



AMCOL CORPORATION

CONDITION MONITORING TEST PROCEDURES AND REPORTING

GENERAL OVERVIEW

CONDITION MONITORING AT AMCOL



- AMCOL offers a variety of no cost services and test procedures used to assess process conditions in order to determine future action plans.
- Results on a given sample should be considered only a spot view and not necessarily the everyday conditions.
- Unexpected results are most often followed up with further and more detailed testing.

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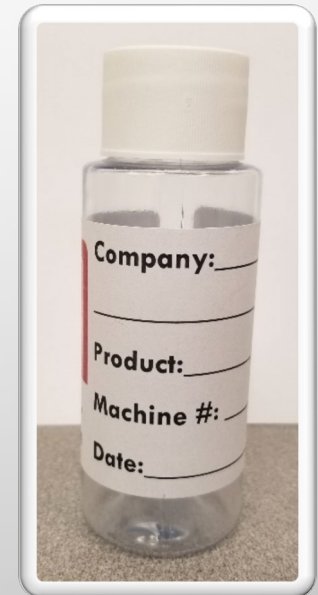
Acting and Reacting

General Commentary
Corrective Actions

SUBMITTING SAMPLES FOR TESTING

RETRIEVING AND LABELING

- Pre-labeled bottles are available from AMCOL.
- Container size is based on test procedures.
 - 2oz & 8oz
- Proper care should be given to ensure the sample is taken from the coolant output nozzle when possible.
- Be sure the label is completed legibly and accurately.



SUBMITTING SAMPLES FOR TESTING

TRANSPORT AND LOGISTICS



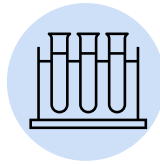
- Samples generally are considered acceptable to transport by UPS or other small parcel delivery services.
- Samples are shipped to AMCOL CORPORATION, 21435 DEQUINDRE, HAZEL PARK, MI, USA, 48030. Send to the attention of “QUALITY ASSURANCE TESTING”.

IN-USE COOLANT TESTING

GENERAL INFORMATION

- There are standard tests and more specialized procedures performed to monitor the condition of the coolant.
- The results provide a snapshot of the conditions at an exact time and with regular testing establish baseline conditions for long-term planning.
- Test results are reported with ideal conditions also noted as a benchmark standard.

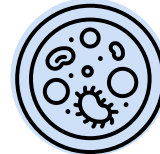
IN-USE COOLANT TESTING STANDARD PROCEDURES



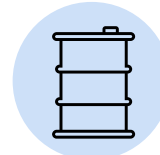
Dilution



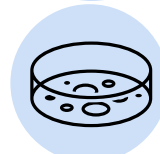
pH



Bacteria & Fungi



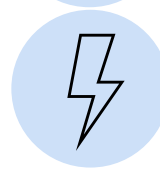
Percent Tramp Oil



Cast Iron Chip Resistance (CIC)



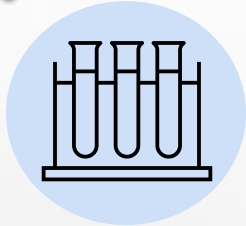
Galvanized Corrosion Resistance (G70)



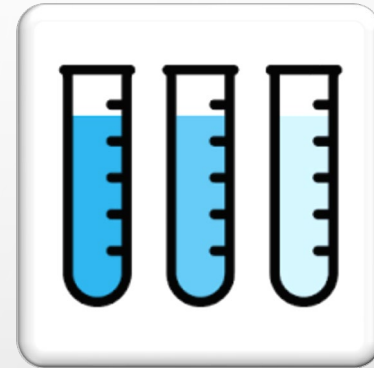
Conductivity

STANDARD PROCEDURES

DILUTION

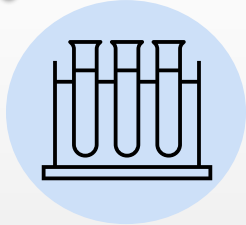


- A digital refractometer is used to determine the ratio of diluting water to coolant concentrate in the sample.
- A digital readout number is cross referenced to determine concentration.
- In the lab, a logarithmic calculation automatically calculates the reported number.
- There are also charts and graphs that can be used for this same determination.



REFRACTOMETER READING

DILUTION CORRELATION



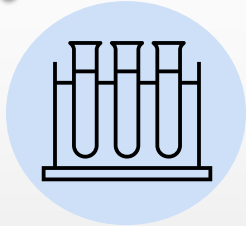
- Each product has a corresponding dilution correlation chart that is unique to that exact product. Simply match the refractometer reading to the dilution.

Typical Refractometer Correlation Chart

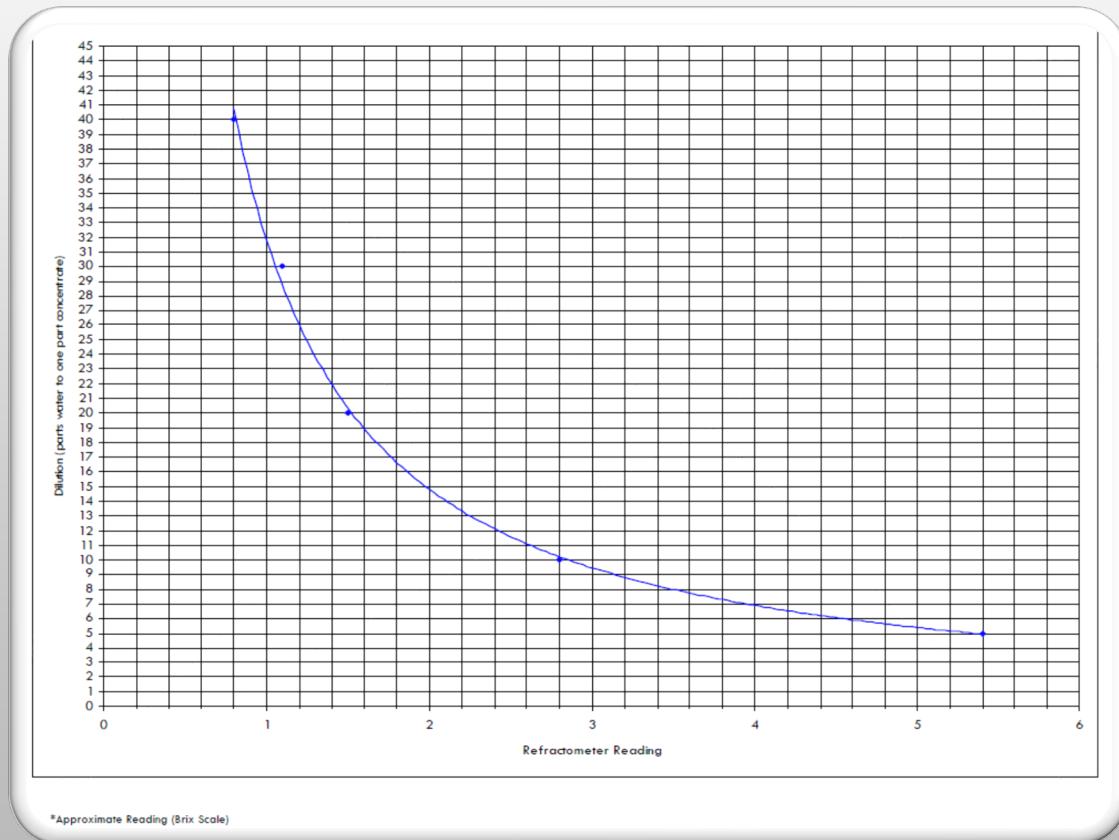
Reading*	Dilution	% 2200 GT (M10)
0.8	40:1	2.4
1.1	30:1	3.2
1.5	20:1	4.8
1.6	19:1	5.0
1.7	18:1	5.3
1.8	17:1	5.6
1.9	16:1	5.9
2.0	15:1	6.3
2.1	14:1	6.7

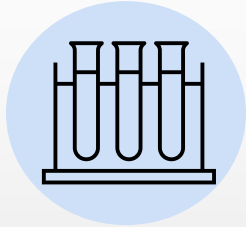
Reading*	Dilution	% 2200 GT (M10)
2.2 - 2.3	13:1	7.1
2.4 - 2.5	12:1	7.7
2.6 - 2.7	11:1	8.3
2.8 - 2.9	10:1	9.1
3.0 - 3.3	9:1	10.0
3.4 - 3.7	8:1	11.1
3.8 - 4.2	7:1	12.5
4.3 - 4.9	6:1	14.3
5.0 - 5.8	5:1	16.7

REFRACTOMETER READING DILUTION CORRELATION



- Refractometer readings can also be cross referenced on a correlation graph.
- These graphs are logarithmic. As with any logarithmic graph, a formula can be used to match the reading with dilution. This is how dilutions are determined in the lab.





INTERPRETING THE RESULTS

DILUTION

- Dilution is the ratio of coolant concentrate to diluting water.
- Dilution is likely the single most important result. Yet by the time it is reported, it has likely changed.
- If you are unable to consistently maintain proper dilution, a fluid proportioning device is recommended. AMCOL recommends a water-powered chemical proportioner from Dosatron; for more information, contact your AMCOL representative.
- Ideal dilution for in-use coolant is 8:1 – 12:1.

STANDARD PROCEDURES

pH



- A digital meter is used to measure pH.
- Probes are calibrated daily and replaced monthly.
- Unusual results outside of the expected norm are confirmed using test strips.



INTERPRETING THE RESULTS

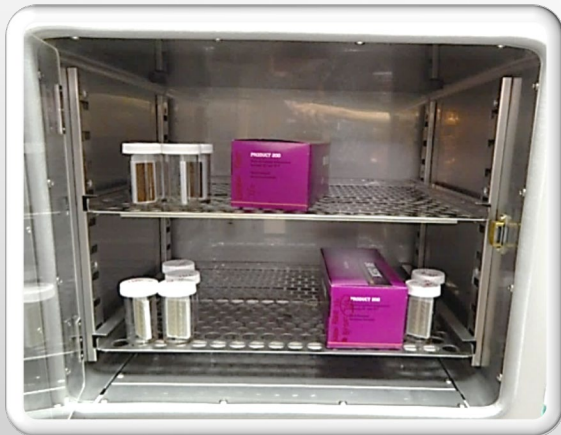
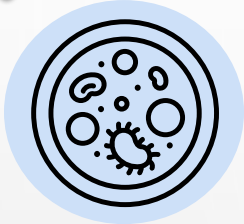
pH



- pH is the measure of free acid concentration in the solution.
- A pH above 7 is referred to as alkaline where the concentration of free acid is near zero.
- Acids are generally corrosive to most metals.
- AMCOL coolants contain special additives designed to maintain a stable alkaline pH of around 9.0.
- pH is affected by the introduction of acids or acidic compounds and so a pH result below the expected norm should be cause for concern; this is especially true when the results are repeated and trending lower.
- Ideal pH for in-use coolant is 8.90 - 9.40.

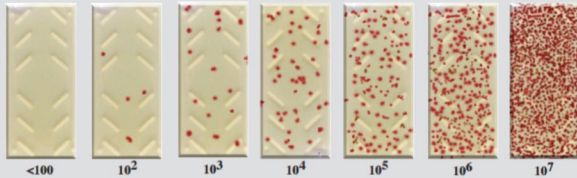
STANDARD PROCEDURES

BACTERIA & FUNGI

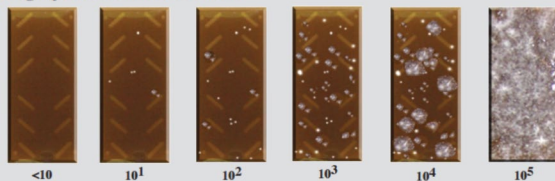


- A small volume of the in-use coolant is extracted with a pipette and slowly poured on a B/F test strip and subsequently placed in an incubator for approximately two days at 30°C.
- The results are cross referenced to a visual aid; results are reported as 0 to 10E7 where “E” indicates an exponent.

Bacteria cfu / ml



Fungi (yeast & mold) cfu / ml





INTERPRETING THE RESULTS

BACTERIA

- Bacteria is generally introduced from the diluting water source or some other coolant contaminant.
- There are additives in AMCOL coolants designed to resist bacteria growth when the coolant is maintained at the recommended dilution ratio.
- In high concentrations, bacteria can degrade coolant additives and affect corrosion protection and lubrication performance.
- There are tankside additives that are used to kill bacteria.
- Contaminants that introduce bacteria contamination should be minimized or eliminated.



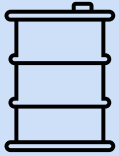
INTERPRETING THE RESULTS

FUNGI

- Fungi can propagate in the coolant as a mass or solid that can inhibit coolant flow throughout the process.
- Fungi can also degrade coolant additives, leading to reduced coolant rust protection and lubrication performance.
- Fungi can be present and observable in the process coolant and not necessarily show positive results in condition monitoring tests. This is especially true when there are areas where coolant flow is limited.
- Fungi should be treated with tank-side additives and any limited flow areas vacuumed or shoveled and disposed.

STANDARD PROCEDURES

TRAMP OIL



- A visual inspection is completed on the sample submitted to determine the amount of oil that has collected on top.
- Samples are left motionless for at least 12 hours to allow the oil to rise to the top and coalesce.



STANDARD PROCEDURES

TRAMP OIL RESULTS



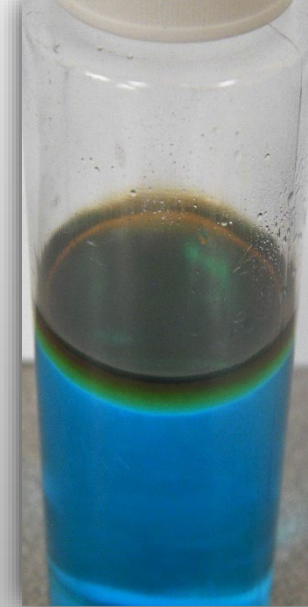
0% = No tramp oil.



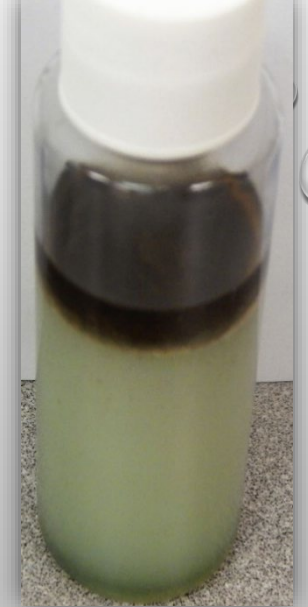
0.1% = Oil is visible around the edges but doesn't form a layer on top.



0.3% = Oil is visible around the edges and is starting to form a layer.



0.5% = A thin layer of oil covers the top of the sample.



1%+ = A thick layer of oil covers the top of the sample.



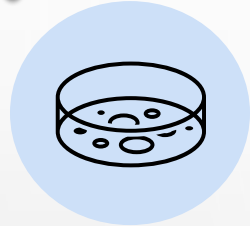
INTERPRETING THE RESULTS

TRAMP OIL

- Tramp oil is a contaminant that enters the coolant from protective oils that are on the metals or from overuse and/or leaking machine oils.
- Tramp oils are a food source for bacteria and potentially affect lubrication properties of the coolant.
- Tramp oils can be skimmed manually or automatically where they collect.
- Any source of excessive tramp oil should be identified and reduced where possible.
- Ideal result for tramp oil is $<0.5\%$.

STANDARD PROCEDURES

CAST IRON CHIP (CIC)

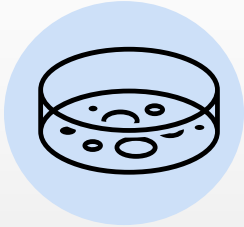


- In this test, coolant is dispensed using a pipette onto a pile of clean dry cast iron chips that are placed on a piece of steel.
- Excess coolant is absorbed with a paper tissue and the sample is placed in a sealed chamber for approximately two days.
- Water is put in a petri dish at the bottom of the chamber to create a humid environment.
- The hygrometer on the chamber typically reads 70% or higher.



STANDARD PROCEDURES

CIC RESULTS



1 = No Corrosion



1.5 = One spot to 20% corroded



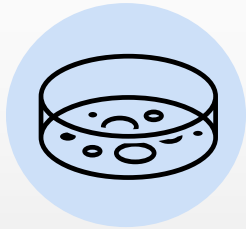
2 = 20% to 40% corroded



3 = 40% to 80% corroded



4 = 80%+ corroded



INTERPRETING THE RESULTS

CAST IRON CHIP (CIC)

- The cast iron chip test is an evaluation of the coolants ability to either inhibit or cause corrosion.
- The expected result for the CIC test should be a “1”.
- An infrequent result of “1.5” can be considered an anomaly in this very sensitive test.
- The cause for a repeating result of “1.5” or higher should be identified and eliminated.
- A dilution ratio that is too high will likely cause a “1.5” result or worse.
- Coolant contaminants from the diluting water, bacteria, fungi, process metals, tramp oils, and others should be considered when attempting to identify possible causes.
- Ideal result for cast iron chip test is a “1”.

STANDARD PROCEDURES

GALVANIZED CORROSION RESISTANCE



In this test, the in-use coolant is dispensed onto a galvanized steel coupon; a cold rolled steel coupon is placed on top, and the fluid is entrapped. After approximately two days, the coupons are opened, and any interaction is observed. The result range is from A to D.



A = No Interaction



A/B = Minimal



B = Slight



C = Moderate



D = Severe



INTERPRETING THE RESULTS GALVANIZED CORROSION (G70)

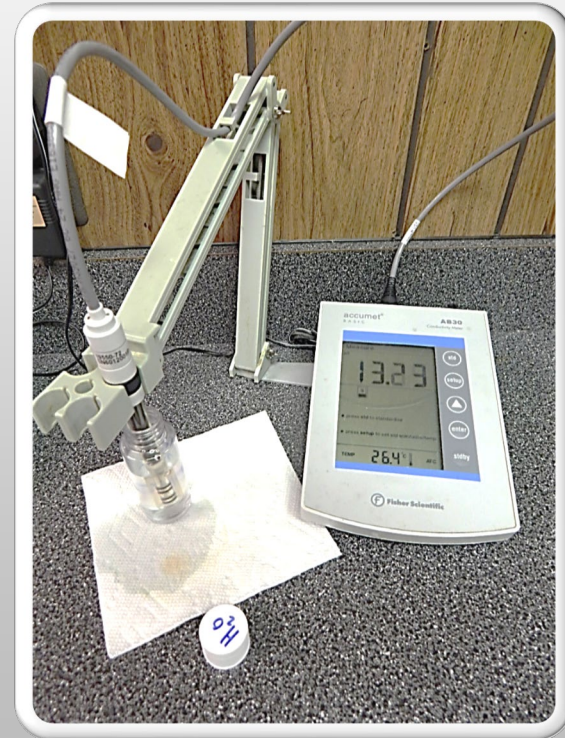
- This identifies abnormal conditions with the coolant that cause interaction with galvanized steels.
- It is a very sensitive test, and an “A/B” result is likely on an irregular basis.
- The same conditions that tend to affect cast iron chip results tend to also affect the galvanized stain test results.
- Ideal result for galvanized corrosion test is an “A”.

STANDARD PROCEDURES

CONDUCTIVITY



- A digital meter is used determine conductivity.
- Probes are calibrated daily and replaced monthly.
- The unit for reporting results is millisiemens (mS).





INTERPRETING THE RESULTS

CONDUCTIVITY

- Conductivity is a measurement of dissolved ions in the solution.
- Coolant concentration will affect conductivity.
- Contaminants in diluting water also cause elevated conductivity results.
- Other sources from processed metals can also cause an elevated conductivity.
- Ideal conductivity for in-use coolants <math><3.50\text{ mS}</math>.

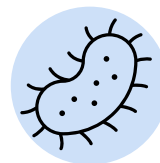
**IN-USE COOLANT
TESTING**
SPECIALIZED PROCEDURES



Chloride Concentration



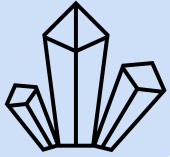
Filterable Solids



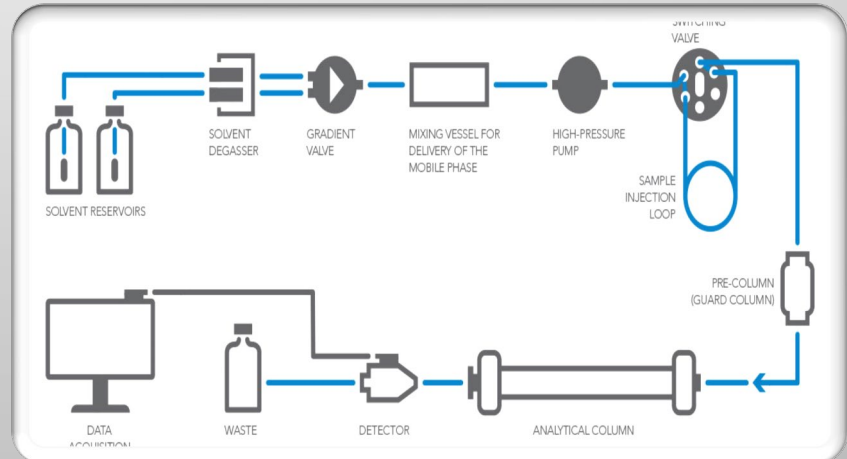
Luminometer (Bacteria & Fungi)

SPECIALIZED TESTING

CHLORIDE CONCENTRATION



- Ion Chromatography (IC) is used to determine the chloride ion content.
- Using this very delicate instrument, a small volume of liquid is injected into a chamber and processed.
- Chloride ion concentration is then determined based the instrument output.





INTERPRETING THE RESULTS

CHLORIDE

- Elevated chloride concentrations in the coolant could shorten the expected shelf life of tubes in storage and transit.
- The primary source for chlorides in the coolant is the diluting water.
- Chloride concentration can only be reduced by adding purified water to the coolant or recharging the coolant system.
- Ideal chloride content for in-use coolants is <300 ppm.

SPECIALIZED TESTING

FILTERABLE SOLIDS



- The in-use coolant is mixed and then vacuum filtered at 0.7 micron.
- The solids are dried, and the mass of the solids is measured and compared to the mass of the initial in-use coolant to then calculate the ppm of filterable solids in the solution.
- Requires at least an 8oz sample bottle.



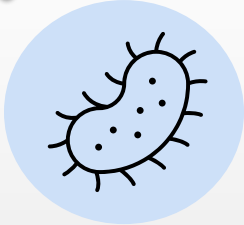
INTERPRETING THE RESULTS

FILTERABLE SOLIDS

- Filterable solids are primarily introduced from the surface of the steel being produced or process coatings that contaminate the coolant.
- Filterable solids affect your finished product cleanliness, machine and tool life, and in some cases the expected shelf life of the part.
- As the name implies, filterable solids are removed using various methods that include baffles, strainers, filters, and other mechanical devices.
- The size, weight, and volume of filterable solids entering the coolant will determine how they are removed.
- Ideal results <1000 ppm.

SPECIALIZED TESTING

LUMINOMETER



- In urgent situations we can determine the presence of bacteria & fungi in a sample within 15 minutes.
- The Luminometer measures the amount of light produced which is directly proportionate to the amount of ATP in the sample.
- This method is approximately 85% accurate compared to the B/F test slides and occasionally gives false negative results.



COOLANT STATUS REPORT (CSR)



Test results are reported on a standardized form called a Coolant Status Report or CSR.



Each CSR shows the current sample as well as any samples processed in the last two months.



Results that are outside of the ideal parameters are highlighted in red on the CSR.



CSRs are typically emailed as a PDF.



An example of a Coolant Status Report follows.



AMCOL Corporation

Metalworking Fluid Systems

helping industry meet ecological criteria since 1902

Customer Name and Location:

AMCOL Contact:

cc:

Mill	Date Taken	Product	Dilution	pH	Bacteria Level	Fungi Level	% Tramp Oil	CIC	G70	Conductivity	Chloride (ppm)	Filterable Solids
<i>Ideal</i>	<i>N/A</i>	<i>2200 LX (M1)</i>	<i>8:1-12:1</i>	<i>8.9-9.4</i>	<i>0</i>	<i>0</i>	<i><0.5</i>	<i>1</i>	<i>A</i>	<i><3.50</i>	<i><300</i>	<i><1000</i>
1	9/8/2016	2200 LX (M1)	8:1	9.40	10E3	10E4	0.1	1	A	2.86	35	436
1	8/24/2016	2200 LX (M1)	12:1	9.35	0	0	0.1	1	A	2.12	12	278
1	8/9/2016	2200 LX (M1)	15:1	9.15	0	0	0.1	1	A	2.17	20	349
1	8/4/2016	2200 LX (M1)	20:1	9.05	0	0	0.1	1	A	2.17	34	1073
1	7/27/2016	2200 LX (M1)	12:1	9.30	0	0	0.1	1	A/B	2.54	52	1333
3	9/8/2016	2200 LX (M1)	8:1	9.35	0	10E2	0.1	1	A	2.77	41	448
3	8/24/2016	2200 LX (M1)	7:1	9.25	0	10E2	0.1	1	A	3.13	16	1899
3	8/9/2016	2200 LX (M1)	8:1	9.20	0	0	0.1	1.5	A	3.08	51	1469
3	8/4/2016	2200 LX (M1)	11:1	9.20	0	10E3	0.1	1	A	2.65	34	1468
3	7/27/2016	2200 LX (M1)	6:1	9.40	0	0	0.1	1	A	2.96	62	2101
4	9/8/2016	2200 LX (M1)	9:1	9.20	10E3	10E4	0.1	1.5	A	2.90	103	<50
4	8/24/2016	2200 LX (M1)	8:1	9.15	0	0	0.1	1.5	A	3.40	26	811
4	8/9/2016	2200 LX (M1)	9:1	9.10	10E3	0	0	1	A	3.13	71	130
4	8/4/2016	2200 LX (M1)	13:1	9.15	0	0	0.1	1	A	2.45	37	822
4	7/27/2016	2200 LX (M1)	10:1	9.30	0	0	0.1	1	A	3.81	88	933

QUALITY MANAGEMENT

SAMPLE DATABASE



Samples submitted for testing immediately begin processing.



There is a data entry and labeling system that is used throughout the process to label each sample and record the results.

QUALITY MANAGEMENT

CONDITION MONITORING FOR COOLANTS



- Upon completion of all test procedures, the remaining fluid is retained for future reference.
- These samples are retained so that any questionable result can be reviewed at a later date.



QUALITY MANAGEMENT INSTRUMENTAL CALIBRATION



PS03 Calibration or Inspection Record Directory: Product Specifications Last Saved By: AA-0009	Form	Page 1 of 2 Last Update: 6/10/2016 Status: Approved for Use
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Scope: This document is used to record calibration, inspection, and/or verification of equipment used by AMCOL Personnel.

Procedure:

1. Record name and date when beginning the use of this document.
2. Complete form as needed.
3. When the document becomes either full or otherwise damaged, forward the original document to Product Manager to be filed.

Recording of Data:

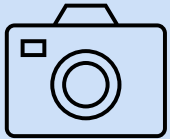
Initiated by: _____ On this date: _____

Date and Time	Equipment or Instrument	Completed by	Reference Procedure	Comments

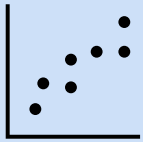
- AMCOL is ISO 9001 certified. As such, instruments are calibrated daily, and the results recorded and posted.

ACTING & REACTING

GENERAL COMMENTARY



Just a Snapshot – The results of condition monitoring tests are used to determine future action plans. Keep in mind that the results of these tests are reported days after the sample is taken and offer only a snapshot of existing conditions.



Look More at Trends – Testing should be completed on a regular basis in order to determine trends and establish future action plans. The cause of repeated test results that are outside the ideal parameters should be investigated and action taken.

ACTING & REACTING

CORRECTIVE ACTIONS



Set a Time – Samples should be submitted on a regular basis. It is recommended that one individual is given the responsibility to retrieve and submit samples. These tests should be completed regularly and often, it is easiest to set a date and time when this is to happen.



Act on the Results – As mentioned earlier, repeating results that are outside of the expected norm should be addressed. Often, these results are inter-relational and so dealing with one problem may address others.



AMCOL CORPORATION

APQ IS ABSOLUTELY, POSITIVELY, QUALITY

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