inspection covers were heavily damaged from excessive heat.

6.3 Incident Damage Descriptions, General Wellpad:

Photos are provided below in support of the descriptions. A complete copy of photos taken by Contek has been provided to Sandridge.

Area Extent: C7 Pump House skid building and the C7 horizontal separator received the most significant damage. There was a fire soot fallout line outside the dike in front of Pump House C5. Wiring, instrumentation and insulation damage was extensive up to and including the Allocation horizontal vessels SW of Pump House C5.

Photo 1: Wellpad View looking east at C8 and C7 Pump Houses, left to right
Soot fallout inside and outside of containment dike is visible

C7 Wellhead – instrumentation was not found to bedamaged

Photo 2: C7 wellhead located NW of Skid C7

Photo 3: Left to right, Pump House Skids C7, C6, C5 and first Allocation Tank west of C5 skid

6.4 C7 Vessel and Exterior Piping Damage:

Damaged C7 Pump House, Separator with damaged suction hose and hydrocarbons inside containment

Photo 5: C7 Separator Closeup of Suction Hose Remains

- The metal flex suction hose for the water phase to the Triplex suction was destroyed, only strands of metal or reinforcing materials were left in place. This opened hose would allow vessel pressure to flow liquids from the pickup line at the bottom of the vessel with some hydrocarbons expected to follow the water phase.
- There were hydrocarbons visible on the ground inside the dike. Sandridge estimated that approximately 5 bbls were released and contained.
- Instrumentation, wiring, insulation and piping were damaged or destroyed.
- The Motor Operator Valve, located about 40 feet NW of the separator, did properly close following loss of power to the Triplex motor and before the fire was observed in this area.
- The higher pressure (5,000 psig) rated discharge flex hose was not damaged to the extent of the suction hose off the Power Fluid Vessel separator. The lower pressure (500 psig) metal flex hose on this suction line for water to the Triplex pump was destroyed with just strands of metal remaining.

6.5 C7 Pump House Skid

Exterior Damage Photos

Photo of C7 Pump House walls facing to the north and west

Photo of C7 Pump House south wall with Power Panel Box in center, low voltage breaker box to left and PLC box to right. Power lines enter the Power Panel Box from the cable tray to the far right.

Photo of C7 Pump House north wall deformation facing the horizontal separator. The discharge line is above the suction line connect at this wall in the foreground.

Photo of C7 Skid flex discharge line exiting north wall above the suction line

6.6 C7 Skid Interior Layout and General Damages

Drawing of C7 Pump House Skid layout See Attachment IV

Timing and location of initial fire and sequence of damages by location is not known. Electrical damage was significant and appears to have been nearly simultaneous between the Power Panel Box and the Triplex pump equipment.

Below is a summary of findings from inspections to be considered in identifying the initial fire potential sources.

- There were no significant flame marks to indicate areas of hottest temperature or ignition points on the C7 Pump House or vessel. Unlike the C5 and C6 Pump Houses, there were no flame or soot marks at the piping connection to the Pump House at the C7 Pump House or the heat of the fire consumed the soot marks. Higher temperatures from the large flame may have burned off the lower temperature insulation flame soot marks.
- The Pump House heater was not in service and had its breakers tripped. Sandridge reported that the pump equipment was running warm and that all doors were open for cooling. There was no evidence that there was live power to the heater. The heater should not be considered to be an ignition source.
- The low voltage cooling fan had its blades destroyed by the incident. This fan on the North wall exhausts towards the C7 Horizontal Separator. There is no evidence that the 110-volt fan was a source of ignition.
- All low voltage instrumentation and lighting wiring was destroyed or damaged including interior lights and exterior 110-volt receptacle next to the low voltage breaker. Only the metal skeleton remained of the receptacle.

6.7 Triplex Pump Photos and Findings

See Triplex Jet Pump layout in Attachment IV shows the motor, variable speed drive, reciprocating plunger and gear arrangement.

- There was significant heat generated to components of the Triplex pump inside the C7 Pump House. This generated heat caused the upper right-hand section of the rear inspection metal plate to be vaporized. There was a small vertical slag pile of molten metal inside this connecting rod section behind the inspection plate. The heat required to produce this damage is consistent with potential damage caused by an electrical Arc Flash. These covers are not the source of the electrical problem but indicate the significant heat that was generated or received at the pump inspection covers.

C7 Triplex Pump Rear Inspection Cover Damage

C7 Triplex Pump rear inspection cover had approximately 10” off the upper right-hand corner melted or vaporized. There is a small metal slag pile in the right end inside of this cover visible in the second photo.

C7 Top Inspection Cover Damage

Left photo shows remnants of top inspection cover on the Triplex pump located over the reciprocating plungers near the water flow through line of the pump. Left photo shows metal remnants of the metal cover. Right photo is a closeup of melted metal slag on the ground next to the cover.

The top, large “Cradle” inspection cover over the plungers was significantly melted on all sides and was falling apart. There were no hard, metal surfaces remaining, only solidified molten metal. The heat required to produce this could have been produced by an electrical Arc Flash.

C7 Triplex Motor Wiring Skid Pass-Through from Power Panel Box to Triplex 200hp Motor

All the wiring to and from the Triplex motor was bare of insulation. This complicates finding the initial source of electrical failure.

Power lines to the Triplex motor leave the Power Panel Box on the south side of the C7 Pump House and are routed under the skid to pass through roughly cut holes in the steel decking.

The two power lines passing through the skid deck to the motor were arched and unsupported, suspended only by the wire cable strength and its connections. The power lines rose from the skid deck opening and arched towards the motor connection. Wiring approached from the left at about 45 degrees from vertical into the motor connection. The photo below shows the weight of the wiring resulting in the connections melting further on the left side. Metal slag is present adjacent to the melted connectors confirming that this was very hot. This is a possible location of a the initial short.

Power In to C7 Triplex 200hp Motor Connection

C7 Skid Pass Through Power Lines and Ground Line 200hp Motor

Ground line and first power line to the right have markings not shown on the second power line. Ground line looks damaged at its connection to the motor mount.

C7 Motor Wiring Pass Through Skid Deck

The two power lines and ground line pass through the skid deck very closely. Wiring insulation is missing. There is a clamp holding the second power line in position over the first power line. The ground line is to the rear.

- Sandridge reported that the 200 hp motor appeared to be fried in that the motor shaft could not be turned with no signs of damage to the shaft or coupling.
- There was no sign of loss of integrity in fluid sections of the pump or piping inside C7. The damaged inspection covers were to access mechanical sections only, not to the produced water that was being pumped.
- There was no sign of mechanical failure prior to shutdown of the motor, Variable Speed Drive, or pump in the Pump House.
- The charge pump and sump pumps were not in service prior to or before the incident.
- All low voltage lighting wiring and instrumentation wiring was damaged or destroyed.

- Skid C7 pressure gauges and the transmitter mounted on the north wall were destroyed, with nothing remaining.

- Only remnants of the pump lubricator and vibration monitoring equipment on top of the C7 Triplex pump remained.

Triplex damage to the flow line pass through chamber of the C7 Triplex Pump.

Significant heat affected the rectangular box at the left end of the pump where the flow pressure is increased from approximately 250 psig up to 4,400 psig for return to the C7 wellhead. If heat is transferred to the suction or discharge steel lines inside the building, the heat can be transmitted to the steel lines outside the building that are insulated.

Damages to Pump House C6 :
C6 Separator and Pump Skid Photos

C5 Pump House and Allocation Vessel Photos

East side of C5 shows local shoot marks above piping to Triplex pump
Allocation Vessels shown to right of C5 Pump House

Flame and soot marks appear above the suction and discharge lines outside of the pump house are similar to C6 marks. Soot marks were present inside also. It is evident here that it was heat from the C7 fire that caused the wiring and insulation to ignite.

C5 Pump Piping

C5 Close up photo of pump piping and wall soot marks

The C6 and C5 pump houses show significantly darker soot marks above the insulation on their Triplex pump suction and discharge piping at the outside wall of the pump house. Soot marks extended in a narrow pattern 5 feet above the piping. Soot marks on C5 and C6 above pump piping insulation are considerably darker than the soot marks from the C7 Pump House area fire as shown on the side edges of the pump houses. These patterns are evidence that external heat from the C7 Pump House area was sufficient to cause the insulation burning and this dark soot pattern.

C5 Triplex Jet Pump Photos – similar to C7 layout and wiring to motor

C5 Discharge Line above Suction Line out/in of C5 Pump
Triplex Pump Top Inspection Cover and handle is visible in background

C5 Power Panel Box and Motor Skid Pass Through Photos

C5 appears to be newer than C6 and C7. The Power Panel is configured similar to C7 and can be used to identify Phase B and C conductor locations in orange and yellow colors. There appears to be more spacing between the motor ground wire and the first conductor power line passing through the skid deck in C5. The C5 ground wire is closer to the front of the motor, shorter length and a single strand wire as compared to the C7 motor wiring.

Allocation Vessels located just SW behind C5 also had wiring, instrumentation and Coriolis meter damages from heat.

C6 Separator and Pump House photos

C6 External wiring, instrumentation, insulation wall, doors and windows were damaged. Internal heat damaged wiring.

- Building damage: front window damaged. East and north walls facing C7 were heavily damaged.
- Similar heat caused the insulation fire and pump wall soot marks above the piping into the Pump House that damaged the wall facing C7 Pump House.

6.8 External Wiring, Grounding and Main Power Circuits

- There were no findings of power irregularities from the main power grid up to the loss of power. The main transformer is located on the NE corner of the Janet pad, just south of the Castle Pump Houses. Power trend lines were reported by Sandridge from their metering systems as stable until loss of power at the motor triggered the shutdown of the entire pad through the Emergency Shutdown Devices and interlocked controls.
- Cable tray wiring was damaged behind C7, C8, C6 and C5 Pump Houses.
- Facility main grounding was based on Oklahoma high thunderstorm severity design with closer than typical grounding rods. This grounding system was tested at 7 ohms resistance following the incident, below standards of 25 ohms. Sandridge considered this to be more than adequate as a grounding standard for other facilities.
- Sandridge reported that inspection of the C7 skid to the facility's main grounding system was normal.

6.9 Key Inspection Findings:

1. No evidence of hydrocarbon or water leaks from the Triplex pump skid inside the C7 Pump House.

2. Only exterior piping release was the frayed suction hose of the horizontal separator that could drain hydrocarbons after water had drained out.
3. Extremely high temperature damages were observed to the rear and top inspection covers of the Triplex pump that were significant enough to melt and or vaporize the metal. Similar heat marks were present at the piping and pump piping box of the pump.
    a. Triplex rear inspection cover had a 10" section of the upper right-hand, vaporized or melted off, only a portion a small melted slag pile was found inside the cover area of the pump.
    b. The thinner top cover was completely melted and solidified with no solid metal remaining. Metal with melted slag was observed on the skid deck.
    c. Significantly blackened pump box observed where flow line pressure is increased up to 4,400 psig for return to wellhead.
4. Significant electrical damage and/or potential wiring problems that could have existed prior to the incident on the C7 pump motor were observed.
    a. Main power conductors. The Power Panel Box that brings facility power into the Triplex Pump Skid was significantly damaged. High voltage Phase B and C conductors that were approximately 6" apart in parallel and vertical alignment had the last couple inches of heavy gauge wiring and connecting lugs vaporized. There were no signs of fire at the location, they were gone. These lines supply the two high voltage conductor power lines going to the motor shown in photos. These conductors could create an Arc Flash by current transfer through the air between them.
    b. There are 2 power lines and one ground wire that pass through the bottom of the Power Panel Box to connect to the Triplex pump motor and ground. Insulation covering on the power wires was missing for several inches from the bottom of the Power Panel Box after the incident. There were no soot markings from sparking or fire on the bottom of this Power Panel Box. It may be possible for these wires to be the initial short to the panel box due to wiring insulation damage up to the bottom of the Power Panel Box.
    c. Power lines into the motor had significant damage that melted connections between the motor and power lines. These lines pass under the pump skid from the Power Panel Box through roughly cut holes for access to the motor. These two lines then rise over the height of the motor and bend down at an approach angle of about 45 degrees from vertical. See comparison photos between C5's wiring on a newer looking skid and the C7 motor power photos.
    d. Motor grounding wire was adjacent and close to the power lines going to the skid with all wire insulation missing. Potential existed for initial short between ground and power wires that may not have had adequate separation or insulation protection.
    e. Power wires passing through the Panel Box Bottom or the skid deck could have become damaged over time.
5. The C7 Pump House appeared to be significantly older and had more wear than the other skids. Frequent or improper skid movement could have the potential to cause damages to the wiring system below the skid deck or at pass through locations. There is no history available of how the skid was moved. Similarly, over the road truck

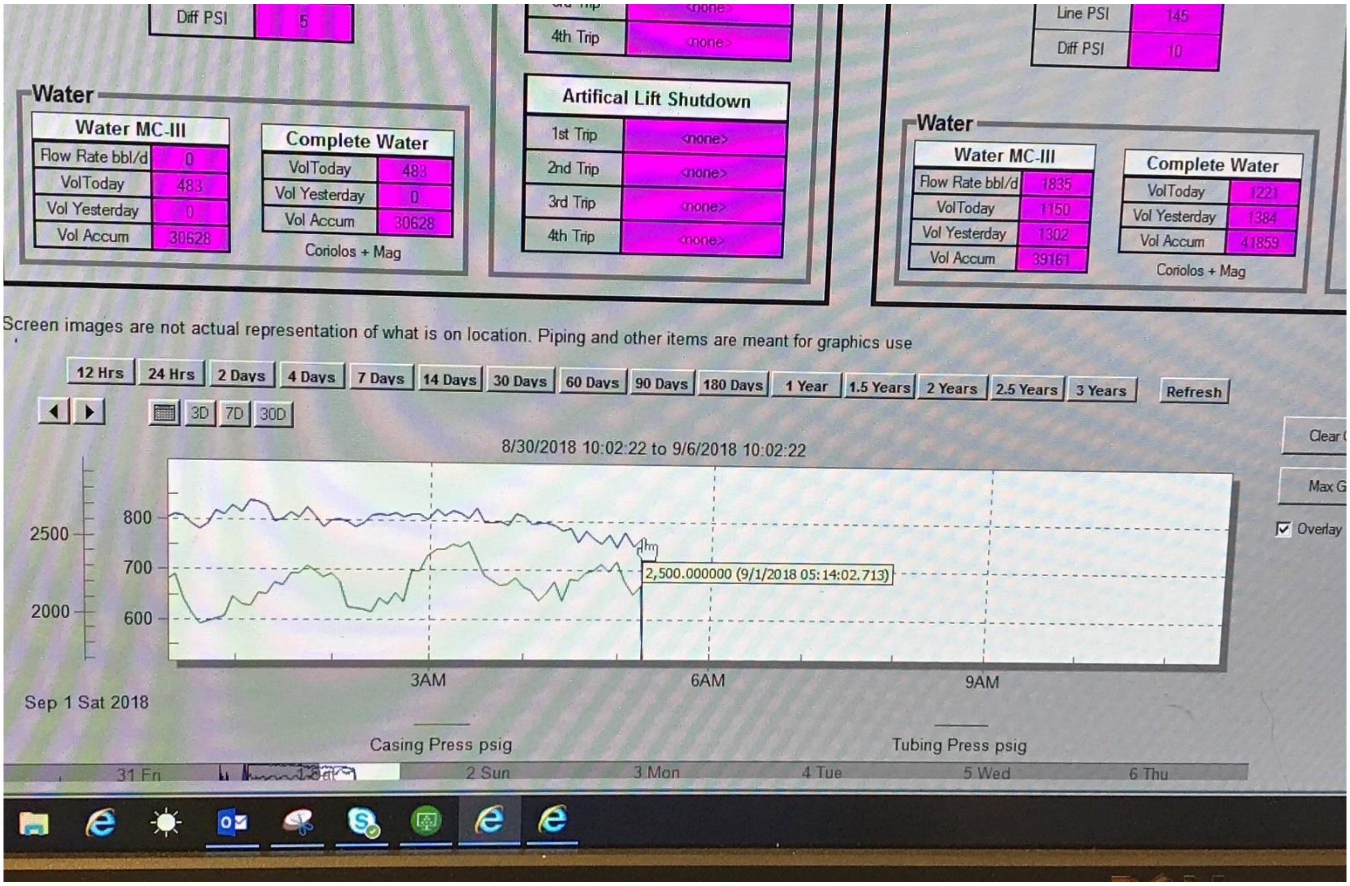
transfers, loading and unloading bumps, can also cause vibrations that can affect wire insulation at connections and pass through openings.

6. Weatherford has verbally confirmed that the C7 Pump House skid passed mechanical and electrical inspection prior to delivery. They are in the process of searching for their documentation. This inspection information was not shared with Sandridge previously.
7. Other skids, C7 wellhead, the Allocation vessels, and cable trays also had damage. The damage and apparent heat received reduced with distance from the C7 horizontal separator.
8. The Power Filter Panel Box behind C7 for power leaving the skid had heat damage inside the box and wiring damage.
9. Skids C5 and C6 had soot marks above the pump connection lines indicating heat and or flame started the piping insulation on fire and left local soot marks. High temperature damage from the large fire did not leave soot marks on the buildings.
10. Pump Houses C6 and C8 that appeared to be the newer pump houses did not have power to the motor going through the Pump House skid deck and Power Panel Box bottom. These power lines were routed through the top of the Power Panel Boxes, through the Pump House wall and secured to the motor without having multiple passes through the skid deck and Power Panel Boxes.

6.10 Incident Response and Post Incident

C-7 Power House loss of power to Triplex motor:
The automated valve on the line from the C7 wellhead to the C7 separator tank responded as designed for the loss of power to the C7 Triplex pump motor. The Motor Operated Valve on the flow line into the dike area of Pump House C7 and its horizontal separator instantly shut off all power on the Castle side and to shut in C7 wellhead through interlock controls. This provided for a safe, controlled site from potential hydrocarbon flowing processes.

Trend data shows loss of pressure power loss to the wellpad at 5:20am Central Time or 4:20am Mountain Time. This confirms wellhead was shut in and wellpad operations were shut in.



DCS data kept in Oklahoma City time zone. Time of 05:14.02 was actually 4:14:02 Mountain Time in Colorado.

Fire response: The initial small fire was witnessed by a well-hand. The well-hand responded promptly. Jackson County Fire Department was called when the fire escalated into the tall flame. There were no injuries or other incidents reported in response to the fire.

Post Incident: The initial inspection was limited due to the need for using SCBA for air supply and facial protection. Total Safety representative Mark Scott directed the airing out and air testing prior to re-entry without respiratory protection. There were no injuries from the inspection process.

Contek Solutions, LLC was contacted for providing damage and root cause assessments. Contek's Lead Investigator was on scene September 5. Contek collected photo documentation and information from employees and contractors on site.

7.0 Investigation of the Incident

7.1 Personnel Interviewed

Sandridge corporate personnel from Oklahoma City on scene by September 5, 2018:
Braden Hail, Facilities Engineering Supervisor
Nathan Harbin Project Manager

Sandridge site personnel:
Grant Hewins, Field Operations Manager
Grady Camper, Production Superintendent
Andrew Bormann, Field Engineer
Shon Crabtree, Electrical and Instrument Technician

Weatherford: Garrett Giddens, Pump Skid Technician
Total Safety: Mark Scott, Field Safety Representative

8.0 Findings and Incident Factors

The incident failure that occurred was related to equipment malfunction. There were no personnel on the wellpad at that time. The only changes to operations were periodic increases in Triplex pump discharge pressure to continue the slow pressure ramp-up to target pressure for the produced water return to the C7 wellhead.

The Triplex pump skids are designed to be portable equipment for either temporary or permanent operations. There are several unknown conditions that could have contributed to this event listed below. Also, there may be multiple potential causes that make it difficult to find a singular cause.

1. Unknown history of Triplex pump skid condition prior to use by Sandridge. There could have been pre-existing damage, including maintenance related and physical damages to wiring and electrical systems prior to arrival, including potential damage to below skid wiring components.
2. Current skid grounding was confirmed by Sandridge to be adequately grounded per plan to the main wellpad grounding system. This was not considered to be a contributing cause.
3. Based on the melting and vaporization of steel and copper wiring and connections, Arc Flash conditions appear to have been present. Arc Flash can be caused by unintended wire contacts, wire insulation damage, loose connections, grounding, or even corrosion on contacts. The single cause point or origin for the initial small fire may not be determinable. Potential points that could cause sparking or other ignition potential are identified in the following Findings and Factors.

8.1 Castle 7 (C7) Pump House initial small fire cause findings and factors.

A small fire was seen from the adjacent Janet well area and the well hand responded to attempt to use a fire extinguisher before the flame increased to 300+ feet in height. There are several potential causes of electrical shorts and three areas experiencing high temperatures in the Triplex pump and additional heat damage in the Power Panel Box that are assessed below that could cause the small fire observed. Desired objective is to determine the cause for the initial small fire and the factors contributing to the larger secondary fire.

Potential Initiator Findings/Factors	Discussion	Conclusion
1. Damaged power lines into motor with melted metal connectors. Bare power wires to motor after the incident. Angulated damage indicates power lines were leaning to one side of the connectors into the motor. Possible source of short and meltdown 	The power lines enter in a curved route that leans the weight of the wiring to one side of the connector. These lines are subject to vibration from the pump and motor. Heavy wire weight can have motion during transport for another risk of rubbing or scraping wiring insultation. Heat damage in this area was significantly below the temperatures required to cause the Triplex pump inspection covers to melt.	These motor wires may have been an initial source for a short or local sparking condition against the connector or the housing. This is a Less Than Adequate (LTA) condition and is a possible power line short. REC: Consider proper weight support for power lines to avoid side leaning against connectors or housings for possible shorts. .

2. **Skid deck opening finding of potential for adjacent ground and power lines to motor to be damaged and short**. Bare wiring found passing through C7 skid deck to motor for 2 power lines and ground line that may have been in contact. This power line feeds the Triplex motor in Finding 1. Possible signs of sparking and soot are visible near the ground wire connection to the motor base anchor connection.  Enlarged view of ground wire to motor base connection and adjacent power lines.  Power lines into the C7 motor.	Large rough-cut openings for wire pass through with the power cable insulation providing the only protection from damage to the wiring insulation. Appears to have a clamp above the skid to secure the insulated line in place. Lines are subject to vibration that can cause additional rubbing and scraping. The potential for grounding the power lines exists at the skid pass through opening and the connectors.	Less than Adequate (LTA) condition, possible ground wire to power wire connection or power wire grounding to skid. If the ground wire contacted the power wire it could be a significant short that could affect the Power Panel Box conductors. REC: consider more separation between ground and power lines at skid pass through and in routing.

3. Motor supply wire potential damage to power lines passing through skid deck to 200hp motor.  **Closeup view of C7 power lines through connectors into oversized cut openings** 	Rough cut skid deck openings without sleeve or other protection and cause rubbing or scraping from vibrations of operation or from transportation. Two power conductor lines were positioned close to the motor ground wire, all three had wiring completely exposed.	Bare or damaged ground and power wires can cause a short. The consequence of the short is dependent on the breaker system and the volts and amperage involved. Both ends of the motor wiring to/through the skid have the potential to short. REC: consider inspections on wiring insulation and protective conduits prior to delivery and periodically

4. Damage to protective conduit on power lines passing through Power Panel Box to Triplex skid.  **C7 looking up from under the Power Panel Box bottom shows ground wire and conductor without insulation.** 	Corrugated conduit insulation cover separated or melted about 6" from the bottom of the panel exposing power wires. Do not know when the separation occurred. Conductor wires did not appear to have any sleeve protection other than the insulation cover of the wiring.	Not sure if this was a potential initiating event or a consequence to the incident. At minimum, LTA condition. Could lead to possible Arc Flash conditions. REC: consider inspections on wiring insulation and protective conduits prior to delivery and periodically.

5. High voltage conductors in Power Panel Box had vaporized wire ends and connecting lugs  	The orange and yellow high voltage conductors are aligned vertically about 6" apart in the lower section of the power box. Electricity transferred through air between conductors is a definition of Arc Flash, this appears to be the case here.	Vaporization of adjacent conductors is a sign that Arc Flash has occurred. This is a location of Arc Flash damage does not define the location of the short that created higher than normal current flow. REC: Labeling, training, PPE per Arc Flash standards to be considered and assessed for Arc Flash Hazards.

6. Potential for Triplex Arc Flash heat to be transferred to discharge (upper) or suction line for potential insulation damage and fire **Enlarged for Detail, brightened** Bottom line is location where 4" suction steel pipe connects to the skid flange. Both suction and discharge lines connect to the skid at flanges outside of the skid. 	The suction and discharge lines connect to the Triplex pump within a couple feet from the melted top inspection cover. Both lines are insulated up to the connection point before the skid wall. There is a potential that excessive heat could be transferred to the steel piping that could cause the insulation to burn outside the Power House.	The 4" steel suction line has significantly more capacity for heating up from a quick heat source than the 5,000 psi rubber discharge hose. The discharge line is steel inside the pump house. Both lines are uninsulated inside the Pump House. An insulation fire outside the pump house would create a small fire until the separator flex hose was damaged. After that hose had a release, water and then hydrocarbons would flow from the separator inside the containment.

7. **Vaporized and melted Triplex pump inspection covers over mechanical components.** The thick steel plating in the rear inspection plate over the connecting rods was missing about 10" in the upper right-hand corner. Thinner inspection over the plungers was completely melted on both sides and falling apart. Rear Inspection Cover over connecting rods: C7 cover missing upper right-hand section:  C5 rear inspection cover for comparison to the damaged C7 pump rear inspection cover  	Rear Triplex inspection cover allows access to the connecting rods of the pump, mechanical section. Melted metal slag was found inside the cover location on the right end where the melt of the cover occurred. Melting of metal can occur with Arc Flash incidents, temperatures from 5,000 to 30,000 degrees F are possible.	Additional evidence of Arc Flash damage that can have temperatures to melt steel. Possible cause of the initial small fire igniting insulation or wiring from the Triplex pump extreme temperatures. Temperatures ranging from 5,000 to 35,000 degrees Fahrenheit are possible from Arc Flash events. Arc Flash for 480/277 volt systems can have stabilized arcs between conductors 3-4" apart and persist for an extended time **REC**: Need Arc Flash assessment to determine appropriate PPE, training, procedures and markings per appropriate requirements and industry practices. This should also include breaker setting recommendations and protection or spacing between high voltage conductors.

Top inspection cover over the discharge and suction piping into the pump: C7 photo below of the top inspection cover remnants after high temperature melting. No solid metal remaining, falls apart when lifting.  C5 photo below of the Top Inspection Cover with lift handle for C7 melted cover comparison: Note also close cover location to discharge and suction lines passing through the pump reciprocation plungers in the rectangular box adjacent to this cover 	Top inspection cover was lighter weight and is not as securely sealed to air exposure than the rear inspection cover. The Top Inspection cover is within 2 feet of the suction and discharge lines into the Triplex pump and within 8 feet of the wall location where these lines are insulated outside the walls of the Pump House.. If one of these lines got sufficiently hot like the similar lines at C6 and C5 from the Triplex pump, they could have caused the initial small fire.	Similar conclusions to rear inspection covers. REC: Need Arc Flash assessment to determine appropriate PPE, training, procedures and markings per appropriate requirements and industry practices.

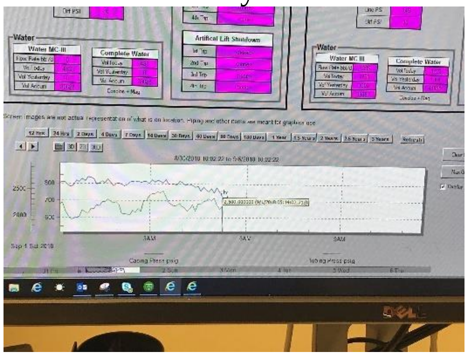
8. **Potential for Arc Flash heat to transfer through piping to insulated piping outside the pump house.** Photo shows black soot marks that are on the inside of C7 pump house with none on the outside.  Outside C7 wall photo below does not show soot markings.   Outside C5 wall photo below shows similar insulation burn marks to C7 inside soot marks. The C5 insulation damage was caused by heat from the large flame.	The melted top cover was within two feet of the suction and discharge lines just off picture to the right of the discharge pulsation sphere. It may be possible for sufficient heat transfer to the inside piping from the Triplex pump to cause the external piping insulation to catch fire. Outside insulation at C5, C6 and C8 caught fire from the heat of the large flame.	If the outside insulation piping caught fire it would spread through the insulation to the flex hose off the separator. The insulation or the insulation cover may catch fire at a low temperature. Rec: Consider insultation and cover fire ratings for alternative insulation and/or covers to reduce risk from ignition from heat or low temperature fires.

9. Low voltage area for fuses, circuit breakers burned up in upper part of Power Panel Box. Lower and middle sections not affected.   **C7 Outside Receptacle and breakers**  	In this area high voltage is transformed to lower voltage. If there is a higher current flow or voltage pass through the lower voltage equipment can get damaged. If there was a low voltage short in the pump house, it could have triggered a short getting back to this equipment.	No finding of an improper low voltage (lighting, instrumentation) equipment source for a short to start a fire or electrical system impact inside the C7 Pump House. All low voltage equipment inside the Pump House was damaged or destroyed including the outlet receptacle on the outside of the south wall of the pump house. The heater was not in use and had the breaker closed. Lighting and instruments worked well until power was shut down following the motor trip. C7 Outside Receptacle The outside 110v receptacle next to the power panel was destroyed except for its metal skeleton and a wire to the breaker. The outside low voltage breaker box had a receptacle next that the only remaining part of the receptacle was the metal skeleton. This could cause a trip back to the power panel if the breaker isn't fast enough or strong enough to trip. Can't verify if the outdoor receptacle had proper weather enclosure and Class/Div rating for occasional hydrocarbon atmospheres.

<table>
<tr><td></td><td></td><td>REC: Low voltage systems should be considered for electrical inspections and should be exterior weather protected.</td></tr>
<tr><td>10. Newer Skids C6 and C8 have power lines to the Triplex motor passing overhead from the Power Panel Box through the Pump House wall instead of through the bottom of the box, under the skid deck and passing through the skid deck to the motor. See C6 motor and overhead wiring photos below.


C6 Window damage and wall damage</td><td>This appears to be a better design to enable better inspection, testing and maintenance on these lines.</td><td>Good change to be considered for all Triplex skids. REC: Consider changing the routing of the power lines to the motor on all skids.</td></tr>
</table>

11. Pre-delivery inspection for quality assurance by Weatherford	Weatherford has verbally confirmed that the Skid passed mechanical and electrical inspection prior to delivery. They have not provided any documentation to date and are searching for the inspection documentation.	Weatherford has not responded to requests for pre-delivery assessment information. REC: Consider pre-delivery quality assessments for skid equipment and wiring by Weatherford and by receiving operations.
12. Wellpad power supply system grounding was tested	Resistance of 7 ohms is significantly below recognized standard of 25 ohms. Higher grounding standards used for high lightning areas is an improvement over minimum requirements.	Wellpad appears to have an adequate grounding system. REC: Test equipment can be used to verify low resistance conditions seasonally as needed.
13. Triplex pump skid is designed to be grounded to the wellpad grounding system.	Sandridge verified skid was grounded to site grounding system.	Grounding may not be a contributing condition
14. **Operating conditions and power supply conditions were normal until loss of power to motor.** There were no changes to operations other than periodic increases in Triplex pump discharge pressure to the wellhead. Power lines going into C7 Power Panel Box were not a source of ignition. Once the loss of power to the C7 motor occurred, the interlocks tripped the ESD/MOV to shut off flow from the wellhead, all power and PLC data was cut off. Trend sheet photo below shows loss of signal at 4:20am Mountain Time.	Automated wellpad shutdown worked well after loss of power to motor detected, also resulted in loss of process data such as pressure, levels, temperature.	No signs that this was process mechanical breakdown or release related. Process shutdowns worked as planned to protect Castle 7 wellhead pump house. No signs of fire initiation in this area from the power supply lines that look intact.

Trend line data shows power and pressure loss simultaneously  C7 Power Supply Lines 	No visual damage to power lines into the C7 Power Panel Box.	Power supply trend lines also showed stable conditions until loss of power to the motor.

Conclusions, findings for initial small fire cause: There was no source location for the grounding short of a conductor that can be confirmed at this time as the initial failure. There were at least 3 locations inside the Pump House and 2 locations outside the Pump House. that could have caused a short or a spark listed below:

- Potential for grounding conductor lines passing through Power Panel Box bottom;
- Potential for grounding conduction lines passing through the skid deck to the motor;
- Potential for grounding the conductor lines at the motor inlet box;
- Potential for grounding conductor lines below the skid; and
- Potential for outside 110v receptacle on the south side of C7 pump house to have shorted to ground.

A high voltage conductor power line that is grounded downstream of the Power Panel Box, would have created a very short, high current flow through the upstream electrical breaker system until that system is tripped off. The C7 Power Control Panel had current arc between two conductors that vaporized wire ends and connectors. Additional information is required to further assess the full potential magnitude of the Arc Flash between the two conductors inside the C7 Power Control Panel. There are several areas for potential improvement that have been identified above for the initiation of the small fire that are addressed in recommendations below.

8.2 Fire escalation to Larger Flame Size by witnesses

Fire as seen from adjacent well pad suddenly increased from a small flame to a 300+ foot flame

Findings/Factors	Discussion	Conclusion
Potential for other Pump Houses and Wellheads to cause or contribute to the initial small fire.	Based on immediate wellhead shutoff with loss of pump power, there was no additional flow from the C7 wellhead or other sources other than the horizontal separator	Wellhead and other Pump House operations are not considered to be a factor in the initial small fire case.
Piping releases limited from metal flex suction hose complete failure. All hard pipe and the discharge flex hose appeared not to have any releases. The C7 horizontal separator's flex metal hose was destroyed. allowing produced water and hydrocarbons to be pressured through the pickup	Opening the suction hose to atmosphere would allow the 300 psig pressure in the vessel to flow water then hydrocarbons out the suction hose opening if the vessel was not vented. Temperature rating is not known on the flex hose.	Photos show hydrocarbons most concentrated around the suction flex hose as expected. REC: Consider a higher temperature rating on the flex hose for protection against external fire sources. Consider potential for automated shutoff valve prior to the suction line outlet.

8.3 History factors

Sandridge and Weatherford representatives were questioned about similar electrical or other fire problems related to the Triplex pump skids. There were no reports or previous incidents.

8.4 Electrical Grounding of C7Pump House Skid

The design plan called for the skids to be grounded to the main wellpad grounding system. This would have required the main backbone of the skid to be grounded to this grounding system. The main grounding system was tested after the incident to confirm that the 7 ohms resistance measured was significantly below target standard of 25 ohms. Additional investigation continues on this system to determine if the skid was grounded as designed. Information to date from Sandridge confirms that the site grounding system was adequate based on its 7 ohm measured resistance. It also appears from this assessment that the C7 Pump House Skid was adequately grounded to this main site grounding system.

9.0 Key Issues

9.1 Abnormal Operations

There were no abnormal well pad, Triplex pump skid, or wellhead operations at the time of this event other than new equipment startup. The design and wiring of Triplex C7 Power House were very similar to C5 that has been in operation with no problems.

9.2 Incidental Factors/Systems Factors New Startup/Equipment

There was no rush for startup. Equipment documentation was checked off as ready, electrician had signed off, Weatherford had signed off, and Oklahoma Corporate operations had signed off per Sandridge.

It is possible that equipment details, specifically wiring conditions, were not assessed closely prior to startup due to similarity to the existing equipment at C5 Pump House and other locations that had been in operation with no problems.

9.3 No known inspection for Skid quality electrical conditions prior to turnover to Sandridge. There should be a supplier or manufacturer pre-delivery Pump House assessment inspections for quality and deviations that include the wiring systems. Weatherford has informed Sandridge that there was an inspection for mechanical and electrical conditions prior to delivery. Weatherford has not provided documentation of the pre-delivery inspection and stated that they are searching for their documentation. The final Triplex Pump House inspections should have both parties present. This initial pre-delivery and post-delivery inspection should be developed and documented.

9.4 Suction metal flex hose should be considered for higher pressure and temperature rating to prevent its destruction in a fire that the discharge flex hose survived.

9.5 Routing of power and ground lines through Power Panel Box bottom and under the pump skid. There were crudely cut or drilled openings in the Skid deck observed that can lead to potential insulation damage to high voltage wiring over time from vibration or from movement on land or in transportation. Newer looking Skids, C6 and C8, had power lines exiting the top of the Skid Power Panel Box that enables easier inspection and replacement. This was a change by Weatherford that appears to be an improvement to reduce risk of exposing high voltage wiring through the wiring insulation. Manufacturer changes should be identified to the user for consideration in application to other skid packages.

9.6 Arc Flash Regulatory and Standard Practice Requirements

There are Arc Flash regulatory and standard practice requirements to prevent injuries and damages from Arc Flash events. There are labeling requirements for 480-volt 3-phase systems based on potential for Arc Flash injury following an Arc Flash assessment.

NFPA 70E and IEEE 1584 assess potential for injury and safe work boundaries and Arc Flash calculation methods. ANSI Z535.4 provides guidelines to be used for signs and labels around potential Arc Flash operations.

10.0 Incident Analysis

10.1 Causal Factors Analysis

Since there was not a single causal event identified for the initial small fire, general electrical cause factors and recommendations are to be included. These are identified below and in recommendations.

Process related questions for the insulation, insulation cover and flex hose low temperature fire risks should be addressed to reduce the potential for these fires. Potential grass fires or other external sources could also impact the facility.

Several factors may be at work during the course of any incident that trigger a sequence of events that result in injury or property damage. A causal factors analysis is used to identify all the factors for which a corrective action is possible.

The principle failure in this event was equipment condition. A limited section of this causal factor analysis was appropriate and is documented below. Causal Factor numbers refer to item numbers from the “Guide for Identifying Causal Factors & Corrective Actions.

Causal Analysis Table

1. Condition: Unacceptable wire insulation, connection, and grounding conditions

Causal Factors	Comment	Recommendations
1.1 Did any defect(s) in equipment, tools, material contribute to hazardous conditions?	Recently received rental/purchased equipment was found to have significant wiring insulation damage after 12 hours of operation. Some of the insulation defects or connection/pass through conditions were considered to be existing prior to startup and could have been detected.	1. For prior used equipment brought on site, consider the need for a thorough assessment of electrical conditions before acceptance or startup. Include these inspection requirements before use in existing or new procedures.

1.2 Was the hazardous condition(s) recognized?	There was no specific electrical inspection on the equipment grounding and all wiring conditions performed prior to startup.	2. Develop a procedure with a checklist for training personnel on electrical equipment hazards to identify hazardous or unacceptable conditions as needed. Recently acquired used equipment specifically need to be subject to this hazard assessment. Arc Flash hazard conditions and applicable requirements, use of PPE, safe practices and other electrical related requirements are to be included. Include the need for inspecting hard to observe locations and the need for supplemental lighting or test equipment as needed. Also include reporting requirements when hazardous or unacceptable conditions are found.
A. Was the hazardous condition(s) reported?	Conditions were not identified and reported prior to the incident.	See recommendation 2 above.
B. Was employee(s) informed of the hazardous condition and the job procedures for dealing with it as an interim measure?	New procedures for inspection and Arc Flash Hazard will be communicated.	3. Communicate the Arc Flash hazard potential to appropriate personnel with temporary instructions until completion of training.
1.3 Was there an equipment inspection procedure to detect the hazardous condition(s)?	There was no existing procedure	See recommendations 1-3 above.
1.4 Did the existing equipment inspection procedure detect the hazardous condition?	No existing procedure.	See recommendations 1-3 above
1.10 Did the general design or quality of the equipment/tool contribute to a hazardous condition?	Yes, the 480-volt 3-phase power to the 200hp motor has the potential to produce Arc Flash that increase requirements for training, PPE and procedures.	See recommendations 1-3 above

2.2 Environment

Causal Factors	Comment	Recommendations
2.7 Other factors. Wiring conditions were difficult to observe due to access below power panel boxes and below skid decks.	Employee inspections need to include observations of the entire length of exposed wiring. Visualization in tight, hidden or in shadow areas is difficult without supplemental lighting.	Include difficult to access inspection guidance in the Equipment Training recommendation 2 above.

10.2 References for Arc Flash standards and guidelines

- NFPA 70E addresses training
- IEEE 1584
- ANSI Z535.4 for labeling
- Practical Solution Guide to Arc Flash Hazards: published by EasyPower, LLC, Downloadable from www.EasyPower.com/arc_flash

11.0 Conclusions

11.1 Cause of the Small Fire

There is no singular specific cause that can be stated with certainty that started the initial small fire. Also, the Triplex pump skid was only put into operation for approximately 12 hours prior to the fire. However, there are a number of potential locations for electrical shorts that could trigger an arc flash between the two large voltage conductors in the

11.2 Contributing Factors

- Less than adequate electrical protection at skid pass through locations, motor power box connectors and power panel box provided the potential for shorts that could trigger Arc Flash from the conductors.
- A low voltage receptacle outside the Pump House below the breaker box may have provided the short that triggered the Arc Flash.
- Possible less than adequate protection existed between the two high voltage conductors that had arc between them resulting in vaporization of the wires and connection lugs.
- Apparently, no supplier pre-delivery or user inspection occurred on electrical conditions prior to use.

11.3 Cause of the fire escalation to a Large Fire

- Initial fire may have caused piping insulation to melt and catch fire at C7 as was also found at C6 and C5 Pump Houses.
- Insulation fire or another fire source up to the flex hose off the horizontal separator destroyed the flex hose.
- Once flex hose was opened, first water then hydrocarbons drained to the ground adding significant fuel to the fire.
- It is not known what temperatures the insulation received, hence following contributing factors may not be relevant.

11.4 Contributing Factors

- Insulation covers and/or insulation may not have been rated to resist igniting from the heat off the Triplex pump.
- There was no insulation on the piping inside the pump house to protect the piping from pump heat that was significant enough to melt metal inspection covers and blacken the pump box around the piping.
- Flex hose off the horizontal separator may have had a low temperature resistance to fire, it was only a 300 psig hose. The 5,000 psig hose held up to both fires.
- There was no valve to shutoff the suction hose from the separator once it was opened.
- Not known if it was a factor, but potentially higher hydrocarbon levels than normal could have been present in the water phase going to the pump.

12.0 Recommendations Prior to Re-Starting the C7 Pump House Skid

Sandridge is planning to replace the complete skid in addition to external repairs needed. Electrical inspection should be conducted on wiring conditions as well as for Arc Flash labeling, training and PPE requirements that may apply or should be considered.

The evidence of Arc Flash from vaporization of conductors in the Power Panel Box and the melted metal covers off the pump should be taken seriously. The high potential high temperatures and Arc Blast conditions should be assessed and understood.

Note that any temporary changes should only be made per facility Management of Change procedures.

These recommendations are provided below.

Recommendation	Description
1	Provide adequate support to power lines to avoid stress in lines or approaching vertical connections from side angle that can cause vibration wear on the insulation.
2	If it is required that we have to pass conductors through metal skid decks, consider more separation and protection between ground and conductor lines, use sleeves or other rub protection to prevent loss of insulation during vibration from operational uses.
3	Consider the need for documented supplier inspections on new and used electrical equipment and facility inspections for electrical system quality prior to putting the electrical equipment in service. You may want to have a short checklist for small equipment and a more detailed checklist for a Pump House skid for example. This program should consider development into a periodic asset electrical safety inspection.
4	Consider having an Arc Flash Hazard assessment on the 200 hp 3-phase motors and similar equipment to ensure proper procedures, training, labeling and PPE are used to meet requirements and best practices. If appropriate, include Arc Flash training as part or requirements for appropriate personnel. Include assessments of downstream and upstream effects from Arc Flash events that will also assess equipment time to trip. NFPA 70E, ISSE 1584. This should address high voltage conductor spacing and protection to prevent electrical arcs between the conductors at their open connections.
5	Consider upgrading piping requirements around the horizontal separator area for upgrading the fire resistance/high temperature ratings on flex hoses, insulation and insulation covers on active wellpads as protection against external fires.
6	Consider the potential for low voltage, 110v and 220v, to create sparking or fire in hydrocarbon areas. Low voltage equipment should be considered for appropriate weather protection and Class and Division requirements around hydrocarbons.
7	Consider providing more protection between the Phase B and C conductors (orange and yellow coded) to reduce the possibility of arc flashing between them when there is a short.
8	Consider changing the routing of the power lines to the Triplex motor to avoid steel skid deck pass through such as present at current Pump House C6 and C8. Overhead lines will need support and outdoor lines may need additional UV or other protection for the area.

13.0 General Recommendations for Existing and Future Triplex Pump Skids

Below are recommendations, based on this investigation, to prevent a reoccurrence of a similar incident at other existing locations and future deliveries of similar Triplex pump skids:

13.1 Recommendations prior to restart of a replacement Triplex Pump Skid

1. Require a pre-delivery quality assessment of Triplex Pump House Skids by the provider prior to delivery with a copy provided. Review the findings for proper corrections.
2. Consider implementing your own pre-acceptance inspection checklist or process prior to accepting delivery of additional Triplex pump skids in addition to the suppliers' process.
3. Develop a standard practice or assessment document for assessing electrical, process and other safety hazards for new skids and as needed for preventive findings and corrections. This should include wiring, grounding, and other potential hazards.
4. Implement Arc Flash assessment, training, marking/labeling and other requirements as appropriate.
5. Track all identified repairs to timely completion.

2. Process Hazard Analysis

Process related recommendations to be considered for Process Hazard Analysis or other assessment:

1. Consider the concerns for Arc Flash and Arc Blast in PHA analysis. We don't know the maximum concentrations of hydrocarbons that reached the pump, but if the pump had higher hydrocarbon present, results could have been significantly worse.

2. Consider changes to separator monitoring to detect high hydrocarbon concentrations going to the Triplex pump for possible interlock shutdown or other operation.

3. Consider changes to the suction line from the separator to the skid:
    a. Higher temperature rated flex hose for external fire conditions;
    b. Adding a valve to shut off at the vessel prior to the suction line flex hose;
    c. Adding hydrocarbon detector by conductivity or other methods for operation shutdown.

4. Consider assessing the need for a second ESD closure device on the wellhead to separator line to ensure proper shutdown.

5. Consider auto-shutdown for high pressure to the separator as well as loss of power to the pump if not present already.

6. Consider including pump skid equipment providers in the PHA or ask for other risk assessment information.

7. Communicate all related PHA and other process findings and action items to be implemented to all workers.

4. Management

Share findings and recommendations appropriately across local and other company operations

1. Consider the need for a standard electrical powered grid grounding and high voltage safety inspection checklist and frequency for all facilities
2. Consider suction line, insulation and pump recommendations from other Sandridge assets and share findings from this incident.

14.0 Special Terms and Conditions

Contek Solutions, LLC is a professional services consulting firm with experience in operations, engineering, hazard analysis and incident investigations. The members of Contek Solutions, LLC are registered engineers and certified safety professionals. Contek Solutions, LLC expresses no opinion as to disciplines, subjects and practices outside those specifically enumerated above. Further, Contek Solutions, LLC expresses no opinion herein as to any matters of State or Federal law. This incident investigation report is based on the foregoing and subject to the limitations, qualifications, exceptions and assumptions set forth herein.

15.0 Qualifications of Professional Conducting the Investigation

Contek Solutions, LLC was formed in 2003 and employs engineers and safety professionals with extensive experience across a wide range of incident investigation and hazard analysis. Relevant experience of key personnel includes conducting investigations of failed equipment as the result of corrosion, fatigue, improper installation, design errors and human factors.

Mr. Jim Johnstone, President, Dallas, Texas

Mr. Johnstone is a registered Professional Engineer in seven states. He holds a “Certified Safety Professional” certificate from BCSP. Mr. Johnstone has over 30 years of industry experience in engineering, operations and EH&S at both domestic and international locations. He has extensive experience in well operations, pipelines, gas processing, engineering and management. Areas of expertise include management systems development; hazard analysis, EHS program implementation, permitting, incident investigations, field operations, air issues, and quantification of potential liabilities, regulatory assurance programs, public affairs and mechanical engineering. Mr. Johnstone has a BS degree in Mechanical Engineering from Washington State University.

Mr. Hadley Bedbury, Technical Consultant, Houston, Texas

Mr. Bedbury is a "Certified Safety Professional" holding a certificate from BCSP and is a Certified Hazardous Materials Manager. He has over 30 years of incident investigation including onshore/offshore oil/gas operations, chemical facilities, and refineries. He has extensive experience implementing EH&S across domestic and international facilities including permitting and risk management. Incident investigations have included process releases, worker falls, fires, and release modeling. Process safety experience includes PHA validations, facility siting, Quantitative Risk Assessments, applicability determinations and PSM/RMP audits. Mr. Bedbury has a BS degree in Chemical Engineering from the University of Minnesota. He is a remediation project manager having lead EPA Superfund site assessments and state directed assessment and remediation programs. Mr. Bedbury is a Texas Registered Professional Engineer in Environmental.

16.0 Signature of Engineering and Safety Professional

The information presented in this report regarding the incident investigation is accurate and complete to the best of my knowledge and belief.

Hadley Bedbury, C.S.P.
Contek Solutions, LLC

17.0 References

1. NFPA 70E
2. Practical Solution Guide to Arc Flash Hazards, 2nd Edition
3. IEEE 1584
4. ANSI Z535.4 labeling

Attachment I

Investigation Team and Contacts

Contek Solutions LLC

ENGINEERING·ENVIRONMENT·SAFETY·MANAGEMENT SYSTEMS

~~PHA~~ SIGN-IN SHEET

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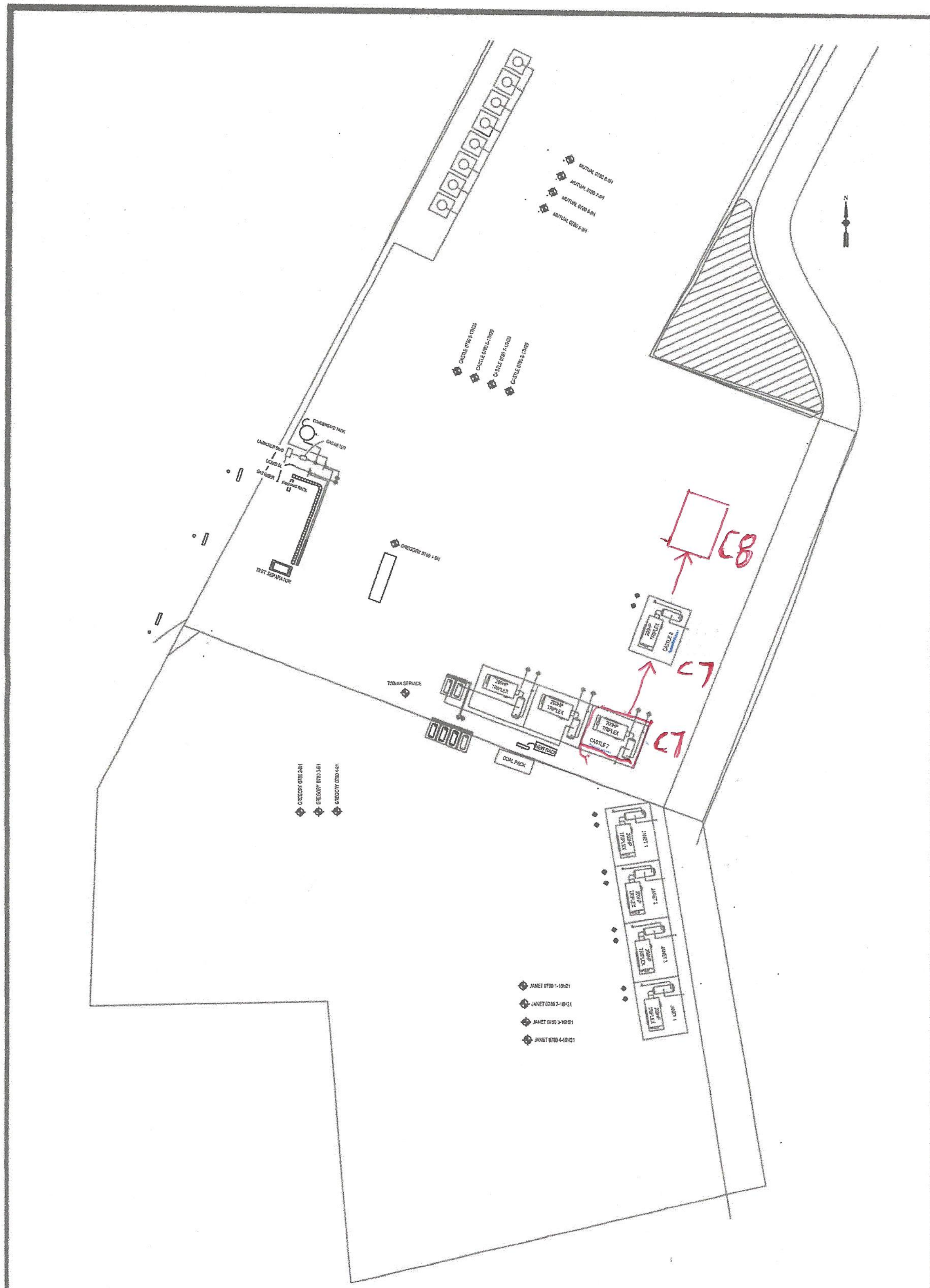
Shawn Crabtree, Sandridge, Electrical/Instrumentation Technician

Mark Scott, Total Safety, Site Safety Representative

Garrett Giddens, Weatherford, Triplex Pump Skid Representative

Attachment II

Wellpad Layout



07N80W-8-SW4SW4			Comp. ID:
JACKSON CO. COLORADO			Comp. ID:
Drawn by:	Engineer: N. HARGIN	Date	Comp. ID:
E-100		Rev.	Comp. ID:

Revision	Description	By	Date

Attachment III

C7 Power Fluid Vessel Horizontal Separator

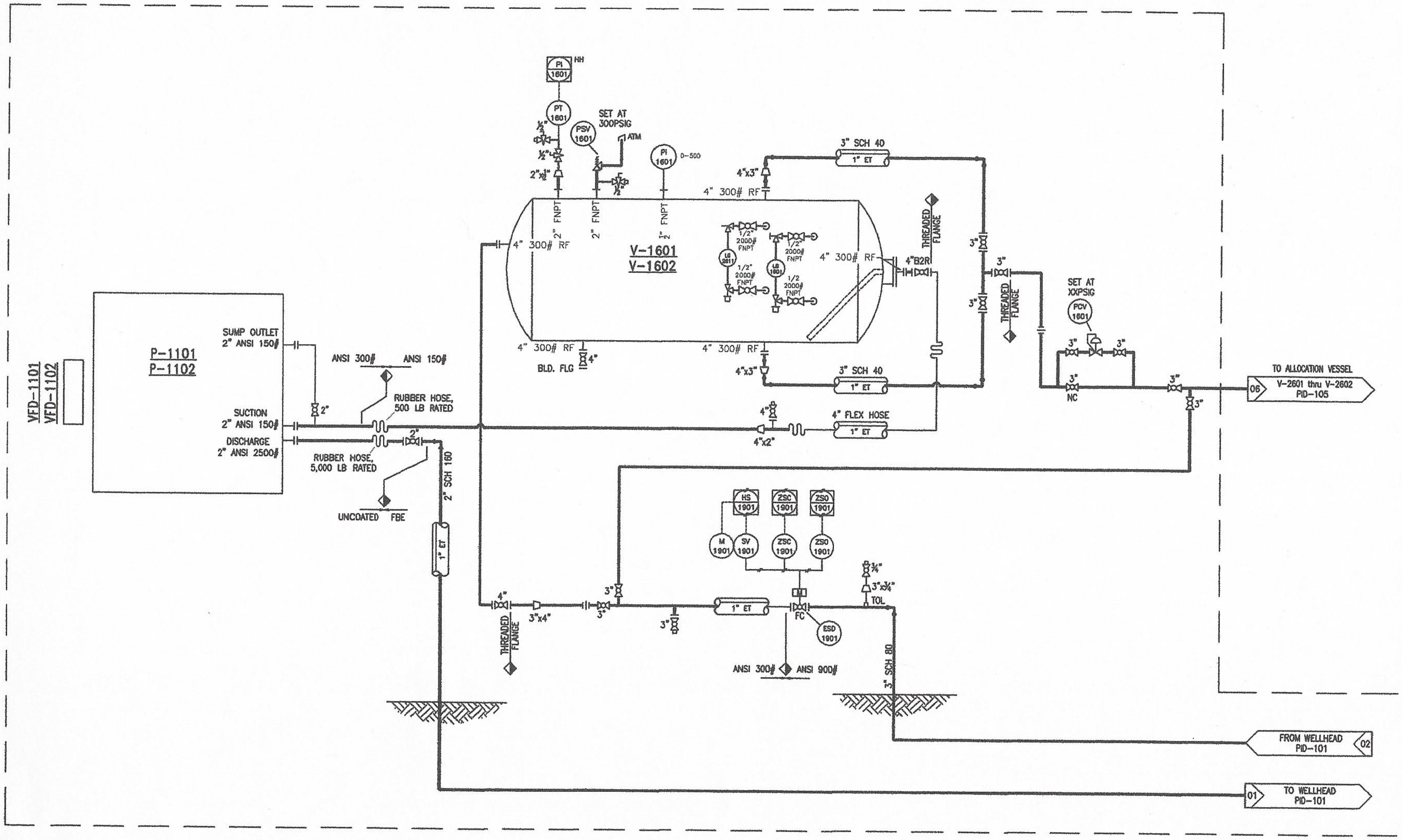
VFD-1101
VFD-1102

P-1101 thru P-1102
TRIPLEX PUMP
POS. DISPLACEMENT
WFT W200 TRIPLEX
RATED POWER: 200HP

JET PUMP SURFACE EQUIPMENT
CASTLE 0780 7-17H20
CASTLE 0780 8-17H20

V-1601 thru V-1602
POWER FLUID VESSEL
6'DIA X 15'LG
DESIGN: 300 PSIG AT 200°F

NOTE: ALL WORK IN THIS AREA IS TO BE CHARGED TO "BATTERYAFE" AND DC GL CODING APPLIES



Revision	Description	By	Date
1	Issue for Review	MDT	3/9/18
2	ISSUED FOR CONSTRUCTION	NH	4/18/18

CASTLE/JANET WELLSITE BATTERY

JET PUMP - P&ID
JACKSON COUNTY, CO

Drawn by: M. THORNHILL | Designer: N. HANSEN | Date: 3/9/18 | Rev.

CSTLJNT-P&ID-103

Attachment IV

Weatherford W200 Triplex Pump

Triplex W200 Layout Overhead View