

Commonwealth of Pennsylvania



EXPLANATION AND SUMMARY OF PRELIMINARY MECHANICAL INTEGRITY ASSESSMENT DATASET

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Executive Summary

The Department of Environmental Protection's (DEP) Mechanical Integrity Assessment Program (Integrity Program) is a quarterly well monitoring requirement that applies to oil and gas operators of both active wells and abandoned wells that have not yet been plugged. At the most basic level, well integrity represents the ability of a well to contain and isolate gas, oil, and brine from drinking water supplies and ecological and human receptors. Maintaining proper well integrity is essential for protecting and preserving public health and safety, drinking water supplies and environmental quality. Over the many decades of oil and gas development in Pennsylvania, failures of well integrity have contributed to hundreds of documented cases of water supply impacts and, in some cases, methane explosions resulting in injuries and fatalities. Pennsylvania's Integrity Program makes the state a worldwide leader in monitoring and addressing integrity issues in operating oil and gas wells.

Although the scope of this program focuses on the prevention of such incidents, well integrity failures also contribute to other forms of long-term environmental degradation. One specific issue is the contribution of greenhouse gas emissions to the atmosphere. For the first time in the state's history, the Integrity Program is enabling the agency to begin to quantitatively gauge the volume of such emissions.

The Integrity Program serves as a screening tool, and provides useful indicator parameters relating to well integrity. These data assists DEP in determining if wells are structurally sound and being operated in a safe manner that is protective of the Commonwealth's environment. It represents one component of an integrated approach for ensuring high environmental protection standards and public health and safety, along with Pennsylvania's rigorous well construction and plugging standards. With the establishment of baseline well integrity metrics collected as part of the program, DEP is able to operate more efficiently by focusing its oversight attention on wells demonstrating anomalous conditions. Prior to having well integrity information, when faced with a water supply problem, the agency often had to assume that all nearby oil and gas wells could potentially be causing the problem and expend limited agency resources investigating non-contributing wells. Having Integrity Program data allows the agency to narrow and focus the scope of water supply investigations, making it much more likely that impacts to water supplies and other receptors will be addressed promptly, thus lowering the risk of human exposure and environmental health and safety. The Integrity Program data also allows the agency to prevent interruptions in well operations at oil and gas wells that exhibit characteristics of sound well integrity.

The Integrity Program regulations were promulgated in 2011. The regulatory language is found in 25 Pa. Code Chapter 78, section 78.88¹ or 25 Pa. Code Chapter 78a, section 78a.88¹. The reporting component was postponed until standard forms and a data-receipt platform could be developed. The regulation requires quarterly inspections at wells to identify the well head pressure or water level, open flow readings or shut-in pressures associated with the well's production annulus, escaping fluids and signs of progressive corrosion. The Integrity Program also requires operators to report wells that do not comply with specific provisions found in the regulations and remediate the identified integrity issues in a timely fashion.

Under the program, oil and gas operators report defined inspection parameters for wells by February 15th of each year following the inspections. Several of the inspection parameters are dependent upon well type, construction detail, and observed conditions; while other parameters are universal for all well types. All operators are expected to perform four (4) quarterly inspections. DEP requires that all inspection data collected at unconventional “shale” gas wells be submitted, but permits conventional oil and gas well operators to provide data for one (1) of the four (4) quarterly inspections to satisfy the reporting requirement. Through the implementation of the Integrity Program and development of an electronic reporting system, DEP has a tool to monitor trends on a well-by-well basis and evaluate time-series well integrity data to aid in the investigation of water supply complaints.

To validate operator-reported data associated with the Integrity Program, the Bureau of Oil and Gas Planning and Program Management completed a field and office audit of the data gathered by operators during the 2014 reporting year and reported to DEP by April 9, 2015. The field study considered randomly selected wells in several counties:

- 23 unconventional wells in Lycoming County,
- 24 unconventional wells in Green and Washington counties,
- 25 conventional wells in McKean County, and
- 24 conventional wells in Indiana County

Although the audited wells were selected at random, the audit locations were generally selected from counties where production activity and operator diversity is high. The field verification study revealed proper operator characterization of the wells’ ability to contain fluids and prevent negative environmental impacts, although there was a relatively high percentage of errors in the how the data were formatted and reported to DEP. The office verification program included a check of data compiled in randomly selected unconventional and conventional well reports in comparison to information contained in well records to determine if operators were completing the forms accurately. The results showed fewer errors in the formatting of the data in comparison to the field audit. These study results will assist in the development of focused and effective training for the regulated community.

¹Note: As this report was being drafted, a final-form rulemaking creating a new Chapter 78a to specifically address unconventional gas wells was being developed. This report and data collected to develop it were compiled prior to the promulgation of Chapter 78a on October 8, 2016. DEP has not edited any of the regulatory citations contained within this report, as only minor changes were made in Chapter 78a relating to the well drilling, operation and plugging regulations in Subchapter D. None of those minor changes apply to the regulations relating to the Integrity Program, and each regulatory citation to Chapter 78 in this report should be read to include a reference to the parallel Integrity Program requirements found in Chapter 78.

Introduction

The Department of Environmental Protection's (DEP) Mechanical Integrity Assessment Program is a quarterly monitoring program authorized under 25 Pa. Code Chapter 78, section 78.88. The regulation requires that oil and gas operators inspect all operating oil, gas, combination (oil and gas), and coalbed methane wells on a quarterly basis for basic well integrity metrics. Wells that meet the definition of "abandoned" in accordance with Act 13 must also be inspected if they have not yet been plugged. The only exception is if well integrity is addressed through specific provisions under a consent order and agreement. A summary report detailing the results of these inspections must be submitted to DEP annually by February 15 in the year subsequent to the inspections and a recordkeeping requirement mandates that inspection records be retained by the operator for five (5) years.

Certain wells are not covered by 25 Pa. Code Chapter 78, section 78.88. These include wells approved for inactive status (completely or partially drilled wells that are not currently in production, but have "future utility"), storage field wells, and wells regulated under the U.S. Environmental Protection Agency's (EPA) Underground Injection Control (UIC) Program. Well integrity at these sites is addressed through other laws and regulations.

Pennsylvania is currently the only state requiring quarterly mechanical integrity inspections of all operating wells. Through introduction of such a requirement, DEP has taken steps to ensure that oil and gas wells are operated in a manner that is protective of human health and the environment within the Commonwealth. Further, data collected under the provisions of the Mechanical Integrity Assessment Program provide a useful reference for both office and field personnel by establishing a baseline operating history for all monitored wells. Finally, the program establishes a mechanism for facilitating continual improvement of regulatory oversight and a useful dataset for evaluating the effectiveness of current regulatory processes prior to undertaking future rulemakings.

Compliance with the Mechanical Integrity Assessment Program necessitates that operators monitor their well inventories and address well characteristics that may eventually result in containment failures, i.e., surface evidence of progressive corrosion or overpressuring of surface or coal casing used as production casing. If no containment issues are noted, the inspection results are simply reported to DEP. Through the implementation of the program, DEP has a way to monitor data trends and evaluate well-specific time-series data in the context of water supply complaint investigations.

DEP has completed independent verification of a statistically representative fraction of the data submitted to confirm information provided by operators and identify areas of the program where enhancements can be introduced.

Descriptions of General Report Information and Integrity Indicator Parameters

This section of the report provides a detailed description of each parameter that is archived in DEP's mechanical integrity database. Parameter limitations are described, when appropriate. It is important to note that the database available for review has been populated from several different sources that are described later in this report. Because of this, formatting may vary. For example, when certain inspection elements are not required for a particular well design, they may either be archived in the database as blank fields or populated with the character string "NA" (not applicable), depending on which source they were derived from. It is also important to note that DEP does not prescribe the methods by which pressures and flows must be measured through regulation, although it has emphasized to operators that a best suggested practice involves quantifying such measurements using the same process at the well each quarter. Following this practice makes the dataset most useful on a well-specific basis.

Operator

The Oil and Gas Operator's name as it has been registered with DEP.

Oil and Gas Operator (OGO)

This is the OGO Number assigned by DEP to each well operator/owner who is responsible for operating a well.

Permit/API

The abridged API number assigned to the well using the following format: CCC-XXXXX. CCC represents the three-digit county code and XXXXX represents the unique, 5-digit county ID. This number is an abridged derivation of the complete Permit/API number that excludes the 037 prefix specific to the Commonwealth of Pennsylvania and any suffixes that provide additional information about the character of the wellbore, e.g., pilot hole versus production hole.

Inspection Year

This is the year during which the Mechanical Integrity Assessment Program inspections took place. Any exceptions to this should be noted in the *Comments* field.

Inspection Date

The date the inspection was completed at the well. Each date is recorded in the following format: MM/DD/YYYY. For unconventional well sites, there will be four (4) inspection dates: one per quarter, unless an inspection was not performed. Explanations of why an inspection may not have been performed may be recorded in the *Standard Comments for No Inspection* or the *Comments* fields. For conventional well sites, there may only be one inspection date, unless an operator has chosen to report all four quarterly inspection results. If only one date appears, it may be the first day of the reporting year (01/01/YYYY), i.e., default date, or it may be the date the inspection was performed at the well. DEP has recommended that conventional well operators provide actual inspection dates and submit data nearest to the time when the report is due. Any exceptions to the formatting described above should be noted in the *Comments* field.

Date Received

The date the most recent report was imported into DEP's data management system. Operators may have submitted and had a report imported prior to this date, but in certain cases subsequent submittals supersede earlier reports.

Form ID

An identifier designating which specific form the operator used to record the Mechanical Integrity Assessment inspection data. For electronic submissions, one of three forms (Form A, B or C) have been available for use historically to generate the annual inspection report. Beginning in 2017, DEP made changes to its reporting system that would only permit electronic submissions of Form C for operators choosing to assemble annual inspection data using a spreadsheet. The *Form ID* field is populated with "HU" for "Home-Use/On-site Use" wells and "CHC" for "Commercial" operators who submitted a "Hardcopy" summary report.

Document Category

This is an identifier for the document type the operator used to submit their annual Mechanical Integrity Assessment report. Historically, either DEP Integrity Form A, DEP Integrity Form B or DEP Integrity Short Form C have been used by operators to report electronically. For the 2017 inspection year (2018 submission year), only DEP Integrity Short Form C is compatible with DEP's reporting system.

Certain operators are permitted to report using paper forms, e.g., home-use/on-site use operators (gas is used on property and not sold) or commercial operators with ten (10) or fewer wells in their inventory. However, DEP prefers electronic submissions and has promoted that option through the development of multiple forms. Additionally, an online form has been developed for 2015 that allow electronic data submission for any operator with web access. Paper form submittals are currently labeled "Operator Scanned Form" in the report. For samples of all forms, please see the Appendix.

Primary Production Pressure (psig)

This is the observed casing pressure (flowing or shut-in) inside the production casing or between the casing and tubing in pounds per square inch gauge (psig) at the time of the inspection, if a gauge is available for reference. All wells drilled after February 5, 2011 must be equipped to measure flowing or shut-in pressures in order to comply with the monitoring requirements of 25 Pa. Code Chapter 78, section 78.88. Certain wells that produce gas through surface or coal strings drilled, altered, reconditioned, or recompleted after February 5, 2011 are required to be equipped with working pressure gauges to monitor surface measured pressures inside coal/surface casings in accordance with 25 Pa. Code Chapter 78, section 78.83(a)(2).

Operators may leave the column blank if no gauge is available or input zero (0) if the field is produced using a vacuum system. This value does not represent a tubing pressure reading unless well tubing is used to isolate the produced horizon by being set on a packer or cemented in place in an open-hole completion scenario, i.e., gas enters the wellbore directly from the exposed reservoir rock and not through perforated casing. This pressure may also be zero (0) in instances where the well is a cased-hole completion, i.e., gas enters the wellbore through cemented production casing that has been perforated, and tubing has been

set on a packer inside of the production casing. This field is required for all gas, coalbed methane, and combination wells equipped with casing pressure gauges.

Production Open Vent Flow

This is the vent flow rate for wells with engineered vents in cases where associated gas is not tied in to production. This often applies for oil wells producing inside of surface or coal casing that vent associated gas to comply with 25 Pa. Code Chapter 78, section 78.83(a)(1) or multi-string oil or combination wells that vent production casing gas because either no pipeline or gas market is available. It is emphasized that this condition is not a well-construction defect, but rather an engineered vent to regulate pressures and allow liquids production.

Production Open Vent Flow Unit (cfpd)

This is the observed flow rate unit in cubic feet per day (cfpd) for the open vent flow described above. Operators may indicate NRM (not readily measurable) if the flow cannot be constrained for measurement or is too low to estimate with standard equipment. This field is not required for all wells, as in most instances production gas is not vented.

Annular Production Pressure (psig)

This is the annular production pressure (flowing or shut-in) outside the production casing and inside the next outer casing string. It applies for wells where the production annulus (outside production casing) is plumbed to a sales line or where production annulus gas is used for other on-site applications. It is recorded in psig, if a gauge is available for reference. All wells drilled after February 5, 2011 must be equipped to measure flowing or shut-in pressures in order to comply with the monitoring requirements of 25 Pa. Code Chapter 78, section 78.88. Certain wells that produce gas through surface or coal strings drilled, altered, reconditioned, or recompleted after February 5, 2011 are required to be equipped with working pressure gauges to monitor surface measured pressures inside coal/surface casings in accordance with 25 Pa. Code Chapter 78, section 78.83(a)(2).

Operators may leave the column blank if no gauge is available or input zero (0) if the field is produced using a vacuum system. This field is required for all gas and combination wells equipped with casing pressure gauges where the production annulus is tied in to a sales line or produced for other on-site applications.

Maximum Allowable Pressure Exceeded

This field indicates if the maximum allowable pressure is exceeded per 25 Pa. Code Chapter 78, section 78.73(c). This field is required if gas is produced, i.e., plumbed to a sales line or used for other on-site applications, inside coal casing or surface casing. This field is populated in accordance with the following procedure:

- Indicate Y (Yes) if the flowing or shut-in pressure inside surface or coal casing (either Primary Production Pressure or Annular Production Pressure) is in excess of $80\% \times 0.433 \text{ psi/ft} \times \text{casing set depth in feet}$.

- Indicate N (No) if the flowing or shut-in pressure inside surface or coal casing (either Primary Production Pressure or Annular Production Pressure) is less than or equal to $80\% \times 0.433 \text{ psi/ft} \times \text{casing set depth in feet}$.
- Indicate U (Unknown) if gas is produced inside surface or coal casing (either Primary Production Pressure or Annular Production Pressure), but the pressure threshold is unable to be calculated because the casing seat depth for the surface or coal casing is unknown.

Populating this field is not required if no gas is produced inside coal or surface casing, although annular gas pressures should always be maintained below this threshold when gas is present inside surface or coal casing. If the maximum allowable pressure is exceeded, operators must report this observation to the District Oil and Gas Inspector Supervisor within 24 hours of identifying the potential problem in accordance with 25 Pa. Code Chapter 78, section 78.88(d).

Water Level or Other

This parameter is required for oil or combination wells producing oil inside of surface or coal casing. The surrogate parameters described below may be provided, as access to water levels at producing wells is often not feasible.

Water level in feet below ground surface, mud scale weight of the produced fluid in pounds per gallon (ppg), average daily pumping time in hours per day, average daily pumping volume in barrels (bbls) per day; or a water quality measurement of the produced fluid in milligrams per liter Total Dissolved Solids (mg/L TDS), mg/L Total Chlorides (mg/L Cl), or conductivity in microSiemens per centimeter ($\mu\text{S/cm}$) are all acceptable for this inspection parameter.

Water Level or Other Unit (various)

This is the unit associated with the water level or surrogate parameter for the value provided above. Measurement options are discussed in the previous section. For wells that do not produce water, NPW is indicated for No Produced Water.

Production Annulus Open Flow or Shut-in Pressure

This is the vent flow rate for gas flowing from the production casing annulus in cfpd, if the annulus valve was open and gas was venting to the atmosphere during the inspection. If the production annulus was shut-in during the inspection, the annular pressure in psig is reported. If no flow or pressure is present, the value will be reported as zero (0). If gas is present, but cannot be quantified, NRM should be recorded. Finally, if the production annulus is inaccessible, i.e., subgrade or obstructed by the surface configuration of the well, "I" is entered in this field. Please note that text characters recorded by operators will be stored in the *Production Annulus Open Flow or Shut-in Pressure Unit* field.

All wells with separate production casing strings drilled after February 5, 2011 must be equipped/designed to measure production annulus flow or pressure in order to comply with the monitoring requirements of 25 Pa. Code Chapter 78, section 78.88.

The presence of gas in this case is not necessarily a defect, but instead may be an intentional well design feature. For example, leaving the cement top down on the production casing to vent a shallow gas-bearing

zone that is not economical to produce due to low pressure or volume may be one reason for the presence of annular gas. Such a design feature may be important for ensuring that gas is isolated to the wellbore.

Production Annulus Open Flow or Shut-in Pressure Unit

This is the unit associated with the Production Annulus Open Flow or Shut-in Pressure measurement. These measurement options are discussed above.

Fluids Noted

All remaining annular spaces and any other surface wellhead components must be surveyed for the presence of fluids (gas, oil, or brine). This survey does not include separators, gathering systems, or any other well site apparatus beyond the last valve to the production equipment. N (No) is entered if no fluids are observed during the inspection. In this case, the categories that follow may be left blank. If fluids are observed, Y (Yes) is entered and all applicable categories that follow are completed to indicate which components of the well are affected and which ones are free from any potential issues. It should be noted that there is currently no reporting provision for pressure observed in association with outer annular spaces (those outside intermediate, coal, or surface casing strings).

Open Flow Outside Freshwater Casing

This is the cumulative volume of gas observed outside any freshwater casing string, i.e., coal, surface, or conductor casing. For example, if gas flow is observed in any of these annular spaces, the operator enters the combined measured or estimated flow rate in cfpd. If gas flow is present, but cannot be quantified, NRM (not readily measurable) is entered. If no gas flow is present outside freshwater casing, the field will either contain a zero (0) or have no value entered. If freshwater casing annular spaces are inaccessible, i.e., subgrade or obstructed by the surface configuration of the well, and fluids were noted in association with some other well component, "I" is entered in this field. "I" may also be found in this field if data were derived from Form A or B. Please note that text characters recorded by operators will be stored in the *Open Flow Outside Freshwater Casing Unit* field and that Forms A and B were no longer available for use during the 2017 inspection year (2018 reporting year). Any gas sourced from below a freshwater casing shoe that is flowing through the fresh groundwater interval is prohibited by 25 Pa. Code Chapter 78, section 78.81(a)(3). 25 Pa. Code Chapter 78, section 78.85(a)(5) also prohibits gas flow outside surface or coal casing strings.

Open Flow Outside Freshwater Casing Unit (cfpd)

This is the unit associated with any open flows observed outside freshwater casing strings, which are reported in cfpd.

Open Flow Outside Intermediate Casing

This is the cumulative volume of gas observed outside any intermediate casing strings. If gas flow is observed in any of these annular spaces, the operator enters the measured or estimated flow rate in cfpd; or if gas flow is present but cannot be quantified, NRM (not readily measurable) is entered. If no gas flow is present outside intermediate casing, the field will either contain a zero (0) or have no value entered. If intermediate casing annular spaces are inaccessible, i.e., subgrade or obstructed by the surface configuration of the well, and fluids were noted in association with some other well component, "I" is

entered in this field. "I" may also be found in this field if data were derived from Form A or B. Please note that text characters recorded by operators will be stored in the *Open Flow Outside Intermediate Casing Unit* field and that Forms A and B were no longer available for use during the 2017 inspection year (2018 reporting year).

Open Flow Outside Intermediate Casing Unit (cfpd)

This is the unit associated with any open flows reported outside intermediate casing strings, which are reported in cfpd.

Surface Wellhead Equipment Emission Rate

This field is reserved for gas observed in association with any wellhead equipment critical for providing well control, allowing a safe working environment around the well, or preventing environmental impacts. Gas emissions represent measured or estimated flow rates in cfpd. In cases when emissions are noted, but cannot be readily quantified, either NRM or Y (Yes) is entered. Please note that text characters recorded by operators will be stored in the *Surface Wellhead Equipment Emission Rate Unit* field. If no gas is present, the field will either contain a zero (0), N (No), or have no value entered.

Surface Wellhead Equipment Emission Rate Unit (cfpd)

This is the unit associated with any surface wellhead equipment emissions, which are reported in cfpd.

Liquids to Surface or Outside Freshwater Casing

This field designates any liquids (oil or brine) found during the fluid survey to be flowing to the ground surface or outside of any freshwater casing strings (coal, surface, or conductor casing). If liquids are noted, Y (Yes) is indicated, otherwise N (No) or no value is entered. Any liquids sourced from below a freshwater casing shoe that are flowing through the fresh groundwater interval or discharging to the ground surface are prohibited by 25 Pa. Code Chapter 78, section 78.81(a)(3).

Corrosion Problems

This field is used to indicate the presence of severe corrosion that will lead to an imminent environmental release, if not addressed. Surface wellhead equipment designed to contain pressure and/or fluids are the focus of this particular inspection element. DEP considers severe corrosion to be any corrosion problems that, unless repaired, will result in the imminent failure of well components intended to contain pressure or fluids. Imminent is defined as anticipated to occur within the three-month period between quarterly inspections.

Y (Yes) is entered if any severe corrosion is noted, otherwise N (No) is entered. There is no expectation for operators to address minor surface corrosion as part of this inspection, as the presence of some surface oxidation is actually beneficial to the integrity of operating wells. If severe corrosion is noted, it is necessary to report this observation to the District Oil and Gas Inspector Supervisor within 24 hours of identifying the potential problem in accordance with 25 Pa. Code Chapter 78, section 78.88(d).

Comments

These are text comments supplied by the operator. DEP requests that this column be used to note any significant observations during the inspection. Qualifying observations that might appear out of the ordinary to DEP staff reviewing assessment reports, indicating if annular spaces are plumbed to tanks or not accessible, or describing well construction modifications or design clarifications are some examples.

Standard Comment for No Inspection

This is a feature exclusive to Form C that allows an operator to explain why they did not perform an inspection for a well. The following standard options are available. A brief description of why an operator might use these standard comments has also been provided:

- Plugged well [1] – The well has been plugged and does not require a quarterly inspection per 25 Pa. Code Chapter 78, section 78.88 of the regulations. The operator must rectify their records with DEP’s information in this case per the available instructions.
- This is not our well [2] – The well does not belong to the operator and they no longer have legal access to the well site. The operator must rectify their records with DEP’s information in this case per the available instructions.
- Gas storage well [3] – The well is currently being used as a gas storage well and does not require a quarterly inspection per 25 Pa. Code Chapter 78, section 78.88 of the regulations. The operator must rectify their records with DEP’s information in this case per the available instructions.
- Well spud-drilling not completed [5] – The well has not been drilled to total depth (TD). Quarterly inspections are only required the first full quarter after the well has been drilled to TD.
- Regulatory inactive well [6] – The well has been granted regulatory inactive status by the DEP and does not require a quarterly inspection per 25 Pa. Code Chapter 78, section 78.88 of the regulations. The operator must rectify their records with DEP’s information in this case per the available instructions.
- Injection well [7] – The well is currently being used as an injection well and does not require a quarterly inspection per 25 Pa. Code Chapter 78, section 78.88 of the regulations. The operator must rectify their records with the DEP’s information in this case per the available instructions.
- Observation well [8] – The well is currently being used as an observation well and does not require a quarterly inspection per 25 Pa. Code Chapter 78, section 78.88 of the regulations. The operator must rectify their records with DEP’s information in this case per the available instructions.
- Status validation underway [9] – The operator has not been able to complete a quarterly inspection for any number of reasons not captured in the other standard comments. The operator will be required to resolve the situation and provide the necessary inspection information in subsequent reports. It has been recommended that operators also provide a text comment when “status validation underway” is chosen in order for DEP to better understand why the inspection was not completed.

- Permitted but never drilled [10] – A permit has been issued for the well, but has since expired and the operator has decided not to drill the well. The operator must rectify their records with DEP’s information in this case per the [available instructions](#).

It should be noted that for Forms A and B, standard comments are not provided to the operators. If an inspection was not performed, the reason should be detailed within the *Comments* field.

File Name

This is the file name of the report submitted to the DEP.

Region

This is the Oil and Gas District designated inspection oversight for the well location.

County

This is the county where the well is located. It corresponds to the three-digit county code used in the abridged API number.

Municipality

This is the Borough or Township locality of the well as registered in DEP’s eFACTS system.

Unconventional

“Yes” is recorded in this column if the well produces from a geologic formation meeting the Act 13 definition of unconventional formation.

Well Type

This is the type of well reported by the operator when well integrity data were submitted using Form A or B (Gas, Oil, or Combination). Note that for the 2017 inspection year (2018 reporting year), Forms A and B are no longer in use. If Form C is used, the well type is determined by information queried from DEP’s eFACTS system. It should be noted that the well type is not necessarily indicative of how the well was permitted. It may instead designate current production activities at the well.

Interpreting Integrity Indicator Parameters

The Mechanical Integrity Assessment Program provides a useful screening tool for DEP and is most effectively referenced on a well-specific basis, as there are currently no regulatory requirements in place related to measurement procedures or reporting thresholds. Well operating conditions are highly variable and this confounds interpreting well integrity data without some context. Although some generalizations are possible, DEP cautions individuals evaluating the dataset from attempting to draw conclusions about a well's ability to contain pressure and fluids by solely relying on an assessment of the data in this report. Additional field observations or testing are a requisite part of any well integrity evaluation and DEP relies on qualified technical staff to perform such evaluations. The process involves both surface measurements and well logging, pressure build-up testing, casing pressure testing, and other methods.

The intent of collecting the well integrity data specified in the regulations is to establish baseline measurements at a well for reference during subsequent monitoring periods or more extensive mechanical integrity testing. It is known that in certain cases different operator's measure gas flows using tools with different measurement thresholds. For this reason, comparative analyses are likely most useful on a single-well basis. Examining for trends using large well populations may be more difficult for the reasons previously mentioned. Without the specification of measurement thresholds, attempting to absolutely identify which wells may have the highest leak rates is also difficult. This matter is one that DEP is exploring as it looks for program improvements moving forward. With the limitations of the dataset established, the potential utility of some of the integrity indicator parameters has been described in the paragraphs that follow.

Unexpected changes in pressure may be indicative of potential well integrity problems. For example, a drop in pressure may indicate a breach in casing – fluid loading or a loss of containment both could result in a drop in surface-measured pressure in a production casing string. Further, an increase in pressure may indicate loss of zonal isolation – this is most relevant for cased-hole completions where gas is produced through production tubing set on a packer or in cemented annular spaces. A loss of casing integrity in an interior casing string could also result in an increase in annular pressure.

Unexpected changes in vent flow rates could be indicative of well integrity problems. For example, a decrease in flow could indicate a downhole flow restriction. This could result in excessive pressure at a casing shoe for open-hole completions. Increases in vent flow rates could also be indicative of a loss of zonal isolation, i.e., a gas-bearing zone that was previously isolated behind cement may start to flow gas at a higher volume if the cement loses integrity. Additionally, a hole in the production casing could cause higher volumes of gas movement in the production annulus.

As a general rule, monitoring for the presence of fluids and changes in fluid flux represent useful tools for assessing well integrity. As mentioned above, the presence of certain fluids may indicate failure of well barrier elements, i.e., cement or casing. In some cases, however, fluids may be an artifact of well age. For example, prior to establishment of the Oil and Gas Act of 1984, it was common to construct oil and gas wells without the use of cement and such well designs are expected or at least more likely to flow fluids behind casing. Flow rates may also vary seasonally, which is another reason why it is important to understand a well's baseline operating conditions.

For situations where gas is produced inside of surface or coal casing (typically these are installed to depths where rock fractures may still be open), pressures in excess of the hydrostatic gradient could result in overpressuring at the casing shoe and escape of gas into the surrounding formation. Deeper annular

spaces or well hole sections are typically capable of containing fluids under higher pressures, as rock strength increases and permeability decreases as a function of depth. The water level for these kinds of well designs may be a good indicator of casing integrity, as breaches in the casing will allow freshwater zones to load the production hole section with water, changing water quality and forcing operators to remove more water to allow for oil and gas production. Casing that is set too short would result in the same outcome.

Before drawing any conclusions about a well's integrity, it is critically important to understand what "normal" operating conditions are at a well site. There are many situations where wells may be shut in for maintenance or seasonally – this will cause increases in surface-measured pressures. Operators may choose to flow more gas to a pipeline at other times, which will decrease producing back pressures. Maintenance involving fluid removal may cause changes in pressure or flow. Where different fluids are sourced from must also be known to understand if conditions at a well are expected or indicative of a potential problem.

Summary Statistics

This section of the report provides a summary of several key metrics collected as part of the inspection program. It was compiled using information reported by April 9, 2015. No paper submittals are included, although as of the date of this tabulation, approximately 500 paper submissions had been logged in by DEP staff. Separate figures/tables for conventional and unconventional well sites are provided for comparative purposes. The parameters summarized are as follows:

- Number of well sites with associated inspection report compared to number of well sites requiring inspection per DEP records (Tables 1 and 2)
- Number of well sites where standard no-inspection comment was provided in lieu of Mechanical Integrity Assessment data and summary of why inspections were not reported at those sites (Tables 3 and 4)
- Summary of primary production pressures (Figures 1 and 2)
- Summary of annular production pressures (Figures 3 and 4)
- Summary of primary production vent flows (Figures 5a/b and 6a/b)
- Summary of production annulus pressures (Figures 7 and 8)
- Summary of production annulus vent flows (Figures 9 and 10)
- Summary of all fluids noted (Tables 5a/b and 6a/b)
- Summary of severe corrosion incidents reported (Tables 5a/b and 6a/b)
- Summary of surface casing overpressuring reported (Tables 5a/b and 6a/b)

Notes Regarding Data Used to Compile Summary Statistics

- Data were downloaded and tabulated from the most recent Mechanical Integrity Assessment reports submitted to DEP and input into a centralized database as of April 9, 2015.
- Data were compared to a spud data report downloaded on April 10, 2015 for conventional and unconventional wells in DEP's eFACTS system spud prior to January 1, 2015.
- DEP reviewed both conventional and unconventional data submittals and attempted to remove all duplicate submittals. The removal was based on operator information stored in DEP's eFACTS system. A total of 145 wells where inspections were preformed but the well type in DEP's eFACTS system indicated that no inspection should have been performed were transferred into the "Summary of no-inspection events – Table 4."
- For conventional wells where four (4) quarters of data were submitted, only the most recent quarterly data were included in the summary statistics that follow.

- DEP summarized no-inspection events by first isolating any well that had a standard no-inspection comment associated with it. Next, a cursory review of text comments was completed in an attempt to determine if documentation was consistent with the parameters set forth for standard no-inspection comments within the Mechanical Integrity Assessment guidelines and relevant regulations. Such events are listed as “Other” in Tables 3 and 4 below. This analysis was completed because Forms A and B do not have a mechanism for providing standard no-inspection comments.

Total Number of Unconventional Wells with Submitted Report ¹	Total Number of Unconventional Wells Requiring Submitted Report ²	Percentage of Wells Reported
7,756	7,787	99.6%

Table 1. Unconventional well reporting frequency for 2014 inspection year.

Total Number of Conventional Wells with Submitted Report	Total Number of Conventional Wells Requiring Submitted Report ²	Percentage of Wells Reported
72,365	121,127	60%

Table 2. Conventional well reporting frequency for 2014 inspection year.

¹At least one inspection event was reported for these sites in 2014.

²Well counts based on oil, gas, combination, and coalbed methane wells categorized as active or abandoned (but not yet plugged) in PADEP's eFACTS database that were spud prior to January 1, 2015. The spud report for active/abandoned wells was generated on 4/10/2015.

Type of No-Inspection Events Reported at Unconventional Wells	Number of No-Inspection Events (n = 6,066)	Percentage
Observation Well	13	0.2%
Permitted but never drilled	425	7.0%
Plugged well	49	0.8%
Regulatory Inactive	60	1.0%
Status validation underway	1,337	22.0%
This is not our well	7	0.1%
Well spud, drilling not completed	3,845	63.4%
Other ³	330	5.4%

Table 3. Summary of no-inspection events during the 2014 inspection year for unconventional wells (n = 6,066). A total of 29,382 reports were submitted, resulting in a no-inspection frequency of 20.6%. 23,316 (79.4%) reports containing well integrity inspection data were submitted.

Type of No-Inspection Events Reported at Conventional Wells	Number of No-Inspections Events (n = 4,696)	Percentage
Gas storage well	104	2.2%
Injection well	79	1.7%
Observation well	4	0.1%
Permitted but never drilled	304	6.5%
Plugged well	781	16.6%
Status validation underway	1,373	29.2%
This is not our well	1,118	23.8%
Well spud, drilling not completed	618	13.2%
Other ³	315	6.7%

Table 4. Summary of no-inspection events during the 2014 inspection year for conventional wells (n = 4,696). A total of 72,365 unique inspections for wells were submitted, resulting in a no-inspection frequency of 6.5%. 67,669 (93.5%) reports containing well integrity inspection data were submitted.

³An approved no-inspection comment was not provided by the operator, but data analysis indicated an inspection had not occurred.

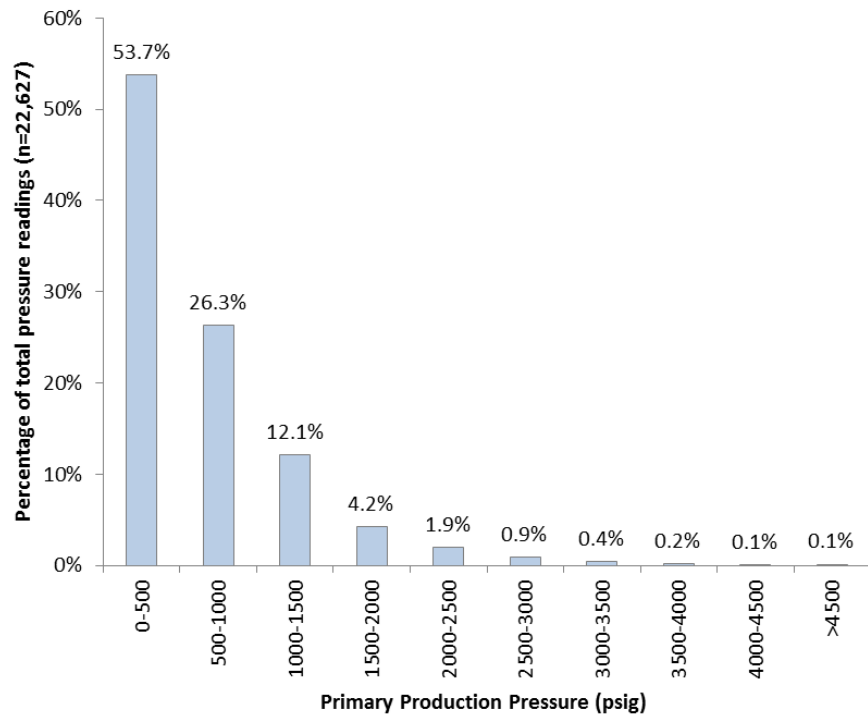


Figure 1. Frequency distribution of Primary Production Pressures reported at unconventional wells (n = 22,627 inspection readings) during the 2014 inspection year. Reported pressures ranged from 0 to 7,891 psig.

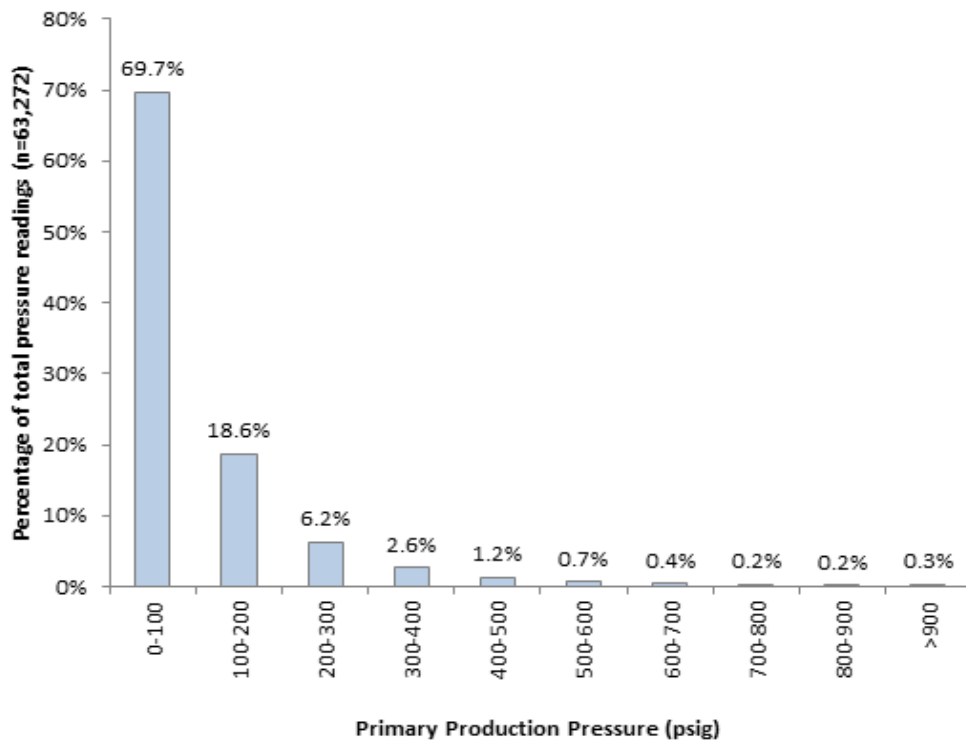


Figure 2. Frequency distribution of Primary Production Pressures reported at conventional wells (n = 63,272 inspection readings) during the 2014 inspection year. Reported pressures ranged from 0 to 7,158 psig.

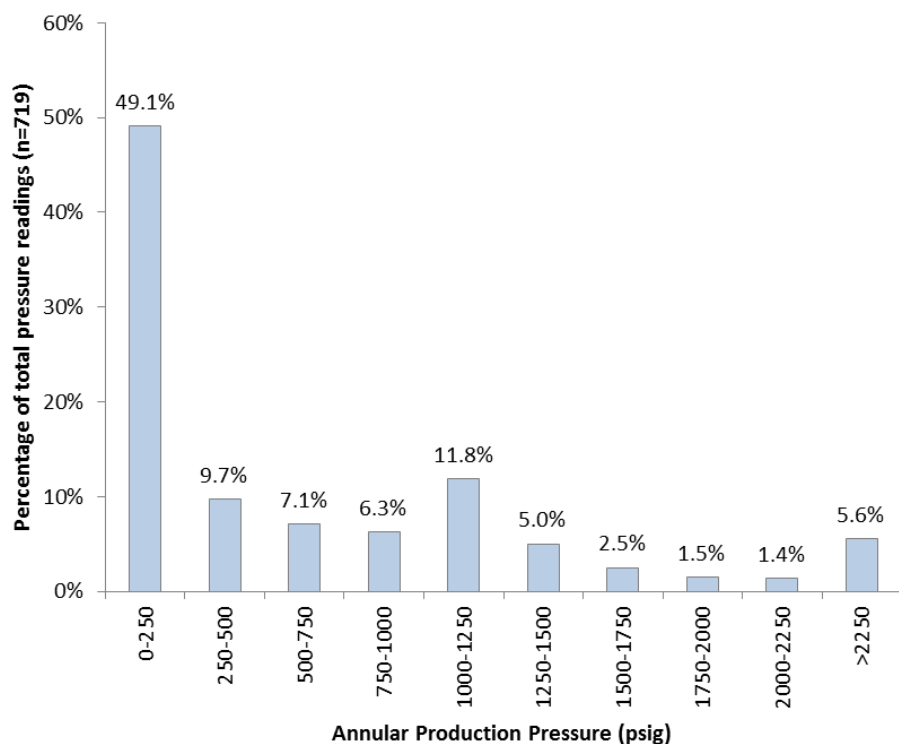


Figure 3. Frequency distribution of Annular Production Pressures reported at unconventional wells (n = 719 inspection readings) during the 2014 inspection year. Reported pressures ranged from 0 to 4,500 psig.

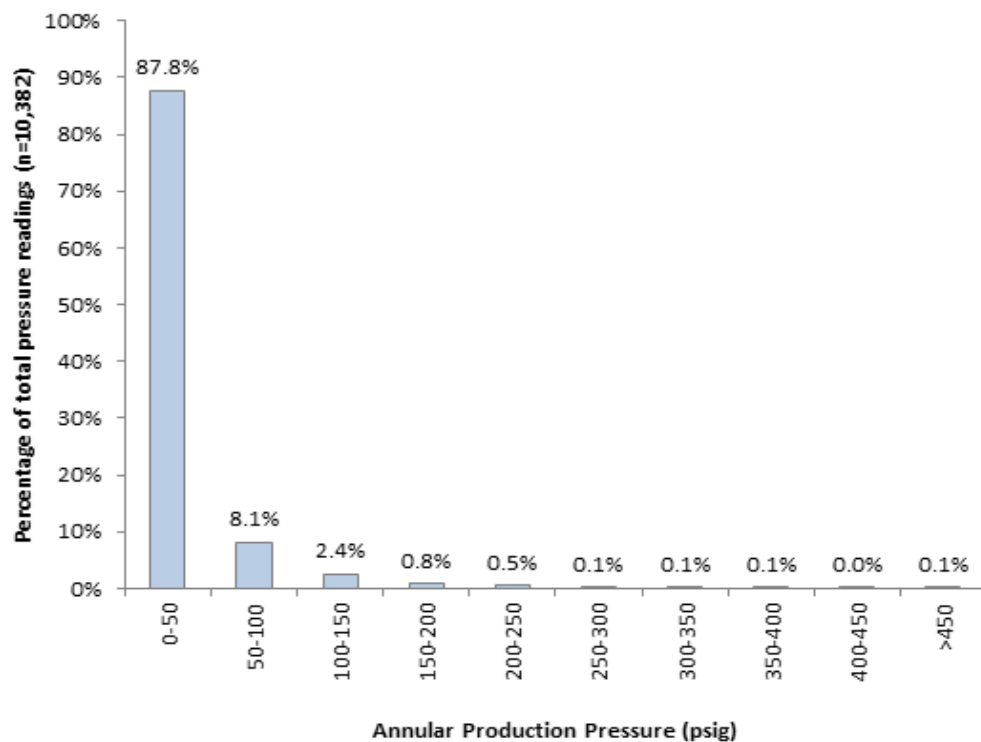


Figure 4. Frequency distribution of Annular Production Pressures reported at conventional wells (n = 10,382 inspection readings) during the 2014 inspection year. Reported pressures ranged from 0 to 975 psig.

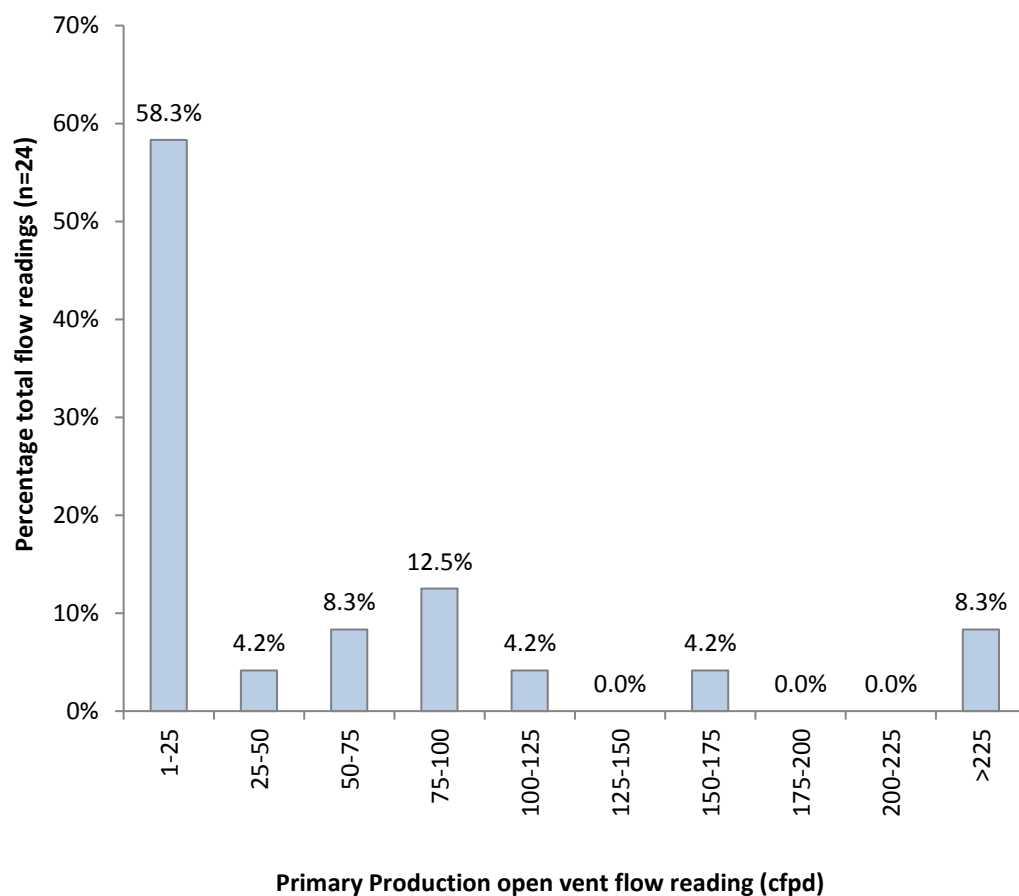


Figure 5. Frequency distribution of Primary Production Open Vent Flows reported at unconventional wells (n = 24 inspection readings) during the 2014 inspection year. Reported open flows ranged from 1 to 519 cfpd.

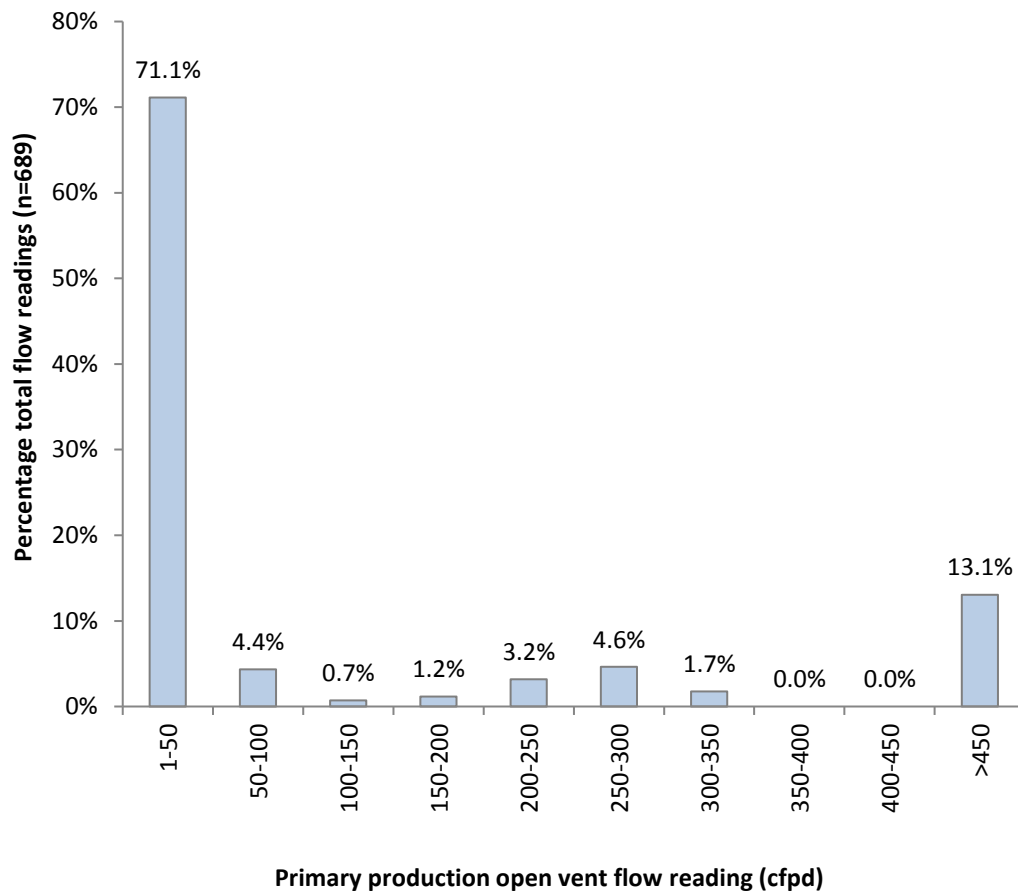


Figure 6. Frequency distribution of Primary Production Open Vent Flows reported at conventional wells (n = 689 inspection readings) during the 2014 inspection year. Reported open flows ranged from 1 to 1,600 cfpd. Additionally, there were 1,876 inspections where vent flows were recorded as not readily measurable (NRM). This information is not depicted in the figure.

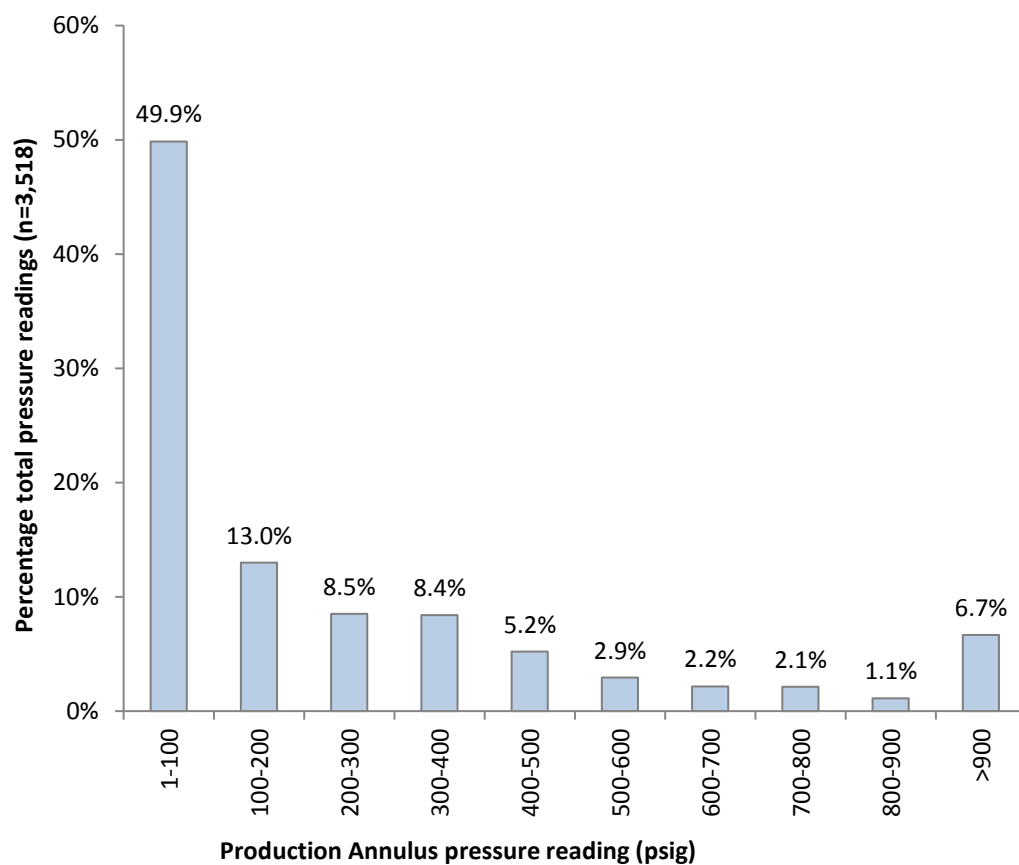


Figure 7. Frequency distribution of Production Annulus Pressure reported at unconventional wells (n = 3,158 inspection readings) during the 2014 inspection year. Reported pressures ranged from 1 to 11,168 psig.

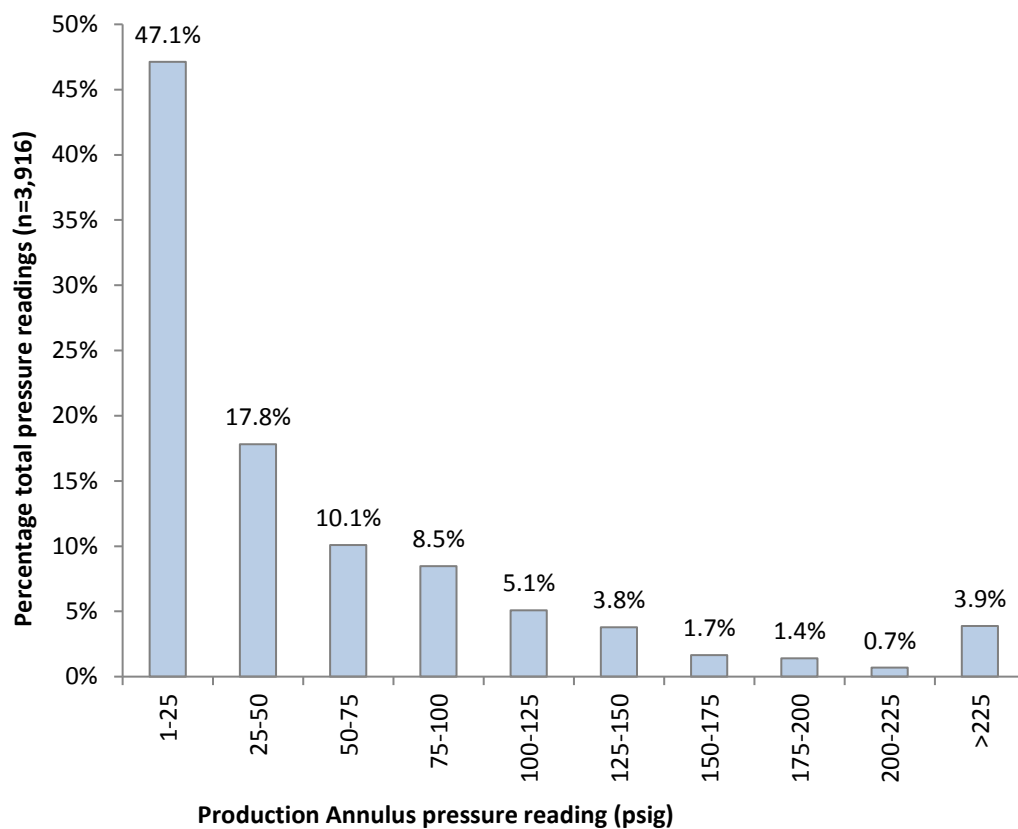


Figure 8. Frequency distribution of Production Annulus Pressure reported at conventional wells (n = 3,916 inspection readings) during the 2014 inspection year. Reported pressures ranged from 1 to 1,300 psig.

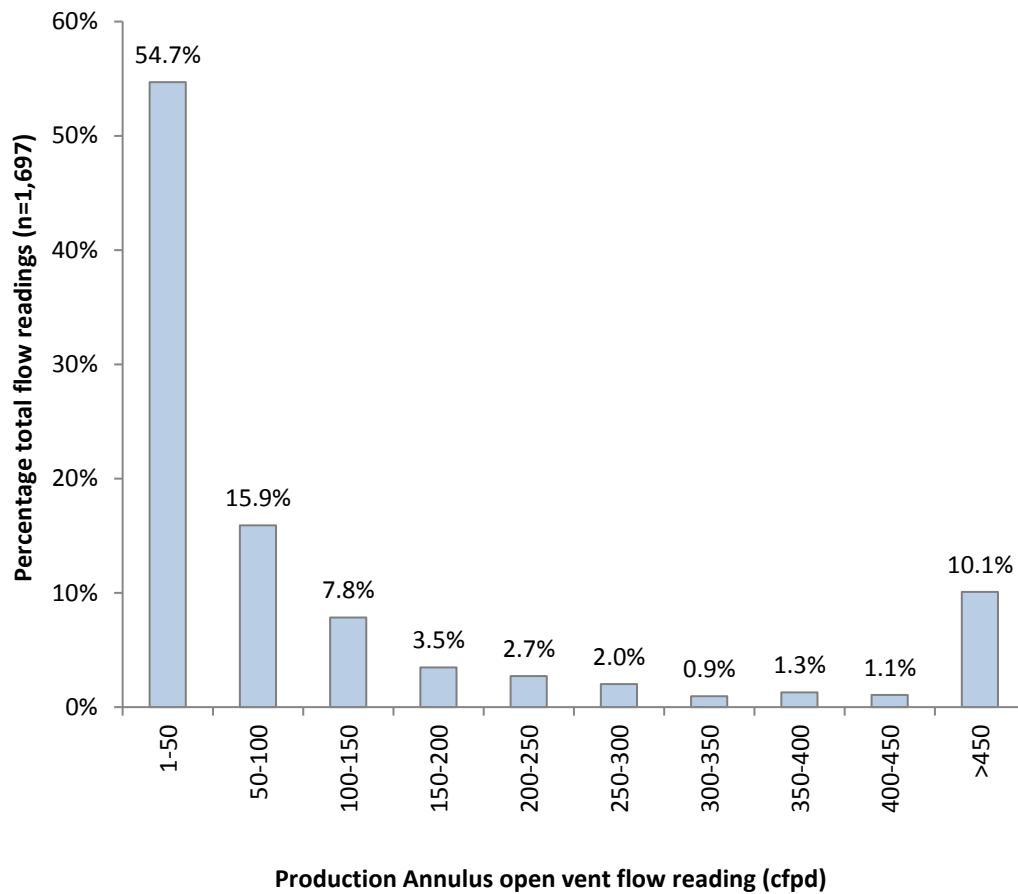


Figure 9. Frequency distribution of Production Annulus open vent flows reported at unconventional wells (n = 1,697 inspection readings) during the 2014 inspection year. Reported open flows ranged from 1 to 26,200 cfpd. Additionally, there were 1,837 inspections where vent flows were recorded as not readily measurable (NRM). This information is not depicted in the figure.

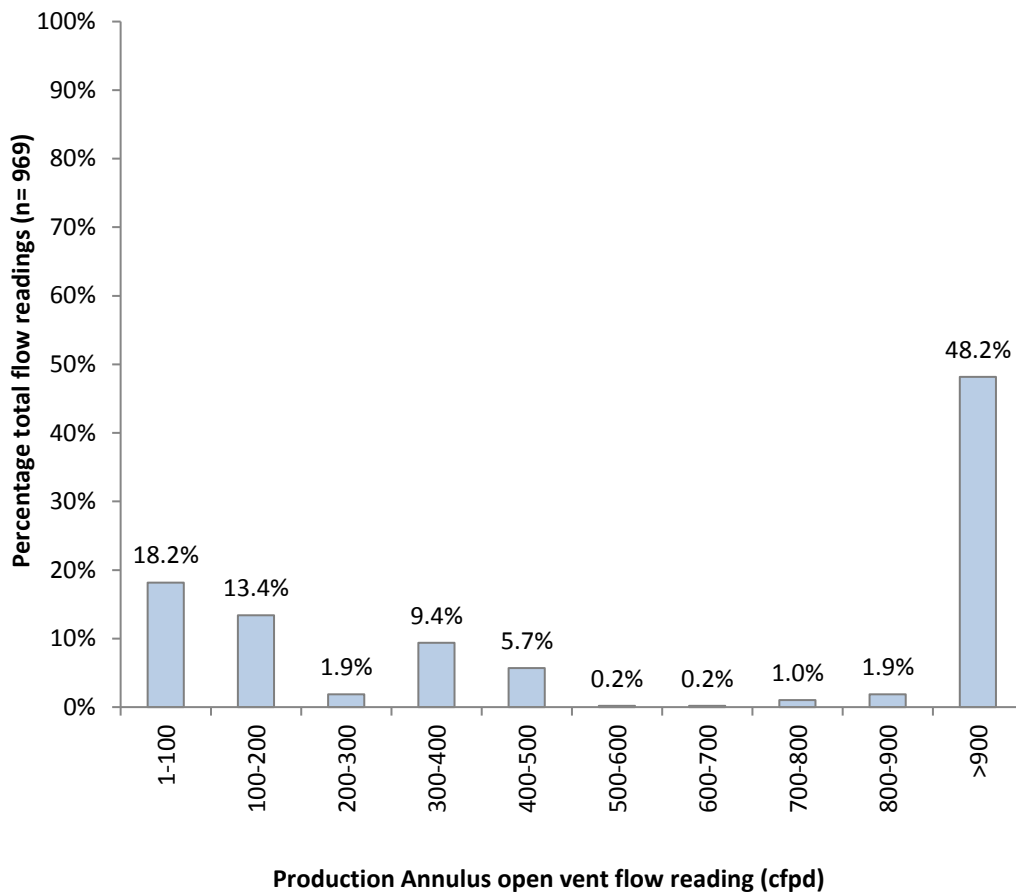


Figure 10. Frequency distribution of Production Annulus open vent flows reported at conventional wells (n = 969 inspection readings) during the 2014 inspection year. Reported open flows ranged from 1 to 48,400 cfpd. Additionally, there were 15,031 inspections where vent flows were recorded as not readily measurable (NRM) and 5,225 inspections where the annulus was reported as inaccessible (I). This information is not depicted in the figure.

	Total of Specific Inspection Events	Percentage of Total Inspection Events
Occurrence of Fluids (gas, oil, or brine)	658	2.82%
Occurrence of Severe Corrosion	4	0.02%
Occurrence of Surface Casing Overpressuring	0	0%
Occurrence of Gas Outside Production Casing (pressure or flow)	7,092	30.4%
Occurrence of Gas Outside Intermediate Casing	234	1.00%
Occurrence of Gas Outside Freshwater Casing	115	0.49%

Table 5a. Unconventional well fluids/corrosion survey and surface/coal casing overpressuring results for the 2014 inspection year (n = 23,316 inspection events).

	Total Wells	Percentage of Total Wells
Occurrence of Fluids (gas, oil, or brine)	305	3.93%
Occurrence of Severe Corrosion	4	0.05%
Occurrence of Surface Casing Overpressuring	0	0%
Occurrence of Gas Outside Production Casing (pressure or flow)	2,524	32.5%
Occurrence of Gas Outside Intermediate Casing	171	2.20%
Occurrence of Gas Outside Freshwater Casing	37	0.48%

Table 5b. Unconventional well fluids/corrosion survey and surface/coal casing overpressuring results for the 2014 inspection year (n = 7,756 wells).

	Total of Specific Inspection Events	Percentage of Total Inspection Events
Occurrence of Fluids (gas, oil, or brine)	1,390	2.05%
Occurrence of Severe Corrosion	314	0.46%
Occurrence of Surface Casing Overpressuring	4	0.006%
Occurrence of Gas Outside Production Casing (pressure or flow)	19,916	29.4%
Occurrence of Gas Outside Intermediate Casing	132	0.20%
Occurrence of Gas Outside Freshwater Casing	45	0.07%

Table 6a. Conventional well fluids/corrosion survey and surface/coal casing overpressuring results for the 2014 inspection year (n = 67,669 inspection events).

	Total Wells	Percentage of Total Wells
Occurrence of Fluids (gas, oil, or brine)	1,390	1.92%
Occurrence of Severe Corrosion	314	0.43%
Occurrence of Surface Casing Overpressuring	4	0.006%
Occurrence of Gas Outside Production Casing (pressure or flow)	19,916	27.5%
Occurrence of Gas Outside Intermediate Casing	132	0.18%
Occurrence of Gas Outside Freshwater Casing	45	0.06%

Table 6b. Conventional well fluids/corrosion survey and surface/coal casing overpressuring results for the 2014 inspection year (n = 72,365 wells).

Data Confirmation Study and Results

Operators in Pennsylvania are required to submit Mechanical Integrity Assessment Program reports to DEP annually—on February 15 for the period between January 1 through December 31 of the previous calendar year.

The Mechanical Integrity Assessment Program relies on a self-reporting system, meaning that data are reported by operators to DEP. All Mechanical Integrity Assessment data are posted as received from the well operator. DEP does not independently verify the data before it is posted.

While state regulations require accurate and on-time data reporting by operators, and operators and DEP endeavor to address any errors discovered after the data are posted, DEP makes no claims, promises or guarantees regarding the accuracy, completeness or timeliness of the operators' data.

To identify potential issues with operator reported Mechanical Integrity Assessment Program data, DEP conducted both file reviews (office audits), i.e., review of well records/completion reports to determine if the correct fields were completed on mechanical integrity inspection forms; and well verification activities in the presence of operators. These studies were implemented to identify recurring issues that can be addressed through future training and also determine the significance of any problems noted. DEP did not attempt assess the computer coding that is used to tabulate operator submitted data, and so for the results that follow, it is assumed all code was designed and executed properly. Well verification activities were completed in select counties for logistical purposes. The chosen counties were generally based on the number of well sites and diversity of operators and are as follows.

Field Inspection – Unconventional

- Lycoming County: 23 unconventional wells were randomly chosen to report accuracy within +/- 20% at 95% confidence level.
- Greene/Washington Counties: 24 unconventional wells were randomly chosen to report accuracy within +/- 20% at 95% confidence level.

Field Inspection – Conventional

- McKean County: 25 conventional wells were randomly chosen to report accuracy within +/- 20% at 95% confidence level.
- Indiana: 24 conventional wells were randomly chosen to report accuracy within +/- 20% at 95% confidence level.

Office File Review – Unconventional

- 95 unconventional well reports were randomly chosen to report accuracy within +/-10% at 95% confidence level.

Office File Review – Conventional

- 96 conventional well reports were randomly chosen to report accuracy within +/-10% at 95% confidence level.

The results of DEP's data confirmation study follow.

Field Inspection – Unconventional

For data verification activities at unconventional wells in Lycoming County, of the 23 wells that were observed; eight (8) reports were filled out correctly, four (4) reports contained observations for which clarifying comments were recommended, and 11 reports contained errors. None of the wells that were part of the field review had well integrity issues related to containment, i.e., well issues that indicate a higher potential to affect water supplies or result in potential well site safety concerns. A summary table is included below (Table 7) and the wells that were part of the study along with relevant observations are tabulated in the appendix of this report.

Lycoming County Field Unconventional Verification	Number of Reports	Percentage	Range of Possible Outcomes	
Error Free Reports Submitted	8	34.8%	14.8%	54.8%
Reports for which Additional Clarification is Recommended	4	0.58%	7.4%	37.4%
Reports Containing Errors	11	47.8%	27.8%	67.8%
Reports that Indicate the Presence of More Serious Well Integrity Concerns	0	0.0%	0%	20%

Table 7. Summary of field verification results for unconventional wells visited in Lycoming County.

For data verification activities at unconventional wells in Greene and Washington counties, of the 24 wells that were observed; four (4) reports were filled out correctly, one (1) report contained observations for which clarifying comments were recommended, and 19 reports contained errors. One (1) of the wells that was part of the field review had well integrity issues related to containment, i.e., well issues that indicate a higher potential to affect water supplies or result in potential well site safety concerns. The operator did report this in their Mechanical Integrity Assessment submission. A summary table is included below (Table 8) and the wells that were part of the study along with relevant observations are tabulated in the appendix of this report.

Greene and Washington Counties Field Unconventional Verification	Number of Reports	Percentage	Range of Possible Outcomes	
Error Free Reports Submitted	4	16.7%	0.25%	36.7%
Reports for which Additional Clarification is Recommended	1	4.2%	0.06%	24.2%
Reports Containing Errors	19	79.2%	59.2%	99.2%
Reports that Indicate the Presence of More Serious Well Integrity Concerns	1	4.2%	0.06%	24.2%

Table 8. Summary of field verification results for unconventional wells visited in Greene and Washington counties.

The statistics for unconventional wells suggest that reports with errors occur 47.8% +/- 20% (n = 11 out of 23) and 79.2% +/- 20% (n = 19 out of 24) of the time for Lycoming and Greene/Washington counties, respectively; although the problems noted had nothing to do with mischaracterizing a well's ability to contain fluids.

Field Inspection – Conventional

For data verification activities at conventional wells in McKean County, of the 25 wells that were observed; seven (7) reports were filled out correctly, four (4) reports contained observations for which clarifying comments were recommended, and 14 reports contained errors. Two (2) of the wells that were part of the field review had well integrity issues related to containment that were not reported by the operator, i.e., well issues that indicate a higher potential to affect water supplies or result in potential well site safety concerns. A summary table is included below (Table 9) and the wells that were part of the study along with relevant observations are tabulated in the appendix of this report.

McKean County Field Conventional Verification	Number of Reports	Percentage	Range of Possible Outcomes	
Error Free Reports Submitted	7	28.0%	8.0%	48.0%
Reports for which Additional Clarification is Recommended	4	4.0%	0.06%	24.0%
Reports Containing Errors	14	56.0%	36.0%	76.0%
Reports that Indicate the Presence of More Serious Well Integrity Concerns	2	8.0%	0.03%	28.0%

Table 9. Summary of field verification results for conventional wells visited in McKean County.

For data verification activities at unconventional wells in Indiana County, of the 24 wells that were observed; 13 reports were filled out correctly, one (1) report contained observations for which clarifying comments were recommended, and ten (10) reports contained errors. One (1) of the wells that was part of the field review had well integrity issues related to containment that was not reported by the operator, i.e., well issues that indicate a higher potential to affect water supplies or result in potential well site safety concerns. A summary table is included below (Table 10) and the wells that were part of the study along with relevant observations are tabulated in the appendix of this report.

Indiana County Field Conventional Verification	Number of Reports	Percentage	Range of Possible Outcomes	
Error Free Reports Submitted	13	54.2%	34.2%	74.2%
Reports for which Additional Clarification is Recommended	1	4.2%	0.01%	24.2%
Reports Containing Errors	10	41.7%	21.7%	61.7%
Reports that Indicate the Presence of More Serious Well Integrity Concerns	1	4.2%	0.01%	24.2%

Table 10. Summary of field verification results for conventional wells visited in Indiana County.

The statistics for conventional wells suggest that reports with errors occur 56.0% +/- 20% (n = 14 out of 25) and 41.7% +/- 20% (n = 10 out of 24) of the time for McKean and Indiana counties, respectively; although the problems noted generally did not involve mischaracterization of a well's ability to contain fluids.

Office File Review – Unconventional

Office audits observations face some limitations, as current operational conditions cannot be assessed and surface configurations cannot be determined. For the statewide office audit of unconventional well reports, of the 95 well reports that were randomly chosen, only 63 could be accessed through DCNR's PAIRIS/WIS database. Of those; 46 reports appeared to be completed correctly, eight (8) reports contained observations for which clarifying comments were recommended, and nine (9) reports contained errors. A summary table is included below (Table 11) and the wells that were part of the study along with relevant observations are tabulated in the appendix of this report.

Office File Review – Unconventional	Number of Reports	Percentage	Range of Possible Outcomes	
Error Free Reports Submitted	46	73.0%	61.0%	85.0%
Reports for which Additional Clarification is Recommended	8	12.7%	0.7%	24.7%
Reports Containing Errors	9	14.3%	2.3%	26.3%

Table 11. Summary of office audit results for unconventional well reports submitted from throughout the state.

The statistics for unconventional wells suggest that reports with errors occur 12.7% +/- 12% (n = 8 out of 63) of the time in the overall dataset. The uncertainty is slightly higher than the study design due to the smaller sample size evaluated.

Office File Review – Conventional

For the statewide office audit of conventional well reports, of the 96 well reports that were randomly chosen, 89 were able to be accessed through DCNR's PAIRIS/WIS database. Of those; 67 reports appeared to be filled out correctly, nine (9) reports contained observations for which clarifying comments were recommended, and thirteen reports contained errors. A summary table is included below (Table 12) and the wells that were part of the study along with relevant observations are tabulated in the appendix of this report.

Office File Review – Conventional	Number of Reports	Percentage	Range of Possible Outcomes	
Error Free Reports Submitted	67	75.3%	65.3%	85.3%
Reports for which Additional Clarification is Recommended	9	10.1%	0.1%	20.1%
Reports Containing Errors	13	14.6%	4.6%	24.6%

Table 12. Summary of office audit results for conventional well reports submitted from throughout the state.

The statistics for conventional wells suggest that reports with errors occur 10.1% +/- 10% (n = 9 out of 89) of the time in the overall dataset.

Appendix

A blank copy of the Form C with the inspection headings is embedded below.

A copy of paper Form C can be accessed at DEP's E-Library:

<http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=8290&DocName=MECHANICAL%20INTERGRITY%20ASSESSMENT%20REPORT%20-%20FORM%20C.PDF%20>

Instructions for paper Form C can be accessed at DEP's E-Library:

<http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=8288&DocName=MECHANICAL%20INTERGRITY%20ASSESSMENT%20REPORT%20-%20FORM%20C%20-%20INSTRUCTIONS.PDF%20>

A copy of the Home-Use Operator form can be accessed at DEP's E-Library:

[http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=9908&DocName=MECHANICAL%20INTERGRITY%20ASSESSMENT%20REPORT%20-%20HOME%20USE%20WELLS%20\(CONVENTIONAL%20OPERATIONS%20ONLY\).PDF%20](http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=9908&DocName=MECHANICAL%20INTERGRITY%20ASSESSMENT%20REPORT%20-%20HOME%20USE%20WELLS%20(CONVENTIONAL%20OPERATIONS%20ONLY).PDF%20)

Instructions for the Home-Use Operator form can be accessed at DEP's E-Library:

[http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=9906&DocName=MECHANICAL%20INTERGRITY%20ASSESSMENT%20REPORT%20-%20HOME%20USE%20WELLS%20\(CONVENTIONAL%20OPERATIONS%20ONLY\)%20INSTRUCTIONS.PDF%20](http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=9906&DocName=MECHANICAL%20INTERGRITY%20ASSESSMENT%20REPORT%20-%20HOME%20USE%20WELLS%20(CONVENTIONAL%20OPERATIONS%20ONLY)%20INSTRUCTIONS.PDF%20)

Summary tables of wells that were part of the field and file review verification process.

- Field Review
 - Lycoming County
 - Greene/Washington Counties
 - McKean County
 - Indiana County
- Office File Review
 - Unconventional
 - Conventional
- Field Review
 - Images collected during field verification study

Form C

OGO:				Wellhead Pressure / Flow			
Permit #	Farm name	Unconventional	Inspection Date	Primary Production Pressure (psig)	Primary Production Vent Flow as Required per 78.83(a)(1) or Other (cfpd)	Annular Production Pressure (psig)	Maximum Allowable Pressure Exceeded per 78.73(c) (Y/N/U)

Water Level or Other		Open Flow (cfpd) or Shut-in Pressure on Production Annulus (psig)		Fluids Survey (Gas, Oil, or Brine)				
Water Level or Other Measurement	Water Level or Other Unit	Open Flow or Shut-in Pressure Measurement	Open Flow or Shut-in Pressure Unit	Any Fluids Noted (Y/N)	Gas Outside Freshwater Casing (cfpd)	Gas Outside Intermediate Casing (cfpd)	Surface Wellhead Equipment Gas Emissions (cfpd)	Any Liquids (Oil or Brine) to Surface or Outside Freshwater Casing (Y/N)

Corrosion Problems (Y/N)	No-inspection comments	Text comments

Verification Study Table: Unconventional Wells in Lycoming County					
Permit (API) Numer	Appears Correct	Additional Clarification Recommended	Reporting Errors/Other Concerns Noted	Potential Well Integrity Issue	Comments
081-20060	1				
081-20189	1				
081-20200	1				Well production annular space shut-in by operator according to report and open during field verification: if shut-in for inspections, recommend using consistent methodology during each inspection, i.e., if shut-in, apply same shut-in period for each inspection.
081-20287	1				Error noted as a result of DEP computer coding for Forms A and B.
081-20383	1				
081-20432			1		Gas noted in production annulus during field verification but not reported during operator inspections. Error noted as a result of DEP computer coding for Forms A and B.
081-20464	1				
081-20537			1		Gas noted in production annulus during field verification but not reported during operator inspections. Wells on pad all being plumbed to a single tank, but operator indicated each annulus is isolated during mechanical integrity inspections. Clarifying comment recommended regarding why production annulus was classified as inaccessible during Quarter 1 inspection.
081-20624			1		Production annulus field not completed correctly. Comments indicated it was assessed during the Quarter 1 inspection.
081-20658		1			Notable change in primary production pressure noted: clarifying comment recommended.
081-20669		1			Operator noted that well was switched over to vacuum: clarifying comment recommended.
081-20840			1		Production annulus field not completed correctly.
081-20852			1		Production annulus field not completed correctly.
081-20901			1		Production annulus field not completed correctly.
081-20983			1		Gas noted in production annulus during field verification but not reported during operator inspections.
081-20985			1		Gas noted in production annulus during field verification but not reported during operator inspections. Clarifying comment recommended regarding why production annulus was classified as inaccessible during Quarter 1 inspection.
081-20998		1			Comments explaining status changes recommended.
081-21000		1			Notable change in primary production pressure noted: clarifying comment recommended.
081-21033	1				
081-21077	1				
081-21130			1		Produced annulus status for Quarter 3 requires explanation. Small, unsustained level of gas noted in production annulus during field verification. Wells on pad all being plumbed to a single tank and should be isolated during mechanical integrity inspections. See Images 1 through 4.
081-21286			1		Operator completed more columns than necessary on form.
081-21327			1		Production annulus field not completed correctly.
Summary	8	4	11	0	
	34.8%	17.4%	47.8%	0.0%	

Summary table of study results for unconventional wells: field verification in Lycoming County.

Verification Study Table: Unconventional Wells in Greene County					
Permit (API) Numer	Appears Correct	Additional Clarification Recommended	Reporting Errors/Other Concerns Noted	Potential Well Integrity Issue	Comments
059-25049			1		Multiple reporting problems noted including annular production and water level fields, but uncertain of origin.
059-25167			1		Multiple reporting problems noted including annular production and water level fields, but uncertain of origin.
059-25372	1				
059-25474			1		Multiple reporting problems noted including annular production and water level fields, but uncertain of origin.
059-25544			1		Tubing pressure reported instead of casing pressure.
059-25755	1			1	Gas bubbling confirmed in cellar during field verification.
059-25936	1				
059-26251		1			Explanation needed for Quarter 1.
125-23515			1		Only three (3) quarters reported: explanation needed (well spud date 1/26/2009).
125-23794			1		Production annulus field not completed correctly.
125-23849			1		Production annulus field not completed correctly.
125-23860			1		Production annulus field not completed correctly.
125-24114			1		Production annulus field not completed correctly.
125-24247			1		Production annulus field not completed correctly.
125-24412			1		Production annulus field not completed correctly.
125-24459			1		Production annulus field not completed correctly.
125-24632			1		Production annulus field not completed correctly: line pressure and not annular pressure reported
125-24700			1		Production annulus field not completed for Quarter 4: explanation needed.
125-24711			1		Production annulus field not completed correctly.
125-24817	1				
125-24858			1		Production annulus field not completed correctly: line pressure and not annular pressure reported
125-24860			1		Production annulus field not completed correctly.
125-24899			1		Production annulus field not completed correctly.
125-26953			1		Production annulus field not completed correctly.
Summary	4	1	19	1	
	16.7%	4.2%	79.2%	4.2%	

Summary table of study results for unconventional wells: field verification in Greene and Washington counties.

Verification Study Table: Conventional Wells in McKean County					
Permit (API) Numer	Appears Correct	Additional Clarification Recommended	Reporting Errors/Other Concerns Noted	Potential Well Integrity Issue	Comments
083-03280	1				Well Plugged: no observation was made.
083-47221	1				
083-04391	1				Well Plugged: no observation was made.
083-36431			1		Ability to measure pressure not reported accurately based on field verification and follow-up with company representative.
083-39773			1		Tubing pressure not required and production annulus status (outside surface casing) not reported correctly.
083-42190			1		Production annulus pressure not recorded in correct field and overpressuring field informaton not needed because of 2-string design.
083-46042	1				
083-46314			1		Tubing pressure not required and production annulus status (outside surface casing) not reported correctly.
083-46810		1			No notes/comments relevant to marked pressure change: recommend using "Text Comment" field to record additional information. During field verification very low pressure noted. Also see Image 5.
083-46943			1		Tubing pressure not required and production annulus status (outside surface casing) not reported correctly.
083-46984			1		Water level and overpressuring fields not completed correctly.
083-48582		1			PSIG unit for production annulus reading should be reported using CFPD unit.
083-48770			1		Casing (primary production) pressure, overpressuring, and production annulus fields not completed correctly.
083-49778			1		Production annulus field not completed correctly.
083-50106			1		Overpressuring field not completed correctly.
083-50185			1		Production annulus field not completed correctly.
083-50323	1				
083-50388	1				Well Plugged: no observation was made.
083-51332			1	1	Well appears to have leaks that may not have been reported previously. Casing (primary production) pressure should possibly have been zero if always on a vacuum. Also see Image 6.
083-51536	1				
083-51562			1		Production annulus field not completed correctly.
083-52169			1		Water level field not completed correctly.
083-52552			1	1	Water level, production annulus, and overpressuring fields not completed correctly. Regarding the fluids noted field: operator should have indicated "yes" because operator reported a surface equipment leak. No leaks noted during field verification.
083-54858		1			Overpressuring field possibly needed because 4.5-inch casing is only 50 feet deeper than surface casing and lost circulation may have occurred (well spud date 2/14/2011).
083-55866		1			Overpressuring field possibly needed because 4.5-inch casing is only 50 feet deeper than surface casing and lost circulation may have occurred (well spud date 2/26/2013).
Summary	7	4	14	2	
	28.0%	16.0%	56.0%	8.0%	

Summary table of study results for conventional wells: field verification in McKean County.

Verification Study Table: Conventional Wells in Indiana County					
Permit (API) Numer	Appears Correct	Additional Clarification Recommended	Reporting Errors/Other Concerns Noted	Potential Well Integrity Issue	Comments
063-00278	1				
063-20357	1				
063-21389	1				
063-23012	1				
063-23784	1				
063-24484	1				
063-24984			1		Incorrect reporting of annular pressure based on field verification.
063-26201		1			Well is on compression and compressor has been down. Clarifying comment to explain well surface configuration recommended.
063-27051	1				
063-27095			1		Operator should have classified production annulus as inaccessible based on field verification. See Image 7.
063-28052			1		Production annulus field not completed correctly.
063-28133	1				
063-28324			1		Operator should have classified production annulus as inaccessible based on field verification. See Image 8.
063-28852			1		Production annulus field not completed correctly.
063-30610	1				Error noted as a result of DEP computer coding for Forms A and B.
063-31143			1		Production annulus field not completed correctly.
063-31525	1				Error noted as a result of DEP computer coding for Forms A and B.
063-32475			1		Operator reported tubing pressure instead of casing (primary production) pressure.
063-32685			1	1	Well was configured differently at time of field verification. Equipped with deteriorating plugs in annuli which could not be opened to allow field measurements. Significant well corrosion not noted in report. See Image 9.
063-34301	1				Error noted as a result of DEP computer coding for Forms A and B. See Image 10.
063-34336			1		Well equipped with a check valve: if annular pressure is higher than line pressure, well will flow at producing pressure into line; otherwise check valve will close to prevent backflow into well. Line pressure should have been reported in annular production pressure field.
063-34766	1				
063-36294	1				
063-36759			1		Production annulus field not completed correctly.
Summary	13	1	10	1	
	54.2%	4.2%	41.7%	4.2%	

Summary table of study results for conventional wells: field verification in Indiana County.

Verification Study Table: Unconventional Wells					
Permit (API) Numer	Appears Correct	Additional Clarification Recommended	Reporting Errors/Other Concerns Noted	Unable to Verify Report Parameters	Comments
005-31125				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
013-20015				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
015-20600	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-20773	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-20883	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-20974	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-21079	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-21155	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-21557	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-21726		1			Fluid survey information reported due to coding in Form A/B due to DEP.
015-21809	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-21896	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-22132	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-22275	1				Fluid survey information reported due to coding in Form A/B due to DEP.
015-22544			1		Overpressuring field and fluid survey information do not need to be completed. Clarifying comment related to change in production annulus recommended.
015-22755				1	No scanned Completion Report found in PAIRIS/WIS.
019-21837		1			This appears to be a previously leaking well that was addressed: clarifying comments recommended. Primary production and annular pressure data are notable: clarifying comments recommended. Fluid survey information reported due to coding in Form A/B due to DEP.
019-21924		1			Primary production and annular pressure data are notable: clarifying comments recommended. Fluid survey information reported due to coding in Form A/B due to DEP.
019-22046	1				
019-22086	1				
031-25296	1				
033-22015	1				Operator should report four (4) quarterly results: well is classified as unconventional due to treatment of Upper Devonian Shale. Fluid survey information reported due to coding in Form A/B due to DEP.
033-26885			1		Overpressuring field not completed correctly.
033-26948			1		Overpressuring field not completed correctly.
033-27053				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
033-27111				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
035-21239				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
035-21240		1			Clarifying comment related to pressure relationships between production casing and annulus recommended.
035-21250	1				Fluid survey information reported due to coding in Form A/B due to DEP.
035-21284	1				Fluid survey information reported due to coding in Form A/B due to DEP.
047-24636		1			Annulus pressure higher than production pressure: clarifying comment recommended. Fluid survey information reported due to coding in Form A/B due to DEP.
051-24212	1				
051-24473				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-24424	1				
059-24737			1		Clarifying comments recommended regarding why well appears to have been operated differently from quarter-to-quarter. Annular pressures/flow field not completed for last three (3) quarters. Produced annulus pressure field does not consistent with unconventional operations.
059-25173	1				
059-25422	1				
059-25529				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-25581		1			Recommend comment explaining why production annulus was inaccessible in Quarter 4.
059-25602	1				Effective use of comments in Quarter 3 to explain elevated pressure.
059-25634				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-25635				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-25753				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-25945	1				
059-26033				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-26240				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-26479				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-26540				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
059-26561				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.

081-20056	1				
081-20180	1				
081-20456	1				
081-20534				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
081-20795			1		Production information appears not applicable or inaccurate. Fluid survey information does not need to be completed.
081-21059	1				
081-21080				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
081-21330				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
083-52436			1		Production annulus field not completed correctly and well must be inspected all four (4) quarters.
113-20038	1				Fluid survey information reported due to coding in Form A/B due to DEP.
113-20083		1			Clarifying comment recommended regarding why gas pressure was noted in Quarter 2 on production annulus. Fluid survey information reported due to coding in Form A/B due to DEP.
113-20265				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
115-20221	1				
115-20500	1				
115-20922				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
115-20927	1				Fluid survey information reported due to coding in Form A/B due to DEP.
115-20985	1				
115-21195				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
115-21228	1				
115-21463	1				
117-20279	1				
117-20483	1				
117-20882	1				
117-20890		1			Clarifying comment recommended to explain the change in production annulus status from quarter-to-quarter.
117-20908	1				
117-20918	1				
117-20974	1				
117-21190	1				
125-22472			1		Production annulus appears not to have been consistently inspected.
125-22897	1				
125-23040			1		Production annulus appears not to have been consistently inspected.
125-23882	1				
125-24380	1				
125-24502				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
125-24619			1		Good use of comments, but inconsistent or missing information for fluid survey. This does not appear to be related to computer coding.
125-24860	1				
125-24869				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
125-24872				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
125-24903				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
125-26926	1				
125-27031				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
125-27057				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
125-27065				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
129-28804				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
131-20217				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
131-20295				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
Summary	46	8	9	32	
	48.4%	8.4%	9.5%	33.7%	

Summary table of study results for unconventional wells: statewide office audit.

Verification Study Table: Conventional Wells					
Permit (API) Numer	Appears Correct	Additional Clarification Recommended	Reporting Errors/Other Concerns Noted	Unable to Verify Report Parameters	Comments
003-22023	1				
005-01217	1				Difficult to classify well construction using Well Record. Also, Fluid survey information reported due to coding in Form A/B due to DEP.
005-01466	1				
005-02032			1		Well Record depicts a single-string - annular production not permitted in association with such designs. Vent flow and production annular pressure fields, and fluid survey information completed incorrectly.
005-20613	1				Appears to be a 2-string well on a packer with one gauge.
005-20747	1				Appears to be a 2-string well on a packer with one gauge.
005-21549				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
005-22910	1				
005-22941		1			Unclear how primary and annular production pressures are the same based on information in Completion Report: clarifying comments recommended.
005-25266	1				
005-26289				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
005-27476	1				
005-28023	1				
005-29492		1			Status of surface-by-intermediate annulus not clear: clarifying comments recommended.
021-20162	1				
021-20473	1				Fluid survey information reported due to coding in Form A/B due to DEP.
027-20163	1				
027-20200	1				
027-20439	1				
027-20762	1				
031-00454	1				Fluid survey information reported due to coding in Form A/B due to DEP.
031-00813	1				
031-20442	1				
031-22773			1		Appears to be a single-string gas well based on Completion Report: overpressuring field not completed correctly. Fluid survey information reported due to coding in Form A/B due to DEP.
031-22818	1				Fluid survey information reported due to coding in Form A/B due to DEP.
031-23571		1			Clarifying comment regarding "inaccessible" status recommended.
031-24126	1				Production annulus field possibly a data-entry error.
033-23232	1				Fluid survey information reported due to coding in Form A/B due to DEP.
033-24775	1				Fluid survey information reported due to coding in Form A/B due to DEP.
033-25837	1				
035-20613			1		Corrosion field not completed. Wellhead emission field and fluid survey information not completed correctly. Clarifying comment regarding "inaccessible" status recommended.
035-20826			1		Corrosion field not completed. Wellhead emission field and fluid survey information not completed correctly. Clarifying comment regarding "inaccessible" status recommended.
035-20836			1		Corrosion field not completed. Wellhead emission field and fluid survey information not completed correctly. Clarifying comment regarding "inaccessible" status recommended.
039-23059	1				
039-24136	1				
047-00443				1	No well construction details on 1954 Well Record/Completion Report.
047-00608				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
047-23084	1				
047-24024	1				
049-21696	1				Fluid survey information reported due to coding in Form A/B due to DEP.
049-24206		1			Clarifying comment recommended regarding production status or presence of pressure gauge. Fluid survey information reported due to coding in Form A/B due to DEP.
049-24690	1				
051-20499	1				Fluid survey information reported due to coding in Form A/B due to DEP.
051-22967	1				
053-28737			1		Overpressuring field completed incorrectly.
059-01189	1				
059-22814	1				
059-23740	1				Fluid survey information reported due to coding in Form A/B due to DEP.
059-24246	1				Fluid survey information reported due to coding in Form A/B due to DEP.

059-24812				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
063-20478	1				Fluid survey information reported due to coding in Form A/B due to DEP.
063-22793	1				Fluid survey information reported due to coding in Form A/B due to DEP.
063-23155		1			Clarifying comments regarding "inaccessible" status and primary production pressure of "0" recommended.
063-23179		1			Clarifying comment regarding "inaccessible" status recommended.
063-23369	1				
063-24165	1				Fluid survey information reported due to coding in Form A/B due to DEP.
063-24502	1				Fluid survey information reported due to coding in Form A/B due to DEP.
063-27146	1				Fluid survey information reported due to coding in Form A/B due to DEP.
063-29660	1				Fluid survey information reported due to coding in Form A/B due to DEP.
063-30322	1				
063-34952	1				Fluid survey information reported due to coding in Form A/B due to DEP.
063-35453	1				
063-36722	1				Fluid survey information reported due to coding in Form A/B due to DEP.
065-23169	1				
065-24729	1				Fluid survey information reported due to coding in Form A/B due to DEP.
065-26087	1				
065-26576			1		Annular production pressure/status fields not completed correctly.
083-47026		1			Unclear how primary and annular production pressures are the same based on information in Completion Report: clarifying comments recommended.
083-49286			1		Report not completed correctly.
083-50745	1				
083-51879	1				
085-00194				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
085-21972	1				
085-22693			1		Oil production and production annulus information completed incorrectly.
121-42569	1				
121-43321	1				
121-45614			1		Well Record depicts a single-string - annular production not permitted in association with such designs. Vent flow and production annular pressure fields, and fluid survey information completed incorrectly.
123-20293	1				
123-21594	1				Fluid survey information reported due to coding in Form A/B due to DEP.
123-24194	1				
123-38661				1	No scanned Well Record/Completion Report found in PAIRIS/WIS.
123-39764	1				
123-40953			1		Production annulus field not completed correctly for single-string well.
123-43357			1		Production annulus field not completed correctly for single-string well.
123-44616	1				
123-47358	1				
125-22486	1				
125-23124		1			Clarifying comment recommended regarding production status or presence of pressure gauge.
129-20025		1			Unclear how primary and annular production pressures are the same based on information in Completion Report: clarifying comments recommended.
129-21214	1				
129-23813			1		Overpressuring field completed incorrectly: well is 2-string design.
129-26584	1				Fluid survey information reported due to coding in Form A/B due to DEP.
129-26795	1				Fluid survey information reported due to coding in Form A/B due to DEP.
129-27245	1				Fluid survey information reported due to coding in Form A/B due to DEP.
129-27446	1				Fluid survey information reported due to coding in Form A/B due to DEP.
129-27831	1				Fluid survey information reported due to coding in Form A/B due to DEP.
Summary	67	9	13	7	
	69.8%	9.4%	13.5%	7.3%	

Summary table of study results for conventional wells: statewide office audit.



IMAGE 1. Photograph showing two (2) white poly tanks that five (5) wells on a ten (10) well pad have their 9-5/8 inch (intermediate) by 5-1/2 inch (production) annulus plumbed to. This configuration makes it difficult for DEP to verify Mechanical Integrity Assessment data since all the wells are in communication.



IMAGE 2. Photograph showing green flexible line that can be heard gurgling and seen visibly surging. Observation may indicate transfer of fluid to the annuli of other wells. It appears that operator does have a way to isolate the annuli; however, one well may be adding gas to the annulus of another well that is not making any gas. Wells with annular gas are difficult to verify unless each well is isolated and allowed to vent for a time period to establish a baseline condition from which an accurate observation can be made. This well configuration could result in DEP believing that gas is present outside more annuli than is actually the case.



IMAGE 3. Photograph showing how wells at the ten (10) well pad referenced in IMAGE 1 are configured.



IMAGE 4. Photograph showing how wells at the ten (10) well pad referenced in IMAGE 1 are configured.



IMAGE 5. Photograph showing well at which operator reported 25 psi on 12/9/14. During the field verification study, the pressure was 0.5 psi inside the 7-inch by 2-inch annulus. The cups on the well are worn out and it is not cost effective to replace them according to the operator. It appears the well has not produced oil recently.



IMAGE 6. Photograph showing new gravel placed atop area of stained soil associated with stuffing box leaks. It appears the well is pumped fairly often as evidenced by the polished rod.



IMAGE 7. Photograph showing primary production annulus (8-5/8 inch by 4-1/2 inch) buried below surface with only tubing head exposed. Since no direct visual observation can be made, operator should record “inaccessible” instead of stating that no leaks are present.



IMAGE 8. Photograph showing a well where operator reported production annulus pressure as 0 psig. Pressure could not be determined at the time of the field verification based on current well configuration. Operator should have reported that annulus was “inaccessible.”



IMAGE 9. Photograph showing a well where operator reported production annulus pressure as 0 psig. Pressure could not be determined at the time of the field verification based on current well configuration. Operator should have reported that annulus was “inaccessible.” Severe corrosion was also noted but not reported by operator as part of Mechanical Integrity Assessment data submission.



IMAGE 10. Photograph showing a well where operator reported production annulus as being vented. This may have resulted from an error in DEP computer coding for Forms A and B. For such a configuration, it is recommended that the operator use the comments field to indicate that the annulus is buried and report it as “inaccessible”.