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OIL SAMPLING PROCEDURES

Pressurized Line Sampling Low-Pressure Minimess Tap Sampling

CTP-S-001

This method serves multiple purposes. First, it provides an easy way to identify ingress into the reservoir from such sources as breather vents and new oil addition. It is also a good way to detect wear being generated by the lube oil pump. For systems without pressure-side, in-line filters, pressurized line sampling helps in assessing the cleanliness of the oil being fed to the components. When assessing the machine's condition, this provides the background against which return line samples from bearings and gears should be assessed or evaluated? For systems with in-line filters, it provides the background against which filter performance is assessed. For wet-sump circulating systems that don't allow drain line sampling, this is the preferred sampling location for primary trending.

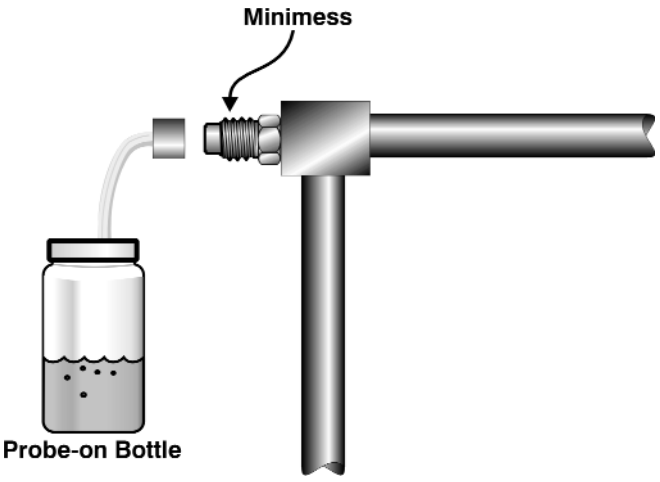
The table below provides the relative applicability and value of pressurized-line sampling for various machine types. This method is superior to any tank or sump sampling method.

Lubrication System or Machine Type	Pressurized-Line Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Gear System	Best
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	NA
Hydraulic System	Less Desirable
Compressor	Avoid
Large Circulating System	Less Desirable
Engines	Avoid

The table rates the quality and applicability of this sampling method to various machine types.

Material Requirements

- A suitable bottle lid adapter for sampling pressurized oil systems enclosed in a durable zip-lock bag, except during use.
- A spare container for collecting the flushing fluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag before entering the plant or field area for sampling. All of the contained sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.
- A bottle label and any other documentation that will accompany the sample.
- A minimess sampling port must be installed at a suitable location on pressurized feed lines. Ideal locations are in turbulent fluid areas of the pipe where at least 10 psi pressure exists.
- Disposable probe-on type sample port adapters with 12 inches of polyethylene plastic tubing cut at a 45-degree angle on the exposed end stored in a large zip-lock bag until needed; or a reusable

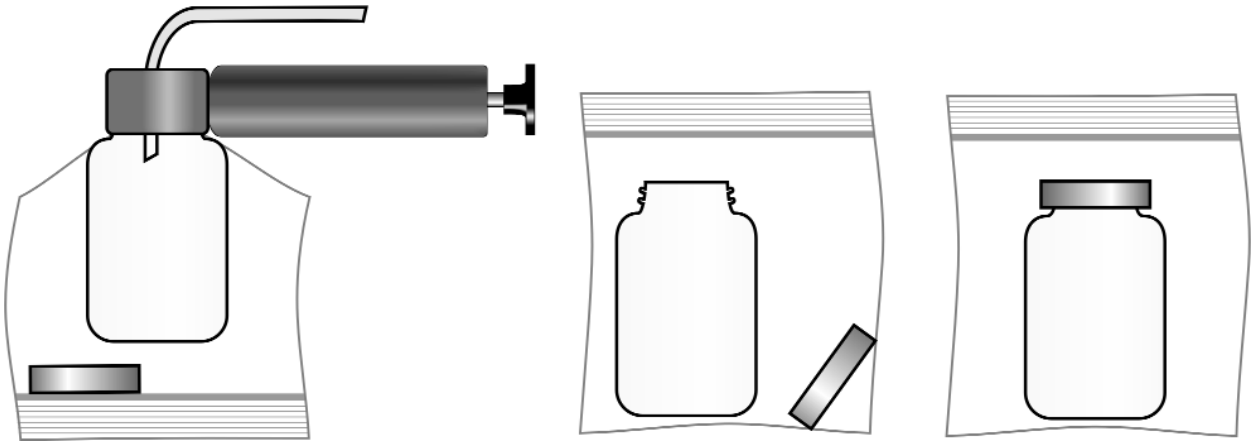


probe-on adapter and a coil of polyethylene plastic tubing.

- A suitable knife for cutting the plastic tubing.

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level before sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust cover from the sampling port.
8. Inspect the opening of the minimess port to ensure that no debris has collected.
9. Clean the minimess port if required.
10. If a reusable probe-on type adapter is used:
    - Cut 12 inches of plastic tubing, cut one end at a 45-degree angle.
    - Remove the reusable probe-on type adapter from the plastic bag.
    - Attach the blunt end of the plastic tube to the probe-on adapter.
11. If a disposable probe-on type adapter is used, remove it from the zip-lock bag.
12. Remove the bottle adapter from its plastic bag and attach the end of the tube cut at a 45º angle.
13. Securely attach the bottle adapter to the flushing bottle, being careful not to contaminate either end of the tubing.
14. Push or thread the probe-on type adapter onto the test port to initiate flow into the flushing bottle.
15. Flush approximately 100 ml of fluid from the test port, or a volume equal to at least three times the dead space.
16. Stop the flow of oil into the flushing bottle by removing the probe-on type adapter from the sampling port.
17. Once the flush is complete, carefully unthread the probe lid adapter from the flushing bottle taking care not to contaminate the lid adapter or plastic tubing.
18. Thread a sample bottle onto the probe adapter. This is accomplished by removing the bottle cap from the sample bottle without opening the plastic bag. Once the cap is removed, the bottle opening is threaded into the probe adapter lid through the plastic bag - with the bottle and cap still in the bag and the bag remaining sealed. During this process, the tube that protrudes through the adapter lid will rupture the bag as the bottle is being threaded onto the probe. Tighten the bottle to ensure a sufficient seal. Using a clean pointed object, puncture the bag below the vent hole in the probe adapter cap space.
19. Push or thread the probe-on type adapter onto the test port to initiate flow into the sample bottle. Always hold the sample bottle in an upright position.
20. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.



21. Stop the flow of oil into the sample bottle by removing the probe-on type adapter from the sampling port.
22. Unthread the probe adapter lid from the sample bottle.
23. Without opening the plastic bag, thread the original cap back onto the bottle securely.
24. Remove the sample bottle from the plastic bag.
25. Return the sampling adapter to its plastic zip-lock storage bag to avoid contamination.
26. Thread the dust cover back onto the sampling port.
27. Dispose of the flushing fluid properly. Do not return it to the operating machine.
28. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
29. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
30. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment and ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Information about debris generated by components is often diluted by the fluid in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Debris generated by components may settle in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Particles tend to settle in low-velocity flow return lines.
- High-velocity flow return lines tend to experience particle "fly-by" unless the sampling valve is located properly.
- An off-line filter may remove particles that are generated by components or ingested into the sump or tank, causing a falsely low reading.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature before sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Check system pressure. If greater than 300 psi, a helical pressure-reducing coil must be used.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between the lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high-quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent upon sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones “on the run”.
- Flush upstream of filters and downstream of components to assess the machine'scondition.
- Install sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximize data quality and consistency and minimize procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at properfrequency.
- Record sampling hours to “time normalize” the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples tothe maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

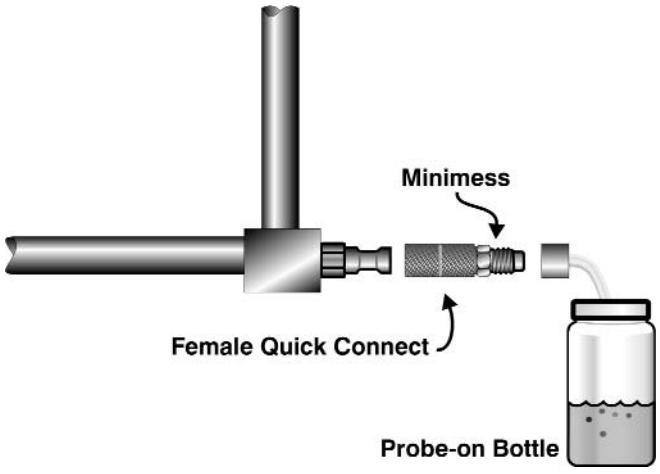
Pressurized Line Sampling - Portable Minimess Tap Sampling

CTP-S-002

Pressurized line sampling serves multiple purposes. First, it provides an easy way to identify ingress into the reservoir from such sources as breather vents and new oil addition. It is also a good way to detect wear being generated by the lube oil pump. For systems without pressure-side, in-line filters, pressurized line sampling helps in assessing the cleanliness of the oil being fed to the components. When assessing the machine's condition, this provides the background against which return line samples from bearings and gears should be assessed. For systems with in-line filters, it provides the background against which filter performance is assessed. For wet-sump circulating systems that don't allow drain line sampling, this is the preferred sampling location for primary trending. The following table provides the relative applicability and value of pressurized line sampling for various machine types. This method is superior to any tank or sump sampling method.

Material Requirements

- A suitable bottle lid adapter for sampling pressurized oil systems enclosed in a durable zip-lock bag, except during use.
- A spare container for collecting the flushing fluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag prior to entering the plant or field area for sampling. All of the contained sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.
- A bottle label and any other documentation that will accompany the sample.
- A minimess tap installed to a female quick-connect that mates with the male quick connects installed on the machines.



Lubrication System or Machine Type	Pressurized-Line Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Gear System	NA
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Best
Hydraulic System	Best
Compressor	Best
Large Circulating System	Best
Engines	Best

The table rates the quality and applicability of this sampling method to various machine types.

- A male quick-connect must be installed at a suitable location on pressurized feed lines. Ideal locations are in turbulent fluid areas of the pipe where at least 10 psi pressure exists.
- Disposable probe-on type sample port adapters with 12 inches of polyethylene plastic tubing cut at a 45 degree angle on the exposed end stored in a large zip-lock sandwich bag until needed; or a reusable probe-on adapter and a coil of polyethylene plastic tubing.
- A suitable knife for cutting the plastic tubing.

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust-cap from the male quick-connect installed on the machine.
8. Remove the female quick-connect and minimess assembly from its protective storage container and affix it to the male quick connect on the machine.
9. Remove the dust cover from the minimess.
10. Inspect the opening of the minimess port to ensure that no debris has collected.
11. Clean the minimess port if required.
12. If a reusable probe-on type adapter is used:
    - Cut 12 inches of plastic tubing, cut one end at a 45-degree angle.
    - Remove the reusable probe-on type adapter from the plastic bag.
    - Attach the blunt end of the plastic tube to the probe-on adapter.
13. If a disposable probe-on type adapter is used, remove it from the zip-lock sandwich bag.
14. Remove the bottle adapter from its plastic bag and attach the end of the tube cut at a 45 degree angle.
15. Securely attach the bottle adapter to the flushing bottle, being careful not to contaminate either end of the tubing.
16. Push or thread the probe-on type adapter onto the test port to initiate flow into the flushing bottle.
17. Flush approximately 100 ml of fluid from the test port, or a volume equal to at least three times the dead space.
18. Stop the flow of oil into the flushing bottle by removing the probe-on type adapter from the sampling port.
19. Once the flush is complete, carefully unthread the probe lid adapter from the flushing bottle taking care not to contaminate the lid adapter or plastic tubing.
20. Thread a sample bottle onto the probe adapter. This is accomplished by removing the bottle cap from the sample bottle without opening the plastic bag. Once the cap is remove, the bottle opening is threaded into the probe adapter lid through the plastic bag - with the bottle and cap still in the bag and the bag remaining sealed. During this process, the tube that protrudes through the adapter lid will rupture the bag as the bottle is being threaded onto the probe. Tighten the bottle to ensure a sufficient seal. Using a clean pointed object, puncture the bag below the vent hole in the probe adapter cap space.
21. Push or thread the probe-on type adapter onto the test port to initiate flow into the sample bottle. Always hold the sample bottle in an upright position.
22. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
23. Stop the flow of oil into the sample bottle by removing the probe-on type adapter from the sampling port.
24. Unthread the probe adapter lid from the sample bottle.
25. Without opening the plastic bag, thread the original cap back onto the bottle securely.
26. Remove the sample bottle from the plastic bag.

27. Return the sampling adapter to its plastic zip-lock storage bag to avoid contamination.
28. Thread the dust cover back onto the sampling port.
29. Disconnect the female quick-connect from its male counterpart and place the device in its protective storage container.
30. Inspect the male quick connect to ensure that it is not leaking and replace its dust-cap.
31. Dispose of the flushing fluid properly. Do not return it to the operating machine.
32. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
33. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
34. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment and ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Information about debris generated by components is often diluted by the fluid in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Debris generated by components may settle in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Particles tend to settle in low velocity flow return line.
- High velocity flow return lines tend to experience particle "fly-by" unless the sampling valve is located properly.
- An off-line filter may remove particles that are generated by components or ingested into the sump or tank, causing a falsely low reading.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Check system pressure. If greater than 300 psi, a helical pressure-reducing coil must be used.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high-quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent on sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.

- Sample from live zones “on the run”.
- Flush upstream of filters and downstream of components to assess the machine’s condition.
- Install sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to “time normalize” the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

Pressurized Line Sampling - Low Pressure Ball Valve Sampling

CTP-S-003

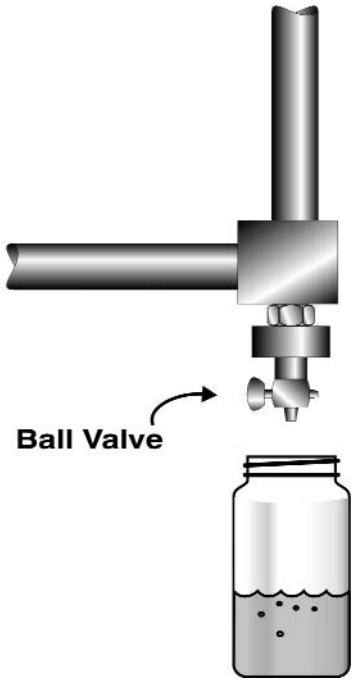
Pressurized line sampling serves multiple purposes. First, it provides an easy way to identify ingress into the reservoir from such sources as breather vents and new oil addition. It is also a good way to detect wear being generated by the lube oil pump. For systems without pressure-side, in-line filters, pressurized line sampling helps in assessing the cleanliness of the oil being fed to the components. When assessing the machine's condition, this provides the background against which return line samples from bearings and gears should be assessed or evaluated. For systems with in-line filters, it provides the background against which filter performance is assessed. For wet-sump circulating systems that don't allow drain line sampling, this is the preferred sampling location for primary trending.

Material Requirements for Obtaining a Sample

- A certified clean capped sample container.
- A larger flushing container.
- A ball valve appropriately installed on the system to obtain a representative sample.
- Bottle label and any other required documentation that will accompany the sample.
- Appropriate shipping container(s) if the sample(s) is (are) to be sent to an outside laboratory.

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust-cap (where applicable) from the sample valve and it to induce flow.
8. Flush the valve with a volume of at least five times, preferably 10 times, the dead-space volume in the pipe-stem, port-extension, etc. into a disposal bottle or pail.



9. Remove the lid from the sample bottle taking care not to touch the inside surface of the bottle or lid. Do not remove the lid until ready to fill the sample bottle.
10. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
11. Once filled, close the sample valve and re-cap the bottle immediately, making sure that the cap fits tightly on the bottle.
12. Inspect the sample valve to make sure that a tight, leak free seal is achieved and replace the cap where applicable.
13. Dispose of the flushing fluid properly. Do not return it to the operating machine.
14. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.

Lubrication System or Machine Type	Pressurized-Line Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Gear System	NA
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Best
Hydraulic System	Best
Compressor	Best
Large Circulating System	Best
Engines	Best

The table rates the quality and applicability of this sampling method to various machine types.

15. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
16. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment and ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Debris generated by components is often diluted by the fluid in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Debris generated by components may settle in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Particles tend to settle in low velocity flow return lines.
- High velocity flow return lines tend to experience particle "fly-by" unless the sampling valve is located properly.
- An off-line filter may remove particles that are generated by components or ingested into the sump or tank, causing a falsely low reading.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C. use appropriate thermal insulation material to protect hands.
- Check system pressure. If greater than 300 psi, a helical pressure-reducing coil must be used.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high-quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
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Other properties are dependent on sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones "on the run".
- Flush upstream of filters and downstream of components to assess the machine's condition.
- Use sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Employ procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

Pressurized Line Sampling - High Pressure Sampling

CTP-S-004

Pressurized line sampling serves multiple purposes. First, it provides an easy way to identify ingress into the reservoir from such sources as breather vents and new oil addition. It is also a good way to detect wear being generated by the lube oil pump. For systems without pressure-side, in-line filters, pressurized line sampling helps in assessing the cleanliness of the oil being fed to the components. For systems with in-line filters, it provides the background against which filter performance is assessed or evaluated. For wet-sump circulating systems that don't allow drain line sampling, this is the preferred sampling location for primary trending.

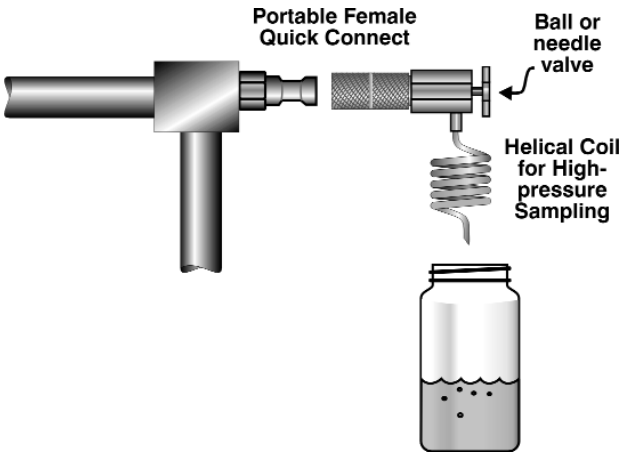
The table below provides the relative applicability and value of pressurized-line sampling for various machine types. This method is superior to any tank or sump sampling method.

Lubrication System or Machine Type	Pressurized-Line Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Gear System	NA
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Best
Hydraulic System	Best
Compressor	Best
Large Circulating System	Less Desirable
Crankcase Lubrication	Best

The table rates the quality and applicability of this sampling method to various machine types.

Material Requirements for Obtaining a Sample

- A certified clean capped sample container.
- A larger flushing container.
- A pressure reducing device comprised of a female quick-connect adapter coupled to a suitable ball or needle valve fitted with a length of tubing formed into a helical coil that produces a pressure drop. **CONFIRM THAT THE HELICAL COIL'S LENGTH RELATIVE TO ITS INTERNAL DIAMETER IS SUFFICIENT TO DROP THE PRESSURE TO BELOW 300 PSI GIVEN THE SYSTEM'S OPERATING PRESSURE AND THE FLUID'S VISCOSITY AT OPERATING TEMPERATURE.**
- Bottle label and any other required documentation that will accompany the sample.
- Appropriate shipping container(s) if the sample(s) is (are) to be sent to an outside laboratory.



Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust cover from the male quick-connect installed on the machine.
8. Remove the pressure-reducing device from its storage container, remove its dust-caps and clean if required.
9. Attach the pressure-reducing device by mating its female quick-connect to the male quick-connect installed on the machine.
10. Carefully open the sample valve to induce flow.
11. Flush the port with a volume of at least five, preferably 10 times, the dead-space volume in the pipe-stem, port-extension, etc. into a disposal bottle or pail.
12. Remove the lid from the sample bottle taking care not to touch the inside surface of the bottle or lid. Do not remove the lid until ready to fill the sample bottle.
13. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
14. Once filled, close the sample valve and re-cap the bottle immediately, making sure a good tight fit is achieved.
15. Disconnect the pressure-reducing device.
16. Inspect the male quick-connect to make sure that a tight, leak free seal is achieved and replace its dust-cap.
17. Wipe-down the pressure-reducing device, replace the dust-caps on the quick-connect opening and on the end of the helical coil, and return it to its storage container.
18. Dispose of the flushing fluid properly. Do not return it to the operating machine.
19. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
20. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
21. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment and ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Debris generated by components is often diluted by the fluid in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Information from debris generated by components may settle in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Particles tend to settle in low velocity flow return lines.
- High velocity flow return lines tend to experience particle "fly-by" unless the sampling valve is located properly.
- An off-line filter may remove particles that are generated by components or ingested into the sump or tank, causing a falsely low reading.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Check system pressure making certain the valves and adapters used for high pressure sampling are rated to withstand the maximum pressure generated by the machine.

- FLUID UNDER HIGH PRESSURE IS DANGEROUS. BE CERTAIN THAT THE PRESSURE REDUCING DEVICE IS IN GOOD WORKING ORDER AND ADEQUALTELY DESIGNED TO SAFELY REDUCE THE SYSTEM'S PRESSURE TO BELOW 300 PSI WHEN THE FLUID IS AT OPERATING TEMPERATURE.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high-quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent on sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones "on the run".
- Flush upstream of filters and downstream of components to assess the machine's condition.
- Install testing sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

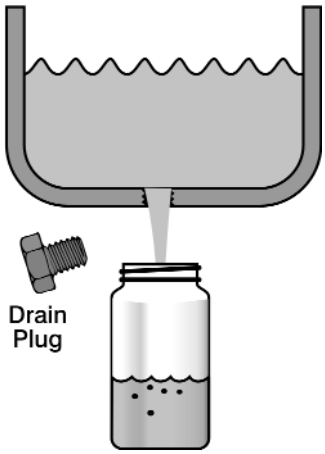
Drain-Port Sampling

CTP-S-005

Drain-port sampling involves the removal of tank and sump drain plugs so that a sufficient quantity of oil can gravitate and drain into a sample container. Once the sample has been obtained, the plug is threaded back into the port. In some cases, an equal amount of makeup fluid must be added to the sump to make up for the fluid loss. In large tanks, a ball valve often replaces the use of a pipe plug and serves as the tank drain.

Material Requirements for Obtaining a Sample

- An appropriate hand-wrench to extract the pipe plug from the port.
- A certified, clean, capped sample container.
- A larger flushing container.
- Bottle label and any other required documentation that will accompany the sample.
- Appropriate shipping container(s) if the sample(s) is (are) to be sent to an outside laboratory.



Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the drain plug.
8. Flush the plug with a volume of at least three times the dead-space volume in the pipe-stem, port-extension, etc. into a disposal bottle or pail.
9. Remove the lid from the sample bottle taking care not to touch the inside surface of the bottle or lid. Do not remove the lid until ready to fill the sample bottle.
10. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
11. Once filled, recap the bottle immediately, making sure a good tight fit is achieved.
12. Resecure the drain port plug, making sure that a tight, leak-free seal is achieved.

13. Dispose of the flushing fluid properly. Do not return it to the operating machine. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
14. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
15. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment.
16. Ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- If the sample is removed from the bottom of a tank, there is a possibility of obtaining a high particle concentration as a result of sedimentation.
- If a sample is taken from the main body of the fluid after machine shutdown, a particle concentration that is too low may be obtained due to settling of the debris.

Lubrication System or Machine Type	Drain-Port Sampling
Bath-Lubricated Plain Bearings	Less Desirable
Ring-Lubricated Plain Bearings	Less Desirable
Gear System	Less Desirable
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Less Desirable
Hydraulic System	Less Desirable
Compressor	Less Desirable
Large Circulating System	Less Desirable
Crankcase Lubrication	Less Desirable

The table rates the quality and applicability of this sampling method to various machine types.

- There are convection currents in the fluid medium. On shutdown, many machines are hotter than the ambient temperature. This results in convective stirring of the oil, thus delaying the particle settling.
- Most wear particles are not spherical in shape. They generally have a larger projected area-to-weight ratio than spherical particles. Consequently, the particles sink more slowly than spherical particles of the same weight.
- Wear particles are frequently enveloped by a gel. These gels, which have densities comparable to the oil, lower the effective density and cause the particles to sink more slowly than they otherwise would.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality can not be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent upon sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environment conditions.
- Sample from live zones "on the run".
- Flush upstream of filters and downstream of components to assess the machine's condition.
- Install sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

Drain-Port Vacuum Sampling

CTP-S-006

Drain-port vacuum sampling involves drawing a sample from a permanent sampling fixture or port instead of a tube being lowered into the tank or sump. It requires the installation of the sampling port such as a minimess in place of the drain plug. The minimess should be fitted with a tube to extend the sampling device up from the bottom of the sump or reservoir. A vacuum sampling device is used to pull the sample into the bottle. This method has distinct advantages over most other methods used for sampling tanks, sumps and static containers.

The primary benefit is that samples can be pulled from strategically selected locations in the tank or sump. These locations are generally selected to avoid unrepresentative amounts of water and debris found on the sump's bottom from entering the sample bottle. Additionally, because a test port is used, the awkward requirement of removing fill ports, vents or drain plugs is avoided.

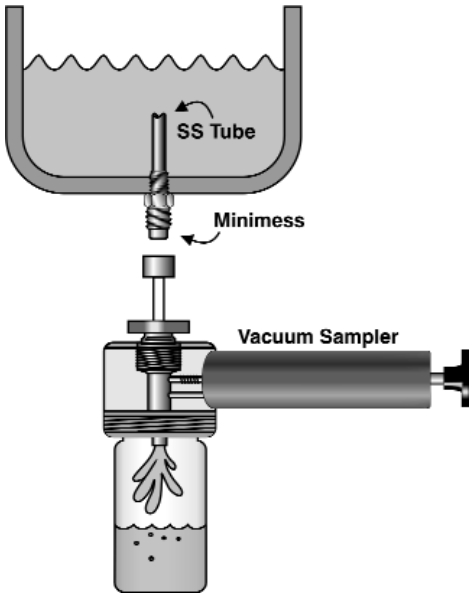
Also, unlike drop tube sampling and drain plug sampling, vacuum sampling from a port can be accomplished by a single technician. All of these advantages distinctly increase of integrity and viability of an oil analysis program. The figure below illustrates the sampling location and general extraction method.

Material Requirements for Obtaining a Sample

- A suitable vacuum pump for sampling oil is required. The vacuum pump should be enclosed in a durable zip-lock bag except duringuse.
- A static sampler adapter with which to attach the vacuum pump to the minimess port. The adapter should be enclosed in a durable zip-lock bag except during use.

Lubrication System or Machine Type	Drain-Port Vacuum Sampling
Bath-Lubricated Plain Bearings	Best
Ring-Lubricated Plain Bearings	Best
Gear System	Best
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Best
Hydraulic System	Less Desirable
Compressor	Good
Large Circulating System	Less Desirable
Crankcase Lubrication	Good

The table rates the quality and applicability of this sampling method to various machine types.



- A spare container for collecting the flushing fluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag prior to entering the plant or field area for sampling. All the sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.
- A coil of plastic polyethylene tubing, as used by the sampling pump, placed in a large zip-lock plastic bag.
- A suitable knife to cut the tube.
- Bottle label(s) and any other documentation that will accompany the sample(s).

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust cover from the sampling port.
8. Inspect the opening of the minimess port to ensure that no debris has collected.
9. Clean the minimess port if required.
10. Cut the tube to an acceptable length (no longer than necessary) while it is still in the plastic bag, being careful not to contaminate the ends of the tubing. The end to be placed in the sample pump should be cut at a 45 degree angle.
11. Place one end into the vacuum pump such that at least one-half inch will protrude into the bottle cavity.
12. Secure the end of the tube cut at an angle into the pump head such that a proper seal is achieved.
13. Insert the other end of the tube into the static sampler adapter.
14. Thread the flushing bottle tightly onto the vacuum pump.
15. Attach the sample adapter to the sample port securely being careful not to contaminate the probe end of the adapter or the opening of the sample port.
16. Actuate the pump to vacuum out approximately 100 ml into the flushing bottle in order to adequately flush the tube of pre-existing debris. For long sections of tube the flushing volume should be increased.
17. Once the flush is complete remove the flushing bottle.
18. Remove the bottle cap from the sample bottle without opening the plastic bag.
19. Once the cap is removed the bottle opening is threaded into the pump cavity through the plastic bag allowing the plastic tube that protrudes from the pump to puncture the bag while the bottle and cap remain in the sealed bag.
20. Tighten the bottle sufficiently to accomplish an air-tight seal. (If a seal cannot be obtained, use a lighter weight plastic bag.)
21. Actuate the pump to draw the sample into the bottle while keeping the sample bottle in an upright position. Occasionally, it is best for two people to sample the oil using this method. One person operates the vacuum pump while the other holds and directs the tube to the correct location within the tank or sump.
22. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
23. Once the bottle has been filled, unthread it from the vacuum pump.
24. Without opening the plastic bag, thread the cap back onto the bottle securely.
25. Remove the bottle from the zip-lock bag.
26. Remove the plastic tubing from the static sampler adapter and the vacuum pump.
27. Dispose of the plastic tubing. DO NOT REUSE.
28. Wipe down the static sampler adapter and the place at which the vacuum pump interfaces with the sample bottle with a new lint-free cloth. Dispose of the used wipe-down cloth.
29. Return the static sampler adapter and vacuum pump to their zip-lock bag to avoid contamination.
30. Dispose of the flushing fluid properly. Do not return

it to the operating machine.

31. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
32. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
33. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment and ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Failure to ensure that the machine is sampled during operation, or the same time after shutdown, each time.
- Contaminating the sample during handling.
- In circulating systems, failure to locate minimess port downstream of ingestion points.
- Contamination of the plastic tubing.
- Contamination from the vacuum pump.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality can not be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent on sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

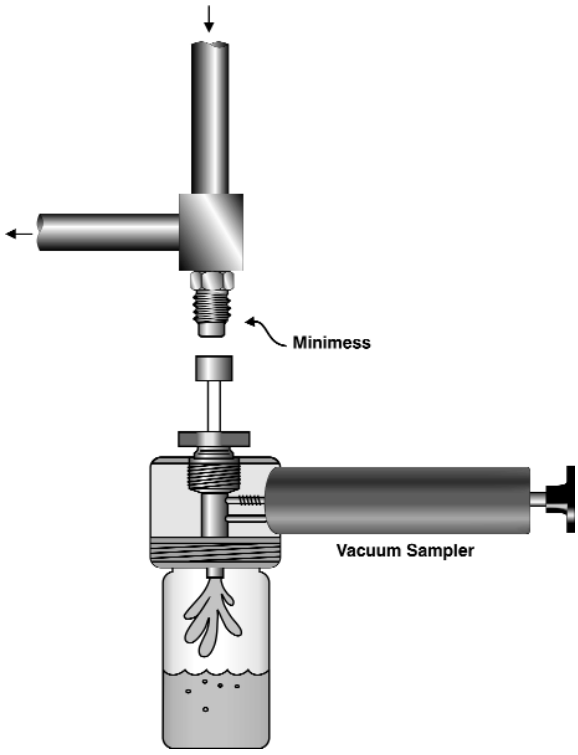
Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environment conditions.
- Sample from live zones “on the run”.
- Flush upstream of filters and downstream of components to assess the machine’s condition.
- Install testing sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to “time normalize” the data
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

Drain-Line Vacuum Sampling

CTP-S-007

Sampling from the common return line yields excellent information about the overall health of the operating components and the system as a whole. In the sampling scheme, this should be the primary point from which samples are drawn on a compressor or other rotating equipment with a circulating lubrication system. This sample allows effective analysis of the oil, the machine's health and the machine contamination ingress levels. The figure below highlights the primary return line sample location.



Material Requirements

- A suitable vacuum pump for sampling oil is required. The vacuum pump should be enclosed in a durable zip-lock bag, except during use.
- A static sampler adapter with which to attach the vacuum pump to the minimess port. The adapter should be enclosed in a durable zip-lock bag, except during use.
- A spare container for collecting the flushing fluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag prior to entering the plant or field area for sampling. All the sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.
- A coil of plastic polyethylene tubing, as used by the sampling pump, placed in a large zip-lock plastic bag.
- A suitable knife to cut the tube.
- Bottle label(s) and any other documentation that will accompany the sample(s).

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.

5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust cover from the sampling port.
8. Inspect the opening of the minimess port to ensure that no debris has collected.
9. Clean the minimess port if required.
10. Cut the tube to an acceptable length (no longer than necessary) while it is still in the plastic bag, being careful not to contaminate the ends of the tubing. The end to be placed in the sample pump should be cut at a 45 degree angle.
11. Place one end into the vacuum pump such that at least one-half inch will protrude into the bottle cavity.
12. Secure the end of the tube cut at an angle into the pump head such that a proper seal is achieved.
13. Insert the other end of the tube into the static sampler adapter.
14. Thread the flushing bottle tightly onto the vacuum pump.
15. Attach the sample adapter to the sample port securely being careful not to contaminate the probe end of the adapter or the opening of the sample port.
16. Actuate the pump to vacuum out approximately 100 ml into the flushing bottle in order to adequately flush the tube of pre-existing debris. For long sections of tube the flushing volume should be increased.

Lubrication System or Machine Type	Drain-Line Vacuum Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Gear System	NA
Circulating System - Dry Sump	Best
Circulating System - Wet Sump	NA
Hydraulic System	Best
Compressor	Best
Large Circulating System	Best
Engines	NA

The table rates the quality and applicability of this sampling method to various machine types.

17. Once the flush is complete remove the flushing bottle.
18. Remove the bottle cap from the sample bottle without opening the plastic bag.
19. Once the cap is removed the bottle opening is threaded into the pump cavity through the plastic bag allowing the plastic tube that protrudes from the pump to puncture the bag while the bottle and cap remain in the sealed bag.
20. Tighten the bottle sufficiently to accomplish an air-tight seal. (If a seal cannot be obtained, use a lighter weight plastic bag.)
21. Actuate the pump to draw the sample into the bottle while keeping the sample bottle in an upright position. Occasionally, it is best for two people to sample the oil using this method. One person operates the vacuum pump while the other holds and directs the tube to the correct location within the tank or sump.
22. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
23. Once the bottle has been filled, unthread it from the vacuum pump.
24. Without opening the plastic bag, thread the cap back onto the bottle securely.
25. Remove the bottle from the zip-lock bag.
26. Remove the plastic tubing from the static sampler adapter and the vacuum pump.
27. Dispose of the plastic tubing. DO NOT REUSE.
28. Wipe down the static sampler adapter and the place at which the vacuum pump interfaces with the sample bottle with a new lint-free cloth. Dispose of the used wipe-down cloth.
29. Return the static sampler adapter and vacuum pump to their zip-lock bag to avoid contamination.
30. Dispose of the flushing fluid properly. Do not return it to the operating machine.
31. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.

- Note any abnormalities associated with the machine, filter or operating conditions.
- If the machine has an hour meter, note hours of operation.

32. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
33. If on-site testing reveals a problem, test individual component return lines to localize the problem's source.
34. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment.
35. Ship the bottle to the lab within 24 hours of drawing the sample.
36. If lab analysis reveals a problem, collect samples from individual return lines and submit them to the lab to localize the problem's source.

Potential Sources of Interference

- Without specific component return line sample valves, it is difficult to ascertain which component(s) is (are) generating or ingesting debris.
- Particles tend to settle in low velocity flow return lines.
- High velocity flow return lines tend to experience particle "fly-by" unless sampling valves is located properly.
- A pressure side filter interferes with assessment of reservoir ingest levels.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality can not be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent on sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones "on the run".
- Flush upstream of filters and downstream of components to assess the machine's condition.
- Install testing sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

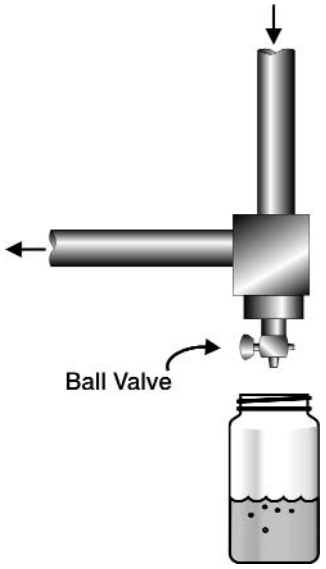
Drain-Line Tap Sampling

CTP-S-008

Sampling from the common return line yields excellent information about the overall health of the operating components and the system as a whole. In the sampling scheme, this should be the primary point from which samples are drawn on equipment with a circulating lubrication system with a return to the sump or reservoir. This sample allows effective analysis of the oil, the machine's health and the machine contamination ingress levels. The figure below highlights the primary return line sample location.

Material Requirements

- A certified, clean, capped sample container.
- A larger container for collecting the flushing fluid.
- A ball valve installed in the appropriate location on the drain-line of the machine.
- Bottle label and any other documentation that will accompany the sample.



- Appropriate shipping container if the sample is to be sent to an outside laboratory

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust-cap (where applicable) from the sample valve and it to induce flow.
8. Flush the valve with a volume of at least five times, preferably 10 times, the dead-space volume in the pipe-stem, port-extension, etc., into a disposal bottle or pail.
9. Remove the lid from the sample bottle taking care not to touch the inside surface of the bottle or lid. Do not remove the lid until ready to fill the sample bottle.
10. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.

11. Once filled, close the sample valve and re-cap the bottle immediately, making sure that the cap fits tightly on the bottle.
12. Inspect the sample valve to make sure that a tight, leak-free seal is achieved and replace the cap where applicable.
13. Dispose of the flushing fluid properly. Do not return it to the operating machine.
14. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
15. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
16. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment and ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Without specific component return line sample valves, it is difficult to ascertain which component(s) is (are) generating or ingesting debris.

Lubrication System or Machine Type	Drain-Line Tap Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Gear System	NA
Circulating System - Dry Sump	Best
Circulating System - Wet Sump	NA
Hydraulic System	Best
Compressor	Best
Large Circulating System	Best
Engines	NA

The table rates the quality and applicability of this sampling method to various machine types.

- Particles tend to settle in low velocity flow return lines.
- High velocity flow return lines tend to experience particle "fly-by" unless sampling valves is located properly.
- A pressure side filter interferes with assessment of reservoir ingest levels.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
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General Tips on Sampling

The importance of oil sample quality can not be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

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Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones “on the run”.
- Flush upstream of filters and downstream of components to assess the machine’s condition.
- Install sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to “time normalize” the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

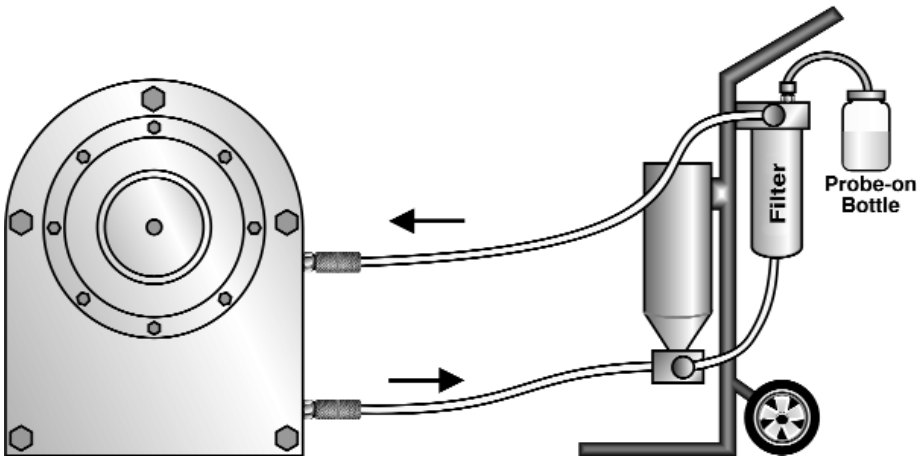
Portable Off-Line Sampling

CTP-S-009

Portable off-line sampling serves two purposes. First, it is an excellent sampling method for machines that don't offer return-line sampling such as gearboxes, engines and other wet-sump type systems. Also, once the sample is drawn, the system can be used to filter or condition the oil if the circulating system is equipped for that job.

Material Requirements

- A portable filtration or fluid conditioning system designed to work at a flow rate appropriate for the fluid and a system that is fitted with appropriate quick-connects (usually female) with which to attach to the tank or sump. The tank or sump must also be fitted with compatible, opposite sex quick connects (usually male) on the fill and drain points. Ideally, diffusers are installed in the sump or reservoir to minimize aeration.
- A suitable bottle lid adapter for sampling pressurized oil systems enclosed in a durable zip-lock bag, except during use.
- A spare container for collecting the flushing fluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag prior to entering the plant or field area for sampling. All the contained sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.
- A bottle label and any other documentation that will accompany the sample. Sampling ports, called minimess valves, must be installed at suitable locations on the portable filtration/conditioning system. Ideal locations are in turbulent fluid areas of the pipe where at least 10 psi pressure exists.
- Disposable probe-on type sample port adapters with 12 inches of polyethylene plastic tubing cut at a 45 degree angle on the exposed end stored in a large zip-lock sandwich bag until needed; or a reusable probe-on adapter and a coil of polyethylene plastic tubing.
- A suitable knife for cutting the plastic tubing.
- A helical coil type pressure reducer for systems exceeding 300 psi.



Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. With the portable filtration/conditioning system filled with the oil in the tank/sump, attach the suction line to the quick connect installed on the drain line.
8. Attach the return line from the portable filtration/conditioning system to the quick connect installed on the fill-port of the tank or sump.
9. Open any protective gate or ball valves installed in series with the quick connects on the fill and drain ports of the tank or sump.
10. If a filter bypass exists on the portable system, open it to bypass the filters.
11. Engage the portable filtration/conditioning system and let it run for several minutes to homogenize the fluid.
12. Remove the dust cover from the sampling port.

Lubrication System or Machine Type	Portable Off-Line Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Splash-Lubricated System	Good
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Good
Hydraulic System	Less Desirable
Compressor	NA
Large Circulating System	Less Desirable
Engines	NA

The table rates the quality and applicability of this sampling method to various machine types.

13. Inspect the opening of the minimess port to ensure that no debris has collected.
14. Clean the minimess port if required.
15. If a reusable probe-on type adapter is used:
    - Cut 12 inches of plastic tubing, cut one end at a 445-degree angle.
    - Remove the reusable probe-on type adapter from the plastic bag.
    - Attach the blunt end of the plastic tube to the probe-on adapter.
16. If a disposable probe-on type adapter is used, remove it from the zip-lock sandwich bag.
17. Remove the bottle adapter from its plastic bag and attach the end of the tube cut at a 45 degree angle.
18. Securely attach the bottle adapter to the flushing bottle, being careful not to contaminate either end of the tubing.
19. Push or thread the probe-on type adapter onto the test port to initiate flow into the flushing bottle.
20. Flush approximately 100 ml of fluid from the test port, or a volume equal to at least three times the dead space.
21. Stop the flow of oil into the flushing bottle by removing the probe-on type adapter from the sampling port.
22. Once the flush is complete, carefully unthread the probe lid adapter from the flushing bottle taking care not to contaminate the lid adapter or plastic tubing.
23. Thread a sample bottle onto the probe adapter. This is accomplished by removing the bottle cap from the sample bottle without opening the plastic bag. Once the cap is remove, the bottle opening is threaded into the probe adapter lid through the plastic bag - with the bottle and cap still in the bag and the bag remaining sealed. During this process, the tube that protrudes through the adapter lid will rupture the bag as the bottle is being threaded onto the probe. Tighten the bottle enough to ensure a sufficient seal. Using a clean pointed object, puncture the bag below the vent hole in the probe adapter cap space.
24. Push or thread the probe-on type adapter onto the test port to initiate flow into the sample bottle. Always hold the sample bottle in an upright position.

25. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
26. Stop the flow of oil into the sample bottle by removing the probe-on type adapter from the sampling port.
27. Unthread the probe adapter lid from the sample bottle.
28. Without opening the plastic bag, thread the original cap back onto the bottle securely.
29. Remove the sample bottle from the plastic bag.
30. Return the sampling adapter to its plastic zip-lock storage bag to avoid contamination.
31. Thread the dust cover back onto the sampling port.
32. Engage the filters as required by closing the filter bypass. Filter the fluid as required.
33. When filtration is complete, disengage the pump on the portable filtration/conditioning system.
34. Disconnect the fill and drain port quick connects.
35. Close gate or ball valves installed in series with the quick connect on the fill and drain ports.
36. Dispose of the flushing fluid properly. Do not return it to the operating machine.
37. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
38. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
39. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment.
40. Ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Information about debris generated by components is often diluted by the fluid in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Information from debris generated by components may settle in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Particles tend to settle in low velocity flow return lines.
- High velocity flow return lines tend to experience particle "fly-by" unless the sampling valve is located properly.
- An off-line filter may remove particles that are generated by components or ingested into the sump or tank, causing a falsely low reading.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- When using this method in potentially hazardous areas, be sure the filtration/conditioning system complies with NEC classification requirements.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Check system pressure. If greater than 300 psi, a helical pressure-reducing coil must be used.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes into contact with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent on sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones "onthe run".
- omp

Flush upstream of filters and downstream of components to assess themachine's condition.

- Install sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at properfrequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples tothe maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

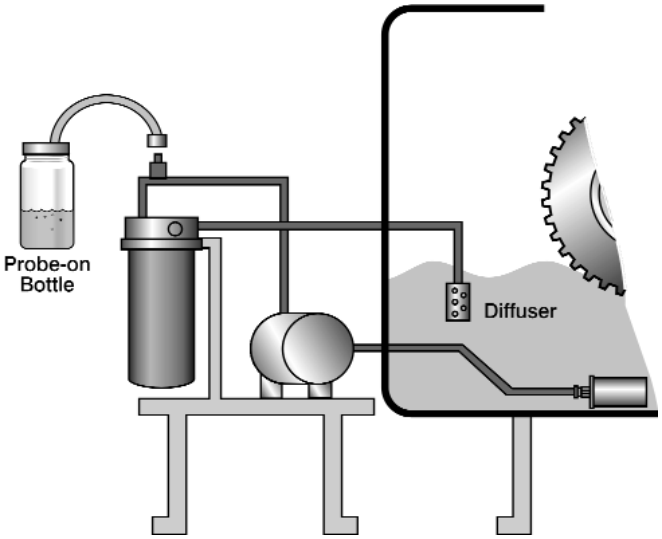
Dedicated Off-Line Sampling

CTP-S-010

Dedicated off-line sampling serves multiple purposes. It provides effective detection of dirt ingestion through breathers, seals or with new oil, and the abnormal generation of machine wear particles. Comparing readings before and after the filter provides the analyst a quick assessment of the filter's performance. This is an excellent sampling method for machines that don't offer return-line sampling such as gearboxes, engines and other wet-sump type systems. The figure below graphically identifies the sample location.

Material Requirements

- A suitable bottle lid adapter for sampling pressurized oil systems enclosed in a durable zip-lock bag, except during use.
- A spare container for collecting the flushing fluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag prior to entering the plant or field area for sampling. All the contained sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.
- A bottle label and any other documentation that will accompany the sample. Sampling ports, called minimess valves, must be installed at suitable locations on pressurized feed lines. Ideal locations are in turbulent fluid areas of the pipe where at least 10 psi pressure exists.
- Disposable probe-on type sample port adapters with a 12 inches of polyethylene plastic tubing cut at a 45 degree angle on the exposed end stored in a large zip-lock sandwich bag until needed; or a reusable probe-on adapter and a coil of polyethylene plastic tubing.
- A suitable knife for cutting the plastic tubing.
- A helical coil type pressure reducer for systems exceeding 300 psi.



Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.

6. Confirm correct test point location.
7. Remove the dust cover from the sampling port.
8. Inspect the opening of the minimess port to ensure that no debris hascollected.
9. Clean the minimess port ifrequired.
10. If a reusable probe-on type adapter is used:
    - Cut 12 inches of plastic tubing, one end cut at a 45-degree angle.
    - Remove the reusable probe-on typeadapter from the plastic bag.
    - Attach the blunt end of the plastic tube to the probe-on adapter.
11. If a disposable probe-on type adapter is used, remove it from thezip-lock sandwich bag.
12. Remove the bottle adapter from its plastic bag and attach theend of the tube cut at a 45-degree angle.
13. Securely attach the bottle adapter to the flushing bottle, being careful not to contaminate either end of the tubing.
14. Push or thread the probe-on type adapter onto the test port to initiate flow into the flushing bottle.
15. Flush approximately 100 ml of fluidfrom the test port, or a volume equal to at least three times the deadspace.
16. Stop the flow of oil into the flushing bottle by removing the probe-on type adapter from the sampling port.

Lubrication System or Machine Type	Dedicated Off-Lin Sampling
Bath-Lubricated Plain Bearings	NA
Ring-Lubricated Plain Bearings	NA
Gear System	Best
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Best
Hydraulic System	Less Desirable
Compressor	NA
Large Circulating System	Less Desirable
Crankcase Lubrication	NA

The table rates the quality and applicability of this sampling method to various machine types.

17. Once the flush is complete, carefully unthread the probe lid adapter from the flushing bottle taking care not to contaminate the lid adapter or plastic tubing.
18. Thread a sample bottle onto the probe adapter. This is accomplished by removing the bottle cap from the sample bottle without opening the plastic bag. Once the cap is removed, the bottle opening is threaded into the probe adapter lid through the plastic bag - with the bottle and cap still in the bag and the bag remaining sealed. During this process, the tube that protrudes through the adapter lid will rupture the bag as the bottle is being threaded onto the probe. Tighten the bottle enough to ensure a sufficient seal. Using a clean pointed object, puncture the bag below the vent hole in the probe adapter cap space.
19. Push or thread the probe-on type adapter onto the test port to initiate flow into the sample bottle. Always hold the sample bottle in an upright position.
20. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
21. Stop the flow of oil into the sample bottle by removing the probe-on type adapter from the sampling port.
22. Unthread the probe adapter lid from the sample bottle.
23. Without opening the plastic bag, thread theoriginal cap back onto the bottle securely.
24. Remove the sample bottle from the plastic bag.
25. Return the sampling adapter to its plastic zip-lock storage bag toavoid contamination.
26. Thread the dust cover back onto the sampling port.
27. Dispose of the flushing fluid properly. Do not return itto the operating machine.
28. Complete or verify all required documentation to accompany the sample, including the following:
    - If pre-printed labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.

29. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
30. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment.
31. Ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Information about debris generated by components is often diluted by the fluid in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Debris generated by components may settle in the tank or sump, and thus, may not be detected, causing a falsely low reading.
- Particles tend to settle in low velocity flow return lines.
- High velocity flow return lines tend to experience particle "fly-by" unless the sampling valve is located properly.
- An off-line filter may remove particles that are generated by components or ingested into the sump or tank, causing a falsely low reading.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Check system pressure. If greater than 300 psi, a helical pressure-reducing coil must be used.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contacts with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent upon sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

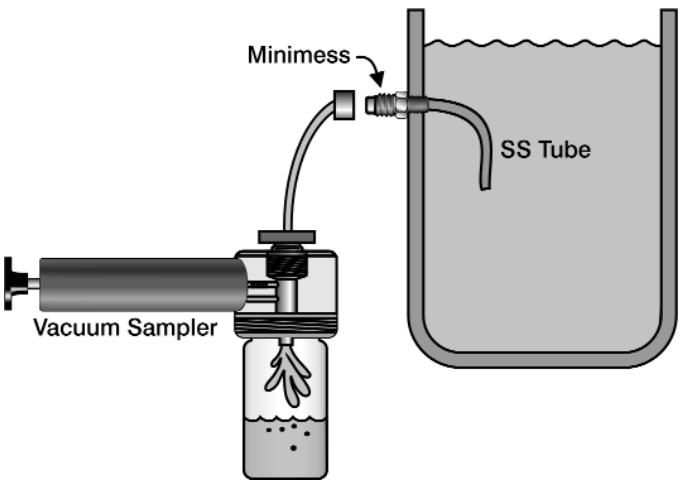
Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones "on the run".
- Flush upstream of filters and downstream of components to assess the machine's condition.
- Install sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

Probe-On Vacuum Sampling

CTP-S-011

Probe-on vacuum sampling involves drawing a sample from a permanent sampling fixture or port instead of a tube being lowered into the tank or sump. It requires the installation of the sampling port, which may involve drilling and tapping into the side of bearing housings and gear casings. A vacuum sampling device is used to pull the sample into the bottle. This method has distinct advantages over most other methods used for sampling tanks, sumps and static containers. The primary benefit is that samples can be pulled from strategically selected locations in the tank or sump. These locations are generally selected to avoid unrepresentative amounts of water and debris found on the sump's bottom from entering the sample bottle. Additionally, because a test port is used, the awkward requirement of removing fill ports, vents or drain plugs is avoided. Also, unlike drop tube sampling and drain plug sampling, vacuum sampling from a port can be accomplished by a single technician. All of these advantages distinctly increase of integrity and viability of an oil analysis program. The figure below illustrates the sampling location and general extraction method.



The table below provides the relative applicability and value of probe-on vacuum sampling for various machine types. This method is superior to any tank or sump sampling method.

Material Requirements for Obtaining a Sample

- A suitable vacuum pump for sampling oil is required. The vacuum pump should be enclosed in a durable zip-lock bag except during use.
- A static sampler adapter with which to attach the vacuum pump to the minimess port. The adapter should be enclosed in a durable zip-lock bag except during use.
- A spare container for collecting the flushing fluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag prior to entering

Lubrication System or Machine Type	Probe-On Vacuum Sampling
Bath-Lubricated Plain Bearings	Best
Ring-Lubricated Plain Bearings	Best
Gear System	Best
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Best
Hydraulic System	Less Desirable
Compressor	Good
Large Circulating System	Less Desirable
Crankcase Lubrication	Good

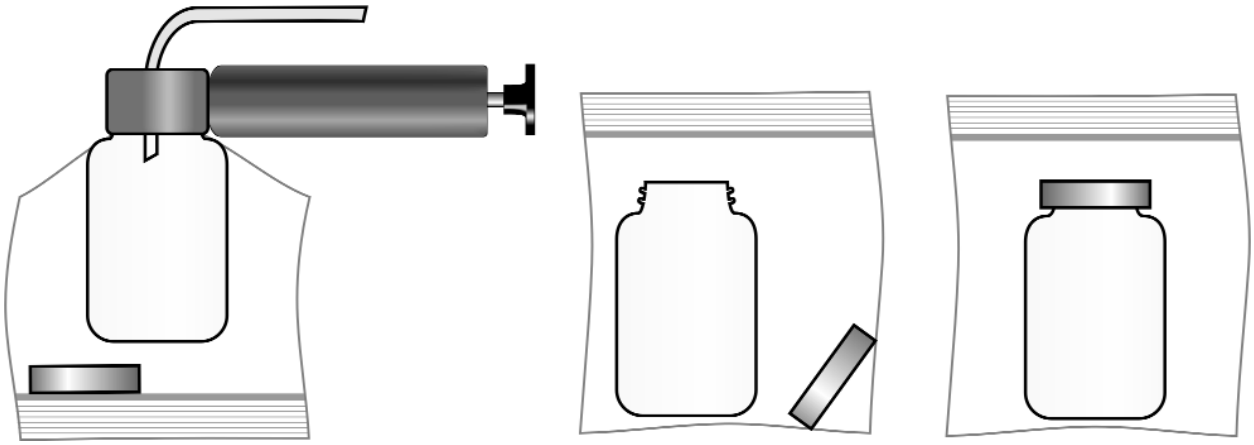
The table rates the quality and applicability of this sampling method to various machine types.

the plant or field area for sampling. All the sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.

- A coil of plastic polyethylene tubing, as used by the sampling pump, placed in a large zip-lock plastic bag.
- A suitable knife to cut the tube.
- Bottle label(s) and any other documentation that will accompany the sample(s).

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.
7. Remove the dust cover from the sampling port.
8. Inspect the opening of the minimess port to ensure that no debris has collected.
9. Clean the minimess port if required.
10. Cut the tube to an acceptable length (no longer than necessary) while it is still in the plastic bag, being careful not to contaminate the ends of the tubing. The end to be placed in the sample pump should be cut at a 45 degree angle.
11. Place one end into the vacuum pump such that at least one-half inch will protrude into the bottle cavity.
12. Secure the end of the tube cut at an angle into the pump head such that a proper seal is achieved.
13. Insert the other end of the tube into the static sampler adapter.
14. Thread the flushing bottle tightly onto the vacuum pump.
15. Attach the sample adapter to the sample port securely being careful not to contaminate the probe end of the adapter or the opening of the sample port.
16. Actuate the pump to vacuum out approximately 100 ml into the flushing bottle in order to adequately flush the tube of pre-existing debris. For long sections of tube the flushing volume should be increased.
17. Once the flush is complete remove the flushing bottle.
18. Remove the bottle cap from the sample bottle without opening the plastic bag.
19. Once the cap is removed the bottle opening is threaded into the pump cavity through the plastic bag allowing the plastic tube that protrudes from the pump to puncture the bag while the bottle and cap remain in the sealed bag (see figure below).
20. Tighten the bottle sufficiently to accomplish an air-tight seal. (If a seal cannot be obtained, use a lighter weight plastic bag.)
21. Actuate the pump to draw the sample into the bottle while keeping the sample bottle in an upright



position. Occasionally, it is best for two people to sample the oil using this method. One person operates the vacuum pump while the other holds and directs the tube to the correct location within the tank or sump.

22. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
23. Once the bottle has been filled, unthread it from the vacuum pump.
24. Without opening the plastic bag, thread the cap back onto the bottle securely.
25. Remove the bottle from the zip-lock bag.
26. Remove the plastic tubing from the static sampler adapter and the vacuum pump.
27. Dispose of the plastic tubing. DO NOT REUSE.
28. Wipe down the static sampler adapter and the place at which the vacuum pump interfaces with the sample bottle with a new lint-free cloth. Dispose of the used wipe-down cloth.
29. Return the static sampler adapter and vacuum pump to their zip-lock bag to avoid contamination.
30. Dispose of the flushing fluid properly. Do not return it to the operating machine.
31. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
32. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
33. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment.
34. Ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Failure to ensure that the machine is sampled during operation, or the same time after shutdown, each time.
- Contaminating the sample during handling.
- In circulating systems, failure to locate minimess port downstream of ingestion points.
- Contamination of the plastic tubing.
- Contamination from the vacuum pump.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent on sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environmental conditions.
- Sample from live zones "on the run".
- Flush upstream of filters and downstream of components to assess the machine's condition.
- Install sampling hardware that minimizes interference and allows samples to be drawn from the same place each time.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at proper frequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples to the maintenance decision process.
- Train staff on the deployment of effective sampling procedures.

Drop-Tube Vacuum Sampling

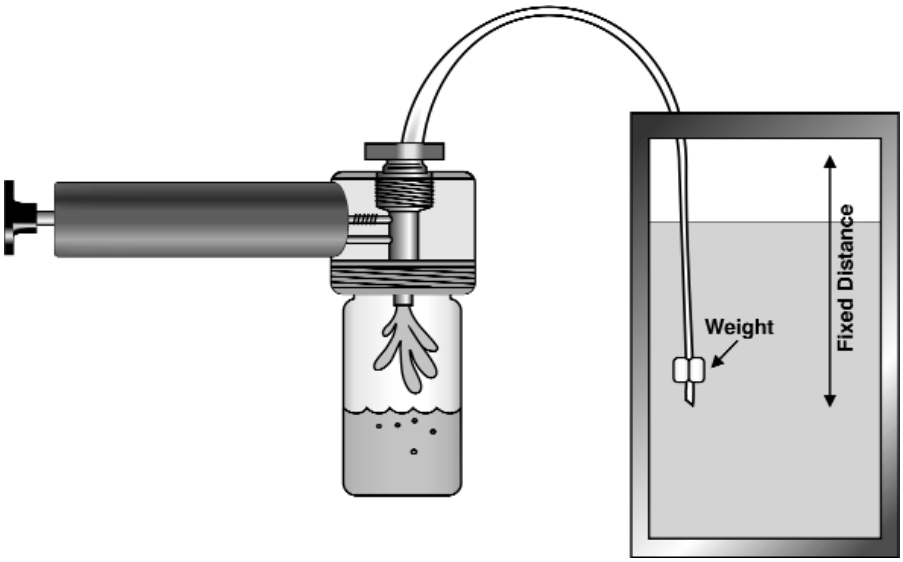
CTP-S-012

Drop tube vacuum pump sampling is one of the most common methods of sampling static tanks and sumps. Its popularity stems from the fact that access to sumps is universally available through fill ports and dip-stick openings. No special permanently installed hardware is needed. The process involves using a commercially available vacuum hand pump attached to a polyethylene tube. The tube is inserted into the tank opening and into the oil gallery. A specimen amount of oil can then be extracted by vacuum into the bottle. The advantage of drop tube vacuum pump sampling is that a sample can be obtained from most equipment without installing special sampling valves and otherhardware.

The figure below illustrates the sample location and extraction method.

Material Requirements for Obtaining a Sample

- A suitable vacuum pump for sampling oil is required. The vacuum pump should be enclosed in a durable zip-lock bag except duringuse.
- A hand-wrench to remove the tank fill port plug or vent where applicable.
- A spare container for collecting the flushingfluid.
- A sample bottle that is capped and placed in a sealed, light-weight, zip-lock sandwich bag prior to entering the plant or field area for sampling. All the sample bottles should be placed into a large zip-lock plastic bag so the smaller bottle bags do not contact dirty surfaces.



- A coil of plastic polyethylene tubing, as used by the sampling pump, placed in a large zip-lock plastic bag.
- A suitable knife to cut the tube.
- Bottle label(s) and any other documentation that will accompany the sample(s).
- Tube weighting material (where required).
- Dip-stick and wire twisties (where required).

Sampling Procedure

1. Draw sample during normal operation or within 10 minutes of shutdown.
2. If a cold sample must be drawn, note the fact on the sample documentation.
3. Check the lube level prior to sampling to confirm it is at the required level.
4. Watch the lube level during sampling to ensure that lubrication starvation is avoided, especially on small sumps.
5. Confirm correct machine identification.
6. Confirm correct test point location.

Do not lower the tube into machine compartments where there is mechanical movement such as gears, bearings, cams, pistons or shafts (Refer also to NFPA standard T2.9.9-1976).

7. Remove plug or cover to the fill port, vent, breather or other opening through which the sample will be drawn.

Lubrication System or Machine Type	Drop-Tube Vacuu Sampling
Bath-Lubricated Plain Bearings	Avoid
Ring-Lubricated Plain Bearings	Avoid
Gear System	Avoid
Circulating System - Dry Sump	Less Desirable
Circulating System - Wet Sump	Less Desirable
Hydraulic System	Less Desirable
Compressor	NA
Large Circulating System	Less Desirable
Engines	Less Desirable

The table rates the quality and applicability of this sampling method to various machine types.

8. Place the cap, vent, etc. facing upward onto a surface where it will not be in contact with dust or other contamination during sampling.
9. Cut the tube at 45 degree angles on both ends to an acceptable length (no longer than necessary) while it is still in the plastic bag, being careful not to contaminate the ends of the tubing.
10. Place one end of the plastic tube into the vacuum pump such that at least one-half inch will protrude into the bottle cavity.
11. Secure the tube into the pump head such that a proper seal is achieved. Thread the flushing bottle tightly onto the vacuum pump.
12. Direct the other end of the tube into the machine compartment opening to a measured distance that is halfway into the tank or sump. If possible, direct the tube end near return-line openings for circulating tanks. In bath lubricated systems, direct the tube end to high agitation areas of the oil compartment. In all cases, avoid sampling from static zones, sump/tank bottoms or top oil layer, and along container walls.
13. If required, attach a weight to the end of the tube and measure the amount of drop into the oil.
14. Also, if required, the tube can be attached to a dip-stick using a wire twisty and then lowered into the tank to a fixed distance, taking care not to contaminate the tank or sump.
15. Sample consistently from the same point in the tank or sump to ensure good trending of data.
16. With the tube inserted into the tank, actuate the pump to vacuum out approximately 200 ml into the flushing bottle in order to adequately flush the tube of pre-existing debris. For long sections of tube, the flushing volume should be increased.
17. Once the flush is complete, remove the flushing bottle.
18. Remove the bottle cap from the sample bottle without opening the plastic bag.
19. Once the cap is removed the bottle opening is threaded into the pump cavity through the plastic bag allowing the plastic tube that protrudes from the pump to puncture the bag while the bottle and cap remain in the sealed bag.
20. Tighten the bottle sufficiently to accomplish an air-tight seal. (If a seal cannot be obtained, use a lighter weight plastic bag.)

21. Actuate the pump to draw the sample into the bottle while keeping the sample bottle in an upright position. Occasionally, it is best for two people to sample the oil using this method. One person operates the vacuum pump while the other holds and directs the tube to the correct location within the tank or sump.
22. Fill the sample bottle to the following level:
    - One-half full for fluids > 150 cSt @ 40°C.
    - Two-thirds full for fluids > 68 cSt @ 40° C and < 150 cSt @ 40° C.
    - Three-fourths full for fluids < 68 cSt @ 40°C.
23. Once the bottle has been filled, unthread it from the vacuum pump.
24. Without opening the plastic bag, thread the cap back onto the bottle securely.
25. Remove the bottle from the zip-lock bag.
26. Remove the tube from the tank or sump.
27. Securely reattach the cap or vent breather to the tank or sump.
28. Remove the plastic tube from vacuum pump.
29. Dispose of the plastic tubing. DO NOT REUSE.
30. Wipe down the vacuum pump where it interfaces with the sample bottle with a new lint-free cloth. Dispose of the used wipe-down cloth.
31. Return the vacuum pump to its zip-lock bag to avoid contamination.
32. Dispose of the flushing fluid properly. Do not return it to the operating machine.
33. Complete or verify all required documentation to accompany the sample, including the following:
    - If preprinted labels are used, be sure the correct label is affixed to the correct bottle.
    - Note any abnormalities associated with the sampling procedure.
    - Note any abnormalities associated with the machine, filter or operating conditions.
    - If the machine has an hour meter, note hours of operation.
34. If the sample is being tested onsite, refer to testing procedures and analyze immediately.
35. If the sample is being sent to a lab for testing, appropriately package the bottle for shipment.
36. Ship the bottle to the lab within 24 hours of drawing the sample.

Potential Sources of Interference

- Failure to ensure that the sample is drawn from the same point each time due to variable distance into the tank or sump.
- Failure to ensure that the sample is drawn from the same point each time due to the drop tube coiling up, in or out.
- Failure to ensure that the machine is sampled during operation, or the same time after shutdown, each time.
- Scraping side-wall deposits into the drop tube when entering the tank or sump.
- Picking up bottom sediment and water.
- Contaminating the sample during handling.
- In circulating systems, failure to obtain live samples downstream of ingestion points.
- Contamination of the plastic tubing.
- Contamination from the vacuum pump.

Safety Considerations

- Conform to all safety requirements specified by plant policy.
- Check lube temperature prior to sampling. If greater than 50° C, use appropriate thermal insulation material to protect hands.
- Wear protective eyewear.
- Wear latex gloves to protect hands. Confirm chemical compatibility between lubricant and the glove material.
- Wash any skin that comes in contact with the lubricant immediately with a high quality industrial hand cleaner and plenty of water.
- Should any lubricant get into the eye, seek immediate medical care.
- Should any lubricant be ingested, seek immediate medical care.

General Tips on Sampling

The importance of oil sample quality cannot be

overstated. Poor samples lead to poor decisions to act or not to act based upon false positive or negative oil analysis readings.

Some oil properties are generally homogenous and relatively unaffected by sample locations. They include:

- Viscosity
- Neutralization number
- FTIR for oxidation, sulfation, nitration and additive levels

Other properties are dependent upon sample location. Those include:

- Particle count
- Moisture levels
- Wear levels

Some general sampling guidelines for drawing samples include:

- Sample while operating under normal application and environment conditions.
- Sample from live zones “onthe run”.
- Flush upstream of filters and downstream of components to assess the machine'scondition.
- Install testing sampling hardware that minimizes interference and allows samples to be drawn from the same place eachtime.
- Flush sampling ports effectively to reach the fluid of interest.
- Use procedures that maximizes data quality and consistency and minimizes procedural noise and interference.
- Use clean bottles and tubing where required.
- Sample at properfrequency.
- Record sampling hours to "time normalize" the data.
- Analyze or send the sample to the lab immediately.
- Educate staff about the importance of high-quality oil samples tothe maintenance decision process.
- Train staff on the deployment of effective sampling procedures.