

PROBLEMS UNIQUE TO OFFSHORE GAS MEASUREMENT

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INTRODUCTION

Some major problems and unique solutions will be addressed with gas measurement on offshore platforms in the Gulf of Mexico. This presentation will show the major roll safety, transportation, and weather play in the technician's ability to verify the accuracy of the gas measurement facility. Proper operation, design, and installation will ensure accurate measurement.

SAFETY

When preparing to depart for an offshore platform, the correct safety equipment is very important. Safety clothing (Fire retardant Nomex, Hypothermia Jackets, Insulated coveralls, etc.), hard hat, protective eyewear with side shields, and steel-toed shoes are safety equipment for offshore use. The pilot will give a preflight briefing showing the danger areas to avoid, survival kit location, life raft location, loading and unloading procedures, and proper communication. Proper life jacket inflation, fit and deflation will also be covered in the preflight briefing. Special care should be taken when carrying long objects in and near the helicopter. When loading the cargo compartment of the helicopter, special consideration must be made for the weight per square inch and physical size limits for each helicopter. While in the aircraft everyone aboard has the responsibility of looking for approaching helicopters, planes, or UFO's.

Upon arrival at your destination, you must sign in and check in with the person in charge. A platform orientation will be conducted showing the safety hazards, audible alarms, and reporting stations for each individual platform or drilling rig. Know where to go on the platform when the alarms sound, some platforms require a written step by step description of the work that will be performed, safety hazards, and preventions. Also alert the person in charge of any special work requirements that may affect the platform's normal operation, personal safety, or environmental impact. At this time you will be notified of restricted area on the platform. Platform personal should be aware of any gas venting, flammable liquid spill, welding, or X-ray testing.

Be aware at all times that safety is first, because if an accident occurs medical attention is a long helicopter ride away. The helicopter pilot cannot transport an injured patient without someone going along to tend to the injuries. If you are seriously injured on an unmanned platform, the pilot is unable to transport you as a passenger. He would have to get someone from the neighboring platforms to care for the injuries while in flight.

When departing a platform always sign out and let the person in charge know how the job went while getting him to sign any necessary paperwork. The pilot must be aware of any items loaded on the aircraft and the weight. The transportation of hazardous materials form must be filled out accompanying any sample cylinders being transported. While the helicopter is running on the heliport, look for operating cranes, flying debris, or inbound aircraft. Let the helicopter pilot know that it is clear on your side to take off.

The physical demands of the offshore environment (excessive stair climbing, swinging onto boats, heavy loads, heat, cold, high winds, etc.) require the offshore worker to be in good physical condition, flexible, and able to work under difficult situations.

TRANSPORTATION

Preplanning your flight will save you time and money. Measurement technicians cannot afford to leave any test equipment behind. Because you cannot drive to each location with your well-equipped vehicle, it is a good idea to preplan each job and list the equipment needed to complete each task. Depending on if a helicopter is used; the weight (personnel, cargo inside and out, test equipment, fuel, etc.) is a major concern. A helicopter may have seating for six passengers but can carry a total weight of only nine hundred (900) lbs. with a full load of fuel. This means that every pound you carry must be essential to the work to be performed.

Cargo loaded on the helicopter must be approved by the pilot and secured from moving around. Beware of the helicopter danger area when loading and unloading while the aircraft is running. If the load is too heavy, the pilot will have to reduce his fuel carrying capability. This adds extra fuel stops to the flight causing less time for the technician to work. You may have to leave tools, test instruments, or passengers behind to meet the weight requirements. Helicopter pilots may have to redistribute the cargo or passenger load to reach the correct center of gravity for the aircraft.

It is a good idea to look at the electronic flow measurement data prior to going offshore. This preplan will reconfirm the platform is flowing allowing you to complete the testing with this one trip (testing, gas sampling, quality assurance, plate inspections, etc.). If gas and/or oil samples are collected, be aware of the D.O.T. CFR #49 transportation regulations (Parts 100-177). Especially be aware of how the regulations can affect you as a transporter and the fines that can be levied

against you if the samples are not handled properly and documented. Know who is eligible to fly with the gas and/or oil sample onboard the aircraft. The D.O.T. transportation of hazardous materials forms must be filled out completely by the handler and properly distributed. The pilot will inspect all containers for the correct labels identifying the sample (contents, hazardous class, weight, packing code, etc.) in an approved carrying case. The case must be padded to protect the sample bottle valves and cylinders. So far we have only talked about flying offshore, but there is another way offshore and it is a boat. The boat can range from a 15-foot aluminum to a 150-foot crew boat (galley, quarters, TV, showers, etc.).

A single engine Bell 206L-1/L-3-turbine helicopter cost \$34000.00 per month plus \$320.00 per flight hour time. A twin engine Boelkow 105 CBS twin-turbine helicopter cost \$36000.00 per month plus \$580.00 per flight hour time. A crew boat is between \$2500.00 and \$3000.00 per day plus fuel at 90 gallons an hour and \$1.40 per gallon. Upon arrival at the platform you may encounter helicopters already landed and no room on the heliport for another aircraft. You will have to circle the platform until one aircraft leaves. Remember the hourly rate is still being charged while you are circling the platform. Be aware some helicopter flight service companies charge flight time for running while on the heliport and taxiing from the heliport to the pickup location.

WEATHER

Weather conditions can be the biggest hazard to overcome that a measurement technician encounters when working offshore. Helicopters and crew boats are both expensive and susceptible to bad weather conditions. Due to passenger safety regulations, helicopters do not normally fly in bad weather conditions (fog, high winds, thunder storms, sleet, etc.). These no fly weather days cause the measurement technician to delay meter testing or cancel the scheduled test. This rescheduling causes problems for the measurement technician, witness, and producer. The measurement technician and witness must be able to work flexible schedules in order to meet contractual and governmental requirements. The producer has to have the custody transfer meters calibrated every forty-two (42) days or request an extension from MMS. Everyone has to work together to meet the forty-two (42) day test requirement for offshore custody transfer meters. The only alternative is to use the crew boat for transportation. Depending on the distance to be traveled, the condition of the sea, and pending weather systems, crew boats may not be a practical way to travel. Another related problem that occurs is one party will be able to fly from his location and the other is grounded due to bad weather and the test must be rescheduled or canceled. It is not uncommon to become weathered-in for weeks at a time especially during the winter months. When arriving at your destination offshore in the Gulf of Mexico you must dress for the occasion. There is nothing to block the wind and on cold days the chill factor can become unbearable. The test equipment, transmitters, radio, and RTU cannot get

wet and operate properly. Rain showers delay or stop the testing causing rescheduling problems. In the hot summer months the humidity can and often does reach 100% and this can drain your energy.

OPERATION

Typical offshore platforms have multiple wells either located on the platform, on a connecting platform, or on a satellite platform. The gas is separated, compressed, dehydrated (if required), and piped through a check meter, then on to the custody transfer meter and the departing transmission line. Any condensate produced is measured through condensate meters and then reinjected downstream of the gas custody transfer meters. Normally the gas and condensate is separated but some carryover into the custody transfer meter tube exists. These liquids must be reduce to a minimum.

Proper platform operating procedures are necessary to good measurement to occur. Separator levels must be checked often to ensure proper operation of the two-phase separators. Liquids should be captured upstream of any gas measurement device. Eliminate liquids in any form from the primary gas measurement device. Factors affecting measurement accuracy include: rate changes, temperature changes, improperly sized orifice plate, platform upsets, different wells flowing intermittently, free liquids, solids, improperly installed orifice plate, etc. Measurement offshore will consist of orifice, turbine, rotary, ultrasonic, and coriolis meters.

Because of the wide range of flow rates for orifice measurement a complete set of orifice plates are needed in half-inch intervals. The Beta Ratio should range from 0.2 to 0.6 to give you the most accurate measurement. It is not uncommon to change orifice plates two to three times a week. The orifice plate should be beveled on the downstream side. The electronic flow measurement device must be updated every time a plate change occurs. The producer will change orifice plates only when the technician is unable to get to the platform due to weather problems, helicopter failures, or no one available. The computer will be updated by gas control and the paper work done by the technician when he verifies the plate size and proper installation.

Turbine meters are also used for a wide range of flow rates offshore. Turbine meters offshore where two phase flow exists from the production platforms has the potential to cause low measurement. Turbine meters should not be used offshore where there is a potential for liquids to collect. Liquids carry sand, paraffin, and other solids that may cause bearing and internal damage to the meter.

Rotary meters are normally used as fuel meters with a strainer upstream to capture solids and liquids. These meters are very accurate as long as the gas is free of any particulates.

Ultrasonic meters are starting to be used offshore with separators directly upstream of the meter run. Baseline

log files should be kept to identify any change in the meter from the flow lab or initial installation. Ultrasonic meters will identify buildup inside the meter tube whether it is using a reflective path or straight across transducers.

Coriolis meters are also being used on the fuel runs for low flow rates for custody transfer. The mass meter is only dependent on the density of the gas as it flows across the meter. This meter was designed to measure liquids and is just now starting to show up in the gas industry for custody transfer meters.

Operators need to contact measurement personnel when problems occur and be accountable for the day-to-day measurement requirements. Operators rely on the previous day volumes calculated by the flow computer, giving them the actual volume they will be paid for. This gives the operator a good check on the actual flow versus the nomination for the gas day.

Measurement personnel should stress to the operator the importance of the electronic flow measurement computer working properly. The operator should be trained to read the computer display and find existing problems such as:

- Correct static pressure
- Correct differential pressure
- Correct temperature
- Correct volume calculation
- Updated previous days volume
- Manual readings in the computer

Measurement personnel should always remember that whatever you carry on the helicopter has to be carried down the stairs to the metering facility and then back up the stairs. Sometimes taking two to three trips before all of the equipment needed is at the meter tubes. This is sometimes referred to as having P.M.S. (Pack Mule Syndrome).

On transmission lines that move both gas and liquids in the same line, a pigging operation is normally performed. If foam pigs are used to move the liquids in the pipeline, then be aware that this pig may separate causing pieces to become lodged in the flow conditioners on delivery meters at the beach. Rags, welding gloves, internal pipeline coating, and foam pigs are just some of the items found in the flow conditioners for delivery stations.

Periodic meter tube inspections need to be performed on all custody transfer meters on all offshore platforms. An end enclosure on each end of all meter runs will allow for a quick inspection of the tube if a problem is suspected. Inspection and cleaning the meter tubes will enhance the measurement accuracy.

DESIGN/INSTALLATION

On all new platform construction during the design stages it is important to have measurement personnel available to review the schematics and offer input on the new installation. The design stage is the time to ensure that

the measurement equipment is designed to the company's standards and any special needs are addressed. Because of the high cost per square foot of production platforms, the platforms are becoming smaller and more compact. Because space is such a premium and the measurement skids are so compact it is good planning to consider the various problems encountered when installing measurement equipment. Listed below are some ideas to help eliminate potential problems and ensure accurate measurement.

- Complete as much work as possible in the design stages before the platform construction begins. Consider the location of tubes, vibrations, paint quality, and probe installation, flanged tubes, inspection end caps and size.
- Ensure the measurement equipment is accessible for routine maintenance. Consider the ease of operation and repairs. Locate cranks in a practical position.
- Ensure the meter tubes are flanged upstream and downstream. The benefits of flanged tubes are ease of inspection, fast installation and less downtime for production.
- Enclosures on each end of the meter tube will allow ease of periodic inspection with little or no loss of production.
- Installing flow conditioners will reduce the length of upstream meter tube required, prevent turbulent flow, and give you a better gas profile.
- Install a check meter to monitor and verify all custody transfer measurement. Don't assume the purchaser's meters never fail or Accounting Departments are always 100% accurate. The check meter is an excellent investment to recover revenue.
- Avoid liquid traps in gas meter tubes. Liquids in the meter tube drains against the orifice plate creating inaccurate measurement and causes freezing during the winter months. Stainless steel tubing should be run with a slight downward slant toward the meter run making sure there are no traps for moisture.
- Direct mount manifolds are used to reduce the liquids collecting in the gauge lines and eliminate the long tubing runs causing gauge line error.
- Determine the anticipated gas flow rate to allow properly sized meter tubes and transmitters to be installed for the most accuracy.
- Keep a file of all meter tube micrometer sheets for future inspections.
- During platform inspection or when micrometer readings are taken it is a good idea to operate all meter run valves and orifice fittings to ensure the integrity of the moving parts.

- Ensure that there are enough taps located in the upstream and downstream piping to satisfy all users (transducers, samplers, flow controllers, check measurement safety devices, etc.).
- Consider if the orifice fitting is to be positioned to roll the plate up (vertical) the fittings will be easier to repair. Four tap holes on each side of the fitting will be usable for check metering, custody transfer, and audit measurement.
- When the orifice fitting is positioned horizontally to roll the plate out towards the operator, liquids are less likely to freeze in the taps or carry over into the meter. However, on larger fittings due to the size and weight, the fitting is more difficult to repair.
- When locating the measurement equipment, consider the corrosion problems created by the salt air environment. Install equipment in buildings or cover the instrument. Be aware of the damage salt-water wash down, drilling rig solvents, and deluge systems can have.
- Stainless steel fittings, transmitter housing, and direct mounts have proven successful in the harsh salt air environment. Stainless steel equipment is a low maintenance item and low maintenance offshore is an automatic savings.

Without the practical input from competent measurement personnel many companies leave themselves open for major production losses and measurement discrepancies.

CONCLUSION

- Companies must depend on trained, competent measurement personnel to monitor their measurement from the wellhead to the beach. Continuous training programs both on the job and off enables the measurement personnel to keep the measurement as accurate as possible. With the use of computers, accurate transmitters, and improved primary elements the potential for error still remains. Measurement personnel are held accountable for the measurement on specific platforms from the design stage through final production. Gas sales statements need to be compared to check volumes, audit measurement, monthly balance prepared, BTU's compared, and all meter reports monitored for errors. Normally, trained measurement personnel who are familiar with specific platforms, gas quality, flow conditions, and rate changes can identify major and minor discrepancies that analysts might overlook. Properly trained, informed, and accountable measurement personnel are key players in identifying and resolving discrepancies that effect major revenues in both offshore and onshore stations. Use measurement personnel to the best of their ability not only as meter mechanics.