NEW YORK BUS SALES

Tech Tip 15-0220-1
Cummins Cold Weather Operation

(REFERENCE TECH TIP #14-0101REVA)

Complaint "MIL" light and buzzer are going off first thing in the morning when cold

Cause There are "several" codes which cause the "MIL" light and many of those codes are cold weather related. One such code is #3542 is cold weather related and Cummins issued TSB #140153 (below) concerning it.

Correction Cummins recommends following their Service Bulletin #3379009 "Operation of Diesel Engines in Cold Climates" (below) as well as using a winter front to assist in reducing the time to increase engine compartment temperatures.

To assist our customers with this issue, we will include winterfronts on orders placed this year. Those customers who do not want winterfronts will need to inform their salesperson.

As a Parts Special we are offering a 15% discount on all winterfronts.

For more information contact our nearest Service Department

Chittenango:	**315-687-3969 or 1-800-962-5768**	**Daryl Wallace or Brian Lamaitis**
Rochester:	**585-424-3320 or 1-800-463-3232**	**Gary Chichester or Dave Schaub**
Ravena:	**518-756-1111 or 1-866-867-1111**	**Ben Reiling**

Customer Service Representatives

Eastern Region	**Gary Bigness 845-500-3707**
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Western Region	**Mike Panzica 716-908-3186**

Service Bulletin Number	Date
3379009	21-MAR-2011

Service Bulletin

Operation of Diesel Engines in Cold Climates

This service bulletin contains generalized information to cover the full range of Cummins® products operating in cold climates. For engine specific cold climate operation information, see the corresponding Operation and Maintenance manual and Owners manual for your engine.

Satisfactory performance of a diesel engine in cold and arctic climates requires modification to the engine support systems, operating practices, and maintenance procedures. Everyone involved with equipment in these climates **must** address the fact that cold climates will have an effect on the starting, performance, and reliability of the equipment as well as the engine. The reliability of the engine and equipment will be seriously impaired if **not** properly prepared for the environment in which it is operating. To winterize equipment there are three objectives:

1. Reasonable starting characteristics followed by practical and dependable warm-up of engine and equipment
2. A unit or installation needs to be as independent as possible from other external influences
3. Modifications which maintain satisfactory engine operating temperatures with a minimum increase in maintenance of the equipment and accessories

As the operating climate becomes colder, an increasing amount of equipment modification is required for satisfactory performance. Modifications that **must** be considered are listed below.

1. Provision for warm intake air in ambient temperatures below -12°C [10°F].
2. Use of covers over the radiator such as a winter front.
3. Shielding oil pan and lower engine compartment from air blasts created during equipment operation.
4. Use of a thermatic controlled fan.

5. Heating lubricating oil when the engine is **not** operating.
6. Heating coolant when the engine is **not** operating.
7. Use of -57°C [-70°F] Arctic Fuel or provision of heat to fuel tanks.
8. Exposed lines **must** be insulated.
9. Filters, pumps or reservoirs outside the engine compartment **must** be insulated to protect against ambient temperatures and air flow.
10. Provision of a separate heater directed to operator's feet to maintain driver and cab temperatures.
11. Warming equipment batteries.
12. Use of an alcohol vaporizer to protect compressed air system.
13. Where an engine is exposed behind the cab, a cover **must** be provided to enclose the engine in the compartment.
14. If equipped with a coalescing breather filter, coalescing breather filter heater and related components.

More detail on these modifications and the impact of cold weather conditions is provided in the sections below.

It **must** be stressed that while the content presented here aims to provide comprehensive detail on engine performance in cold weather conditions, it does **not** provide detail for all scenarios that may compromise engine performance in such conditions.

There are many additional problems that can arise in extreme conditions and adequate preparations may also be dependent on region or location. For these reasons it is recommended that, in addition to reviewing this bulletin, operators consult with their local dealer or distributor for regionally specific cold weather guidance.

Personnel Protection

The wind chill chart, Table 1, is included in this bulletin to emphasize the protection required for the operator working under low temperature conditions. They **must** be protected adequately to correctly perform the task of starting and operating the equipment. Wind chill affects the human more than metals since it is actually a measure of evaporation. The sensation to the skin is a lower temperature as given on the chart. As an example, assume an ambient temperature of -32°C [-25°F] with a 48.27 km [30 mile]/hour wind, the equivalent chill temperature is -61°C [-77°F] or it is equivalent to -61°C [-77°F] with no wind velocity. Temperature in this range will freeze exposed human flesh in less than one minute. Metal would remain at -32°C [-25°F].

Table 1, Wind Chill Rate

Wind Velocity (mph)	Temperature (°F)															
	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
10	20	14	8	2	-4	-10	-15	-21	-27	-33	-39	-45	-50	-56	-62	-68
15	13	7	0	-6	-12	-18	-25	-31	-38	-44	-50	-57	-63	-69	-75	-81
20	9	2	-5	-12	-19	-25	-32	-39	-45	-52	-59	-66	-72	-79	-85	-92

25	5	-2	-9	-17	-24	-30	-37	-44	-51	-58	-65	-72	-78	-86	-93	-99
30	3	-5	-12	-20	-27	-33	-41	-48	-55	-63	-70	-77	-83	-91	-98	-104
35	0	-7	-14	-22	-29	-36	-44	-51	-58	-66	-73	-81	-87	-95	-102	-109
40	-1	-9	-16	-24	-31	-38	-46	-53	-61	-69	-76	-84	-91	-98	-105	-112

NOTE: Temperature and wind velocity related in terms of wind chill showing equivalent temperature under still conditions. (Values are approximate and do not allow for varying humidity.)

Engine Idle

It is recommended that an engine does **not** operate at an idle no load condition for prolonged periods in excess of 15 minutes. Operating engines at idle (650 to 1000 rpm) for prolonged periods in cold ambient temperatures wastes fuel, accelerates wear, and can result in serious engine damage. Under these low temperature conditions, incomplete combustion will occur, allowing deposits of unburned tars and carbon to buildup on the valve guide and valves and eventually cause valve sticking. At low idle (650 to 700 rpm) there will be insufficient coolant flow and coolant temperature at the cab heater to maintain adequate cab heat. In low ambient temperatures, if radiant and convection heat losses are **not** prevented, the engine will **not** consume an adequate amount of fuel to maintain coolant and combustion temperatures. Sufficient support systems are recommended to preclude the necessity to idle engines for prolonged periods.

It is recognized that regardless of recommendations, operators will idle engines for prolonged periods, especially if the driver is sleeping in the cab compartment of the chassis. If the operator insists on prolonged idling, it is recommended that the engine be idled at an rpm which is adequate to maintain coolant temperatures above 60°C [140°F]. In temperatures below minus 18°C [0°F], the engine will need to be idled above 1200 rpm. For this type of operation, a full on-off type fan and winter front **must** be used. Cold weather upfit parts are available for engines not fitted with the factory installed option. Please contact your local Cummins Dealer/Distributor for additional parts information and recommendations on cold weather operation.

Aftertreatment Systems

Engines equipped with an aftertreatment system consisting of an aftertreatment diesel oxidation catalyst and aftertreatment diesel particulate filter require attention when operated in cold climates. Prolonged engine idle speeds (600 to 800 rpm) do **not** provide enough exhaust temperature or exhaust flow to actively regenerate the aftertreatment diesel particulate filter. If the operator insists on prolonged idling on an engine with aftertreatment, the following options can be taken:

- The operator **must** periodically check for the illumination of the aftertreatment diesel particulate lamp and initiate stationary (parked) regenerations, as required. The idle shutdown feature may be used to shut the engine off prior to the red stop engine lamp illuminating and disabling stationary (parked) regeneration.

- The operator can choose to idle the engine at higher engine rpm using the PTO feature. Consult the vehicle manufacturer to enable the active regeneration in PTO feature.

Operation of an engine equipped with aftertreatment in cold climates may also cause the number of active regeneration or stationary (parked) regenerations to increase. In extremely cold climates, stationary (parked) regeneration may **not** be possible, and operating the vehicle with a load may be necessary to actively regenerate the aftertreatment diesel particulate filter. The use of an insulated aftertreatment system is recommended for engines that regularly operate in cold climates.

Electrical Systems

The normal source of energy used to crank an engine is a battery. As the battery temperature decreases, the battery's capacity to produce power is lowered and its ability to recover power is slower. The engine's cranking load increases as the ambient temperature decreases, compounding the battery power loss problem.

Engine manufacturers normally recommend battery and electrical system capacity for specific engine families to provide an adequate start at -18°C [0°F]. For satisfactory operation in colder ambients, the batteries need to be heated to restore their original cranking capacity, or more batteries need to be added. Inadequate battery capacity results in low cranking speed. Cranking speed continues to slow down during the cranking cycle and can progress to the point where the engine will **not** start.

The wire size, length and connections of the starter circuit determine the ability of the battery to freely transmit power to the starter. Undersized wire acts as a restriction to flow of electrical power. Loose or corroded wires and connections can consume up to 50 percent more of the available battery power before it gets to the starter.

An electric starter simply receives electrical energy and converts it to mechanical energy. The peak efficiency of the starter occurs at engine cranking speeds of between 100 to 150 rpm. At lower speeds the efficiency drops off and current flow increases. If the starter is allowed to stall, and the engine will **not** start, 100 percent of the electrical energy turns to heat and will damage the starter and wiring. If cranking speeds are continuously low, either more energy (battery capacity), higher starter torque, or less cranking load is required.

Fuels

The free flow of diesel fuel depends on its temperature, pour, and cloud points. The phenomenon of fuel thickening in cold environments is referred to as waxing (gelling). The temperature at which this wax forms varies with the base stock of fuel. If the engine is operating below the cloud point of the fuel, the wax crystals circulated with the fuel will clog screens, filters, or restrict the fuel lines at the sharp bends, fittings etc. Pour point depressants **only** reduce the size of the wax crystals in the fuel, they do **not** alter the temperature at which the wax crystals form. The **only** known method to prevent wax formation in fuels is to use a lower cloud point fuel or maintain the temperature of the fuel

above the cloud point. This can be accomplished by using fuel heaters whether the engine is running or is **not** running.

When fuel heaters are used, they **must** be selected to maintain fuel temperatures above the cloud point but below the point at which the lubricating quality of the fuel decreases. Selected fuel heaters or filters for any given engine **must not** impose a restriction to the fuel system that exceeds 100 mm Hg [4 in Hg] when measured at the fuel pump inlet.

Blending fuels (such as Number 1 fuel with Number 2 fuel) while reducing the wax point also reduces the BTU content of the fuel, increasing fuel consumption. Blending also reduces the lubricating quality of the fuel which reduces the life of the fuel system components.

WARNING

Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can result in a fire or explosion.

Fuel/Water Separator

Condensation in the fuel **must** be removed for dependable diesel engine performance. Keeping the fuel tanks full and draining condensate daily, will help reduce moisture in the tanks. There are also inline fuel filters available which will separate water from the fuel.

Fuel/Water Separator (Spin-on)

A spin-on fuel/water separator filter is available that will directly replace the standard spin-on fuel filter. It has a self-venting valve which allows water to be drained without breaking the fuel system vacuum. This filter has a longer overall length and requires a remote mounting in some applications.

Lubricating Oils

In addition to the information contained in the following section, it is recommended operators review the appropriate information provided in Cummins Engine Oil and Oil Analysis Recommendations, Bulletin 3810340. Two physical properties, viscosity and pour point, are vital to the lubrication of the engine during cold start up. Viscosity is the **most** important. The lubricating oil **must** pour freely from its containers and it **must** circulate freely throughout the engine. Although it is possible to start an engine when the oil has solidified in the crankcase, doing so can result in catastrophic engine shutdown due to lack of lubrication. There are cold climate operation lubricating oils with a sufficiently low pour point available that will remain in a liquid state at the minimum expected temperatures.

The viscosity of the oil controls engine friction and oil circulation. Oil viscosity influences the following performance factors.

1. Starting and warm up
2. Power output

3. Fuel consumption
4. Engine cooling
5. Starting wear
6. Oil consumption
7. Engine cooling
8. Engine noise

The first five performance factors are improved by using a low viscosity oil, while the last three factors are improved with a high viscosity oil.

Lubricating oil viscosity is one of the most critical factors in engine startability. If the viscosity is too high, the resistance to cranking ability is too high for the engine to reach an acceptable cranking speed.

It is necessary to heat the engine lubricant before starting the engine if the lubricant that is used does **not** have the proper pour point or viscosity. Heating the lubricant will decrease its viscosity, therefore, increasing lubrication and reducing friction during cranking. All filters **must** be located within the confines of the engine compartment so the heat of the engine can be used to prevent gelling of the lubricants.

Air Intake Systems

There are two aspects of intake air system which **must** be taken into consideration when winterizing a vehicle. These considerations are air density and temperature.

Air Density

Air density increases as ambient temperature decreases. The net result in a turbocharged engine is that the peak cylinder pressure increases. An increase of cylinder pressure can contribute to the following types of problems.

1. Blocks cracking
2. Blown head gaskets
3. Excessive crankshaft bearing loading
4. Camshaft break down when hydraulic engine brakes are used
5. Loosening or breaking of head bolts
6. Piston ring beat in
7. Cracked pistons

Air Temperature

There is a direct correlation between intake air temperature and combustion temperature. One of the end results of a diesel engine with cold intake temperatures is that combustion temperatures will be reduced. At reduced combustion temperature, the low ends of the diesel fuel do **not** burn. These unburned heavy ends of the fuel will deposit a tar-like varnish substance on the valve guides and valve stems and cause them to stick in the open position. When the open valves and pistons meet, a break down occurs. Cold intake air temperatures will also result in detonation (uncontrolled combustion) and piston burning.

Below 0°C [32°F], it is recommended that intake air come from inside the engine enclosure. This will provide warm air to the intake and reduce engine heat loss. If the air cleaner is **not** located within the engine compartment enclosure, then ducting **must** be routed from the engine compartment to the air cleaner inlet. Adequate sealing of the engine compartment is necessary. Side curtains alone are **not always** satisfactory. If there are openings around the radiator cowl and underneath the engine, these areas **must** also be sealed. Depending on ambient temperature and engine compartment size, heat the air within the engine compartment to maintain combustion temperatures. An aftercooled engine will perform well in these conditions, as the cooler element which normally cools heated air down to near the level of the coolant temperature, will warm cold intake air up to near the coolant temperature. It is extremely beneficial to provide a temperature controlled on-off type fan so the radiant and convection heat within the engine compartment is **not** dissipated by air flow.

WARNING

To reduce the possibility of personal injury and property damage, never use starting fluid if the grid heater option is used. Starting fluid, which contains ether, can cause an explosion.

CAUTION

Do not use ether with glow plug starting aids as engine damage can occur.

Cooling System

In addition to the information contained in the following section, it is recommended operators review the appropriate information provided in Cummins Coolant Requirements and Maintenance, Bulletin 3666132.

Coolant within a diesel engine is primarily used as a heat transfer media and is subject to potential freezing in cold and Arctic climates. The lowest freezing temperature that can be provided for the coolant is obtained by using a solution of approximately 60 percent ethylene glycol and 40 percent water. This mixture will turn to slush at about -50°C [-60°F]. It is necessary to heat the coolant or use a starting aid (ether) in climates of -1° to 10°C [30° to 50°F] and colder to get a successful start. In climates colder than -23°C [-10°F] it is recommended that coolant heaters be used in conjunction with ether starting aids.

There are three basic types of coolant heaters available in the marketplace. The heaters selected **must** maintain the coolant temperature to a minimum of 50°C [120°F] in any temperature encountered.

- Immersion Heaters
  - Immersion heaters have a heating element immersed within the confines of the engine coolant passage. Heat is transferred to the cylinder liners and block via the coolant. An external electrical source is required to operate the heaters.

- Tank Type Heaters
  - Tank type heaters function on the convection principal. That is, a volume of coolant is heated within a small tank and then the heated coolant is circulated through the engine via the hose connections (similar to a percolator coffee pot). There are heaters available from 1000 to 4000 watts. An external electrical source is required for this type of heat. There are also tank type heaters with recirculating pumps which continuously circulate the heated coolant through the engine systems.

- Fuel Burning Coolant Heaters
  - Fuel burning coolant heaters are designed to burn liquid/vapor type fuels and some will operate on a mixture of fuels. The most common fuel burning heaters normally use diesel fuel, propane or gasoline. These are furnace gun type heaters where fuel is ignited via an igniter and the fuel is then sprayed on a transfer media such as a porous ceramic disc. This flame then heats the coolant via coils contained within the heater and transferred to the engine either by convection or by recirculating pumps incorporated into the heaters. Exhaust gases from these heaters can be used to heat engine compartments and accessories such as batteries.

The minimum amount of coolant that has to be heated for maximum efficiency of the heaters is the volume of coolant in the block and accessories in the coolant bypass system. To achieve this condition, the thermostats and thermostat seals **must not** allow coolant to flow through the radiator when the thermostat is closed. To check for coolant leakage past the thermostat seal and/or thermostat:

1. Remove the engine outlet hose at the thermostat housing. Hold the hose in the air above the radiator baffle level and run engine against the governor. If water comes out of the water outlet connection, the thermostat and/or seal is leaking.
2. If the coolant does **not** reach thermostat opening temperature, changing the thermostat will **not** correct the problem.

Another critical area for cold operating engines is coolant flow through the radiator core when the thermostat is in the closed position. A properly functioning deaeration system **must** be incorporated and there **must** be no reverse flow of coolant through either the fill line or the radiator. The deaeration baffle **must not** leak and **must not** have vent holes. To check for this condition:

1. Drain the cooling system.
2. Remove the make up (fill line) at the water pump and plug the end.
3. Fill the area above the baffle with coolant. If water leaks through the drain cock of the radiator, remove the tank and repair. Coolant can be leaking through the core vent tube which needs to be extended in the expansion area.

Crankcase reather System

For engines with a coalescing breather system, the following equipment is required with temperatures below -23°C [-10°F].

- Breather heater
- Insulation on coalescing breather filter housing
- Insulation on breather inlet tube (if equipped)
- Insulation on breather outlet tube

For crankcase breather systems with a crankcase breather tube:

- Shorten crankcase breather tube to at least 30cm [12 in] above oil pan flange on highway applications for operations below -18°C [0°F].
- Check crankcase breather tube for plugging due to icing daily.

Radiator Shutters

When they are closed, radiator shutters prevent air flow across the radiator core as well as the engine. Air flow across the engine can extend warm-up time and prevent the coolant from reaching minimum operating temperatures in extremely cold ambient temperatures.

The two most commonly used terms associated with the preparation of equipment for low temperature operation are winterization and arctic specifications.

Winterization of the engine and/or components so starting and operation are possible in the lowest temperature to be encountered requires:

1. Use of correct materials (Some materials get brittle and fail at low temperatures.)
2. Proper lubrication, low temperature lubricating oils.
3. Protection from the low temperature air (The metal temperature does **not** change as a result of air flow, but the rate of heat dissipation is significantly increased by the flow of cold air over the exposed surfaces.)
4. Fuel of proper grade for lowest operating temperature
5. Heating to be provided to increase engine block and component temperature to a minimum of -23°C [-10°F] for ether aided starting in lower temperatures
6. Proper external heating source available
7. Electrical equipment capable of operating in lowest expected temperature

Arctic Specifications reference the design material and specifications of components necessary for satisfactory engine operation in extremely low temperatures to -54°C [-65°F]. Contact Cummins Inc., or the equipment manufacturer, to obtain the special items required. The Arctic Specifications listed on the following pages are only general guidelines.

Temperature Controlled Fan Drive

A temperature controlled fan drive can be used to reduce cold air circulation at the engine to help conserve compartment heat. These devices function by completely or partially disconnecting the fan from its drive source at a specified temperature. Several types of fan drives are commonly available: viscous, thermatic, and thermo-modulating.

Equipment Preparation and Maintenance

The amount of modification varies as the temperature changes. Therefore, the following tabulation of recommended equipment is grouped into three temperature ranges. When equipment heaters are required as recommended in this bulletin, it is suggested that all system heaters (coolant, oil and intake air) be used.

The accessory equipment used for low temperature operation and starting require maintenance on a regular schedule like other components on the engine. As an example, don't delay checking the performance of the manifold flame heater until the engine is to be started.

Poor or unscheduled maintenance **always** results in loss of productive time. Normal maintenance practices **must** be followed on all components. The following recommendations apply to all engine models, except as noted.

Winterize 0 to -23°C [32 to -10°F]

- Use ethylene glycol antifreeze 50 percent, water 50 percent, to protect to -29°C [-20° F]
- Use multi viscosity oils meeting API specifications. Refer to Cummins Engine Oil and Oil Analysis Recommendations, Bulletin 3810340. Adhere to a lubricating oil change schedule necessary to maintain clean oil.
- Use fuel with maximum cloud and pour points 6°C [10°F] lower than ambient temperature in which engine operates.
- Use radiator shutters
- System to provide a recommended 150 rpm cranking speed at -23°C [-10°F]
- Provide for warmed intake air from engine compartment in temperatures below -12°C [10°F]
- Shorten breather tube to at least 30cm [12 in] above oil pan flange on highway applications for operations below -18°C [0°F].
- Keep fuel tanks full to reduce moisture condensation. Drain sediment daily.
- Check the preheater coil and electrical systems daily.
- Check of cold weather support systems weekly.
- Check crankcase breather tube for plugging due to icing daily.

Winterize -23 to -32°C to [-10 to -25°F]

- Use ethylene glycol antifreeze 50 percent, water 50 percent, to protect to -29°C [-20° F]
- Use multi viscosity oil meeting API specifications. Refer to Cummins Engine Oil and Oil Analysis Recommendations, Bulletin 3810340. Adhere to an oil change schedule necessary to maintain clean oil. Check oil level every two hours.
- Use fuel with maximum cloud and pour points 6°C or 10°F (lower than ambient temperature in which engine operates.)
- Radiator shutters sealed around edge and adjusted to close tight or shutters plus radiator cover.
- Winterized heavy duty 24 volt cranking system to provide a recommended 150 rpm cranking speed at -32°C [-25°F] after preheat.
- Heated intake air using intercooler manifold, engine compartment enclosures with air cleaner intake air drawn from engine compartment

- Dry type air cleaner
- Shorten breather tube to at least 30 cm [12 in] above oil pan flange.
- Keep fuel tanks full to reduce moisture condensation. Drain sediment daily.
- Check of preheater coil and electrical systems daily.
- Check cold weather support systems weekly.
- Check temperature controls, thermostat, and shutters weekly.
- Check crankcase breather tube for plugging due to icing daily.

Arctic Specifications -32 to -54°C [-25 to -65°F]

- Use ethylene glycol antifreeze 60 percent, water 40 percent mixture.
- Use arctic oils meeting API specifications. Refer to Cummins Engine Oil and Oil Analysis Recommendations, Bulletin 3810340. Adhere to an oil change schedule necessary to maintain clean oil. Check oil level every two hours.
- Use fuel with maximum cloud and pour points 6°C or 10°F (lower than ambient temperature at which engine operates.)
- Tight winter front cover for radiator in front of shutters
- Winterized heavy duty 24 volt cranking system to provide a recommended 150 rpm cranking speed at -32°C [-25°F] after preheat.
- Starting aid: ether or manifold flame heater
- Provide for heated intake air using intercooler manifold, engine compartment enclosures with air cleaner intake air drawn from the engine compartment
- Dry type air cleaner. Install in engine compartment
- Shorten breather tube to at least 30 cm [12 in] above oil pan flange.
- Keep fuel tanks full to reduce moisture condensation. Drain sediment daily.
- Check of preheater coil and electrical systems daily.
- Check of cold weather support systems weekly.
- Check of temperature controls, thermostat, winter front, space heaters starters, and starter electrical system weekly.
- Check crankcase breather tube for plugging due to icing daily.

Cold Weather Aids and Accessory Equipment

Cold weather aids and accessory equipment is available for your specific engine. Contact a Cummins® authorized repair location for more information.

Options Offered

- Coolant heaters
- Battery box heating - all applications
- Hot fresh air heating
- Lubricating oil heaters
- Engine intake air heaters
- Engine compartment heaters
- Manifold preheaters
- Glow plug preheater operation
- Fan drives

- Radiator covers
- Crankcase breather heaters
- Oil pan covers
- Starting motors
- Batteries
- Hydraulic or air cranking motors
- Fuel warmers

Document History

Date	Details
xxxx-xx-xx	Module Created
2014-11-13	Remove outdated information.
2015-1-7	none

Last Modified: 07-Jan-2015