



COOLANT COMPOSITION AND FUNCTION						
<b>Conventional Coolant Components</b> Ethylene/Propylene Glycol <ul style="list-style-type: none"> <li>• Freeze Point Suppression</li> <li>• Boil Point Elevation</li> </ul> Phosphate <ul style="list-style-type: none"> <li>• Iron Protection</li> <li>• pH Control</li> </ul> Borate <ul style="list-style-type: none"> <li>• Iron Protection</li> <li>• pH Control</li> </ul> Silicate <ul style="list-style-type: none"> <li>• Aluminum Corrosion Protection</li> </ul> Nitrite <ul style="list-style-type: none"> <li>• Cast Iron and Steel Protection</li> </ul> Nitrate <ul style="list-style-type: none"> <li>• Aluminum and Solder Corrosion Protection</li> </ul> Mercaptobenzothiazole (MBT) and Tolytriazole (TT) <ul style="list-style-type: none"> <li>• Copper and Brass Protection</li> </ul> Block Polymers <ul style="list-style-type: none"> <li>• Defoamant</li> <li>• Scale and Deposit Control</li> </ul>		<b>Extended Life Coolant Components</b> Ethylene Glycol <ul style="list-style-type: none"> <li>• Freeze Point Suppression &amp; Boil Point Elevation</li> </ul> Potassium Soap of Dibasic Carboxylic Acid <ul style="list-style-type: none"> <li>• Iron, Solder and Aluminum Protection</li> </ul> Potassium Soap of Monobasic Carboxylic Acid <ul style="list-style-type: none"> <li>• Aluminum and Iron (w/sebacate) Protection</li> </ul> Nitrite <ul style="list-style-type: none"> <li>• Cast Iron and Steel Protection</li> </ul> Molybdate <ul style="list-style-type: none"> <li>• Iron Corrosion Protection (w/nitrite)</li> </ul> Tolytriazole <ul style="list-style-type: none"> <li>• Copper Corrosion Protection</li> </ul> Modified Silicone Defoamant <ul style="list-style-type: none"> <li>• Defoamant</li> </ul>				
<p><i>NOTE: Be sure to check your supplemental coolant additive and glycol levels at every oil change to ensure proper protection. Coolant should be tested immediately if there is a drop in SCA levels.</i></p>						
COOLANT MAINTENANCE						
Visual Appearance						
<b>Color</b> <ul style="list-style-type: none"> <li>• should be clear and bright</li> </ul> <b>Oil in Coolant</b> <ul style="list-style-type: none"> <li>• free from oil or petroleum products (can cause seal failures)</li> </ul> <b>Non-Magnetic/Magnetic Precipitate</b> <ul style="list-style-type: none"> <li>• free from precipitate, flocculent, algae, bacteria, and/or sludge (outside contaminants entering the system or coolant chemical dropout); magnetic precipitate should be a trace or less</li> </ul>		<b>PROBABLE CAUSE</b> oil cooler rubber seal or core leaks; combustion gas blow-by into the coolant  improper coolant use, air leaks, defective electrical grounds		<b>POTENTIAL DAMAGE</b> loss of heat transfer, liner and water pump seal damage, block head water passage seal damage  water pump seal abrasion, increased soft metal corrosion (copper & aluminum), liner pitting around lower seals		
<p><i>NOTE: Sample appearance alone does not determine whether a potentially harmful problem exists within the cooling system.</i></p>						
Antifreeze/Glycol %						
	RECOMMENDATIONS	PROBABLE CAUSE	POTENTIAL DAMAGE			
Too Low	<ul style="list-style-type: none"> <li>• Antifreeze level will vary by application and elevation at which the system operates</li> <li>• Engines operating at 195° or above must be at 50% for boil point control</li> </ul>	<ul style="list-style-type: none"> <li>• Improper mixing of bulk coolant</li> <li>• Topping off with water only</li> </ul>	<ul style="list-style-type: none"> <li>• Coolant may boil or the block may freeze</li> <li>• Can cause cavitation and/or corrosion damage</li> </ul>			
Too High	<ul style="list-style-type: none"> <li>• Engines operating at 5000 ft. and above should maintain a 55-60% antifreeze level to prevent coolant boiling</li> <li>• Marine applications must maintain 50-60% antifreeze if the system operates above 195°</li> </ul>	<ul style="list-style-type: none"> <li>• Improper mixing of bulk coolant</li> <li>• Topping off with glycol concentrate</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of heat transfer</li> <li>• Cavitation</li> <li>• Pitted liners</li> <li>• Seals may fail</li> </ul>			
pH						
	RECOMMENDATIONS	PROBABLE CAUSE	POTENTIAL DAMAGE			
Too Low	<ul style="list-style-type: none"> <li>• Conventional Coolant: 8.5 to 11</li> <li>• ELC Formulation: typically 7.0 to 8.5; if pH is above 9.0, possible ELC and conventional coolant mixing</li> <li>• Correct cause of drop in pH</li> </ul>	<ul style="list-style-type: none"> <li>• Coolant is plain water</li> <li>• Source water does not meet engine manufacturer specifications</li> <li>• Ethylene glycol is beginning to decompose</li> <li>• Coolant is burnt</li> <li>• Combustion gas leak</li> <li>• Acid type cleaner used and not flushed thoroughly</li> </ul>	<ul style="list-style-type: none"> <li>• Corrosion on iron components as well as other metals in the system</li> <li>• Electrolysis pitting through liners</li> <li>• Corrosive attack on engine block</li> <li>• Possible corrosion protection chemicals precipitate out of solution</li> </ul>			
Specific Conductance						
	RECOMMENDATIONS	PROBABLE CAUSE	POTENTIAL DAMAGE			
	<ul style="list-style-type: none"> <li>• Normally this level will be between 1000 and 6500 micromhos</li> <li>• When level is excessive, find cause and correct</li> </ul>	<ul style="list-style-type: none"> <li>• Improper source water</li> <li>• Combustion gas leak</li> <li>• Antifreeze level too high</li> <li>• Inhibitor level too high</li> <li>• Inhibitor being added too many times over an extended period of time</li> </ul>	<ul style="list-style-type: none"> <li>• The inability of the coolant to resist carrying an electrical current between the dissimilar metals of an engine's cooling system</li> <li>• Engine becomes a wet cell battery</li> </ul>			
Total Metals						
	RECOMMENDATIONS				PROBABLE CAUSE	POTENTIAL DAMAGE
	Metal	Borderline	Concern	Problem	<ul style="list-style-type: none"> <li>• Air leaks</li> <li>• Electrical ground problems</li> <li>• Combustion gas leaks</li> <li>• Localized over heating</li> <li>• Improper coolant maintenance</li> <li>• Improper source water being used</li> </ul>	<ul style="list-style-type: none"> <li>• Metal corrosion</li> <li>• Liner Pitting</li> <li>• Corrosion or erosion of any iron components</li> </ul>
	Iron	15	25	35		
	Copper	5	10	15		
	Aluminum	5	10	15		
	Lead	15	25	35		
	Zinc	15	25	35		
	Tin	15	25	35		



<b>COOLANT MAINTENANCE (continued)</b>			
<b>Supplemental Coolant Additives</b>			
	<b>RECOMMENDATIONS</b>	<b>PROBABLE CAUSE</b>	<b>POTENTIAL DAMAGE</b>
Too Low	<ul style="list-style-type: none"> <li>The SCA level refers to an additive in conventional coolant</li> <li>Corrosion protection chemicals refer to Extended Life Coolants or Extenders</li> <li>Levels will vary depending on brand of coolant used; 1000 ppm combined of nitrite and molybdate is sufficient for proper protection</li> </ul>	<ul style="list-style-type: none"> <li>Electrical ground problem</li> <li>Maintenance chemicals are not sufficient for metal protection and to prevent sludge from forming</li> </ul>	<ul style="list-style-type: none"> <li>Coolants can form sludge over an extended period of time</li> <li>Corrosion protection chemicals insufficient for proper metal protection</li> </ul>
Too High	<ul style="list-style-type: none"> <li>Supplemental coolant additive/corrosion protection levels should be tested every 500 hours in the field by strip or dropper method and every 1000 hours or 6 months in the lab</li> </ul>	<ul style="list-style-type: none"> <li>Addition of chemicals excessive for engine application</li> <li>Adding inhibitor without checking present level</li> </ul>	<ul style="list-style-type: none"> <li>Silicate and/or phosphate can form deposits</li> <li>Can plug radiator core and after coolers</li> </ul>
<b>SCALING POTENTIAL</b>			
<b>Total Hardness</b>			
	<b>RECOMMENDATIONS</b>	<b>PROBABLE CAUSE</b>	<b>POTENTIAL DAMAGE</b>
(calcium and magnesium)	<ul style="list-style-type: none"> <li>Conventional coolant; less than 80 ppm</li> <li>ELC coolant; less than 60 ppm</li> <li>Have source water analyzed</li> </ul>	<ul style="list-style-type: none"> <li>Improper source water</li> <li>Venting problem</li> <li>Seawater contamination</li> </ul>	<ul style="list-style-type: none"> <li>Scale formation that can be hard and insulating</li> <li>Lack of heat transfer</li> </ul>
<b>Silicon</b>			
	<b>RECOMMENDATIONS</b>	<b>PROBABLE CAUSE</b>	<b>POTENTIAL DAMAGE</b>
(corrosion inhibitor for aluminum protection; also found in some source water)	<ul style="list-style-type: none"> <li>Depends on coolant formulation; ASTM specification is not to exceed 250 ppm silicon in a conventional coolant for heavy-duty diesel engines</li> <li>ELC coolants normally have lower levels</li> <li>Automotive coolants have higher levels due to more aluminum in system</li> </ul>	<ul style="list-style-type: none"> <li>Improper source water</li> <li>Poor coolant maintenance practices</li> </ul>	<ul style="list-style-type: none"> <li>Loss of lubrication</li> <li>Increased ring bearing wear</li> <li>Hot spots due to loss of heat transfer</li> <li>Burnt valves</li> </ul>
<b>Phosphate</b>			
	<b>RECOMMENDATIONS</b>	<b>PROBABLE CAUSE</b>	<b>POTENTIAL DAMAGE</b>
(corrosion inhibitor for iron protection)	<ul style="list-style-type: none"> <li>Should not exceed 10,000 ppm</li> </ul>	<ul style="list-style-type: none"> <li>Over treatment of SCA</li> <li>Over treatment of glycol</li> <li>Excessive phosphate in antifreeze formulation</li> </ul>	<ul style="list-style-type: none"> <li>Inability for the coolant to maintain the phosphate in a soluble state</li> <li>Heavy precipitation due to phosphate falling out of solution</li> <li>Plugging of radiator and oil coolers</li> </ul>
<b>ACID PITTING POTENTIAL</b>			
<b>Sulfate</b>			
	<b>RECOMMENDATIONS</b>	<b>PROBABLE CAUSE</b>	<b>POTENTIAL DAMAGE</b>
	<ul style="list-style-type: none"> <li>The lower the better</li> <li>Sulfate at 600 ppm and greater</li> </ul>	<ul style="list-style-type: none"> <li>Improper source water</li> <li>Combustion gas leaks</li> <li>Sulfuric acid cleaner previously used and not properly removed from system</li> </ul>	<ul style="list-style-type: none"> <li>Sulfate can build or form acid such as sulfuric</li> <li>Combine with calcium to form scale</li> </ul>
<b>Glycolate</b>			
	<b>RECOMMENDATIONS</b>	<b>PROBABLE CAUSE</b>	<b>POTENTIAL DAMAGE</b>
	<ul style="list-style-type: none"> <li>Less than 1000 ppm</li> <li>Correct the localized overheating or air leak</li> </ul>	<ul style="list-style-type: none"> <li>Localized overheating</li> <li>Air leak</li> </ul>	<ul style="list-style-type: none"> <li>Ethylene glycol breaking down to form acids such as oxalic</li> <li>Coolant will be burnt and produce a foul solvent odor as well as take on a varnish characteristic</li> <li>Metal pitting</li> </ul>
<b>Chloride</b>			
	<b>RECOMMENDATIONS</b>	<b>PROBABLE CAUSE</b>	<b>POTENTIAL DAMAGE</b>
	<ul style="list-style-type: none"> <li>Less than 80 ppm</li> <li>Correct source of chloride</li> </ul>	<ul style="list-style-type: none"> <li>Improper source water</li> <li>Defective pressure relief valve or cap on radiator</li> <li>Aging coolant</li> <li>Use of hydrochloric acid type cleaners</li> <li>Failure to remove all the cleaner upon flushing the engine</li> <li>Improper venting</li> <li>Seawater leak</li> </ul>	<ul style="list-style-type: none"> <li>Extremely corrosive to engine components</li> <li>Decarbonizes iron</li> <li>Can form hydrochloric acid</li> </ul>
<b>APPLICATION RECOMMENDATIONS – DRY LAND AND MARINE</b>			
<ul style="list-style-type: none"> <li>Use only water you know meets specifications, preferably distilled or deionized water.</li> <li>Maintain proper levels of antifreeze (50-60%) and supplemental coolant additives. May use antifreeze if desired in older engines operating at 160°.</li> <li>Change coolants as per engine manufacturer's specifications.</li> <li>Make sure all systems are airtight and hold pressure.</li> <li>Be sure electrical grounds are clean and secure; one-half volt will destroy an engine in a very short period of time.</li> <li>Have coolants analyzed every 1000 hours or every 6 months, whichever comes first.</li> </ul>			
<b>NOTE:</b> Even the best coolant maintenance cannot prevent some catastrophic engine failures.			