Technical Document

TRANSMISSION COOLING TESTS FOR ON-HIGHWAY AND ON/OFF-HIGHWAY TRANSMISSION MODELS

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TD157 - TRANSMISSION COOLING TESTS

1.0 INTRODUCTION

This document covers the types of transmission cooling tests and the procedures necessary to evaluate cooling systems and cooler performance.

2.0 REFERENCED DOCUMENTS

Unless otherwise noted, all documents referenced in this document may be found in the Allison HUB website at https://hub.allisontransmission.com/login. To locate the referenced documents look for Tech Data under the Engineering heading on the Allison HUB home page. In this document, these references are identified by italic font. Contact your Allison Transmission representative if you do not have access to the Allison HUB. A list of all items referenced in this document can be found at the end of this document.

3.0 GENERAL REQUIREMENTS

The vehicle chassis manufacturer is responsible for the design, installation and verification of the transmission cooling system. The transmission cooling system must be capable of maintaining the transmission operating temperatures within the limits defined in *Transmission Data* for the *1000/2000*, *2900*, *3000* and *4000* Product Families. The transmission temperatures must be within the temperature limits under all vehicle operating conditions.

There are two different transmission operations that require cooling:

- Transmission Propulsion System – Heat from the torque converter, internal transmission losses and friction must be cooled. Also called converter mode cooling. Propulsion cooling applies to all transmissions.
- Transmission Retarder System – During retardation, heat from the retarder, as well as from internal losses and friction, must be cooled. Retarder cooling applies only to transmissions equipped with an Allison retarder.

During the vehicle design phase, both converter mode cooling and retarder mode cooling must be analyzed in order to determine the following:

- An estimate of the transmission cooling requirements
- The size of the transmission cooler
- The size of the total vehicle cooling system

For detailed information on transmission cooling system design, refer to *Transmission Cooling – Basic* and *Transmission Cooling – Retarder*.

In addition to the analysis and design of the vehicle cooling system, new vehicle cooling systems must be verified by testing in the vehicle. There are a number of cooling system factors that can only be evaluated experimentally. The transmission cooling tests are an extension of the vehicle cooling tests that are performed by the vehicle manufacturer. Engine manufacturers typically require tests to verify the capability of the engine cooling systems. Conduct the engine cooling tests and verify the engine cooling capability prior to conducting the transmission cooling tests. It is often convenient to test the transmission cooling system immediately after the engine cooling tests because the vehicle and much of the instrumentation is already available.

The purpose of the transmission cooling test is twofold:

- Verify that the transmission cooler meets the cooler manufacturer's design specifications
- Verify that the cooling system is capable of providing the required level of transmission cooling

Allison Transmission cooling requirements are dependent on the specific vehicle application. The required conditions for cooling system verification vary by vocation and transmission configuration. Appendix A shows the cooling requirements for each vocation. Please note the following:

- The converter mode condition may be calculated for oil-to-water coolers
- The START/STOP and DOWNGRADE tests are for retarder-equipped transmissions only

Appendix A lists the minimum tests required by Allison. It may be necessary to perform additional testing based on other customer duty cycles and the effect of other vehicle systems. This document contains the requirements for the tests.

The transmission cooling system must provide the required level of transmission cooling in the ambient temperature where the vehicle will be in service. Appendix B lists design ambient temperatures, also called Limiting Ambient Temperatures (L.A.T.) for various worldwide locations.

At several locations in this document, the maximum allowable transmission temperatures are listed for the convenience of the reader. These temperatures were correct as of the date of this document. Allison Transmission does not expect any changes to these temperature limits. However, the official source for transmission temperature limits is the *Transmission Data* for *1000/2000*, *3000* and *4000* Product Families. Allison Transmission recommends that the reader verify the transmission temperature limits prior to making final cooling system decisions.

3.1 COOLER CIRCUIT PRESSURE DROP

Allison requires the vehicle builder to demonstrate that the cooler circuit meets the pressure drop limits shown in *Transmission Data* for the *1000/2000*, *2900*, *3000* and *4000* Product Families. The cooler circuit pressure drop may be measured during the cooling tests. Procedures for measuring the pressure drop across the cooler circuit can be found in *Transmission Cooling – Basic*.

3.2 2900 SERIES TRANSMISSION COOLING SYSTEM REQUIREMENTS

2900 Series Transmission Cooling System Requirements

- Maintain the transmission oil temperatures within transmission temperature limits, even during intermittent severe duty cycles and worse case operating conditions.
- Maintain the transmission oil temperatures within transmission temperature limits at the ambient temperature recommended where the vehicle will be in service. Refer to Appendix B for a list of Allison recommended design ambient conditions for various worldwide locations.
- Remove, as a minimum, the total transmission heat load corresponding to the full throttle 0.8 converter speed ratio point in sixth gear.
- If the full throttle 0.8 converter speed ratio point is at an engine speed greater than the engine's full load governed speed, then use the heat rejection at the full load governed speed point.
- Verify by calculation or by test the ability to maintain transmission oil temperatures within transmission temperature limits at the full throttle 0.8 converter speed ratio cooling point.
- Converter-mode cooling must be accomplished on a continuous and stabilized basis within transmission limits, in worse case ambient conditions, for the full life of the vehicle.
- Known duty cycle requirements for specific vocations can dictate cooling capacity above the minimum level. For example, if it is known that a vehicle will operate most of the time at severe conditions, the cooling capacity must be increased so that operating temperatures will remain well within the maximum limits.

2900 Series Transmission Cooling System Requirements – Special Case

When the transmission's Neutral-at-Stop feature is utilized, then the 2900 Product Family cooling system must meet the following requirements:

- Maintain the transmission oil temperatures within transmission temperature limits, even during intermittent servere duty cycles and worse case operating conditions.
- Maintain the transmission oil temperatures within transmission temperature limits at the ambient temperature recommended where the vehicle will be in service. Refer to Appendix B for a list of Allison recommended design ambient conditions for various worldwide locations.
- Remove, as a minimum, the 1000 btu/min transmission heat load corresponding to an engine speed of 2000 rpm.
- Verify by calculation or by test the transmission cooling system's ability to maintain transmission oil temperatures within transmission temperature limits at a transmission heat load of 1000 btu/min with engine coolant flow & temperature and transmission cooler flow, corresponding to 2000 rpm engine speed.
- Transmission cooling must be accomplished on a continuous and stabilized basis within transmission limits, in worse case ambient conditions, for the full life of the vehicle.
- Known duty cycle requirements for specific vocations can dictate cooling capacity above the minimum level. For example, if it is known that a vehicle will operate most of the time at severe conditions, the cooling capacity must be increased so that operating temperatures will remain well within the maximum limits.

4.0 INSTRUMENTATION REQUIREMENTS

Instrumentation required for transmission cooling tests are listed in the following appendices:

- Appendix C-1: Converter Efficiency Cooling Tests
- Appendix C-2: Retarder Cooling Tests

Appendices C-1 and C-2 list both required and recommended instrumentation for transmission cooling verification tests. The instrumentation on the required list is sufficient to determine the following:

- If the transmission temperature limits have been met
- If the transmission cooling system is performing as designed

NOTE: If there is a problem with the cooling test, the test data or the cooling system, the instrumentation on the Minimum Required Instrumentation list is insufficient for data analysis and troubleshooting. As a result, additional testing with additional instrumentation may be required.

The instrumentation on the recommended list provides valuable data for a detailed analysis of the test and cooling system. A more detailed analysis of the data is useful for the following conditions:

- Problems are encountered during the course of the test
- Temperature data exceeds the transmission temperature limits

The instrumentation on the Recommended Instrumentation list is necessary to analyze the cooling system when the test data exceeds the transmission temperature requirements. If only the minimum instrumentation is used, a full system analysis will not be possible. As a result, additional testing or system modifications may be required.

5.0 CONVERTER EFFICIENCY COOLING REQUIREMENTS

A converter efficiency cooling calculation or test is required on all vehicles. Detailed calculation procedures and conditions are contained in *Transmission Cooling – Basic*. Allison Transmission recommends making the converter efficiency cooling calculations prior to running the converter efficiency cooling test. The data from the calculations can be used to verify that the test data is reasonable and that the cooling system is performing as expected.

For some 85% converter efficiency cooling applications, the 85% converter efficiency point is close to- or at engine full load governed speed. If this is the case, an alternate cooling point may be required. Refer to *Transmission Cooling – Basic* for detailed information.

5.1 TEST METHODS

5.1.1 DYNAMOMETER TESTS

The preferred location for a converter mode cooling test is an environmentally controlled wind tunnel for the following reasons:

- Steady-state, stabilized test conditions are most easily achieved
- Test conditions, such as ambient temperature, air speed and load, can be closely controlled
- More complete and reliable instrumentation is possible

The following two types of dynamometers may be used in a wind tunnel cooling test:

- Chassis dynamometer - large, absorption, wheel dynamometer
- Driveline dynamometer - absorption dynamometer installed in the vehicle driveline

A towed dynamometer test can be conducted, but it is more difficult to perform. The results from a towed dynamometer test may be affected by the following:

- Variations in ambient conditions such as temperature, humidity and precipitation
- Variations in vehicle speed
- Variations in operating grades
- Limitations in instrumentation

5.1.2 IN-SERVICE DUTY CYCLE TESTS

An in-service duty cycle test is sometimes used to evaluate the transmission cooling during normal operation of the vehicle. Because this test is inherently transient in nature, it is typically used for the following purposes:

- Troubleshoot reported cooling problems
- Compare two cooling configurations
- Correlate stabilized dynamometer test data with temperatures observed on the duty cycle

An in-service test can supply valuable information. However, in-service testing can not be used to verify a vehicle cooling system. In addition, instrumentation is typically limited for in-service testing, which reduces the amount of data available for evaluation.

5.2 TRANSMISSION TEST RANGE

Ideally, the transmission propulsion cooling is validated for the heat rejection produced at the appropriate converter speed ratio in first range. In most cases, due to the limitations of the test equipment or of the vehicle, it is necessary to test at the converter efficiency point in one of the higher transmission ranges. Contact an Allison representative for directions to operate the transmission at the specified converter efficiency point in an upper range.

5.3 TRANSMISSION CONVERTER SPEED RATIO

During the converter efficiency cooling test, the best method to assure that the testing is done at the required converter efficiency is to test at the corresponding converter speed ratio. For each converter, there is a direct correlation between a specific converter efficiency and a specific speed ratio. The Speed Ratio (SR) is equal to the converter turbine speed divided by the engine speed:

SR = turbine speed (rpm) / engine speed (rpm).

The speed ratios for the required converter efficiency cooling points are available from iSCAAN.

In 4th range, the transmission gear ratio is 1:1, making the turbine speed equal to the transmission output speed. Thus, in 4th range, transmission output speed can be used to directly calculate the converter speed ratio. If the test is run in a range other than 4th, transmission output speed must be multiplied by the gear ratio in order to obtain turbine speed:

SR = Gear Ratio x output speed (rpm) / engine speed (rpm)

Allison Transmission can provide a special TCM calibration to permit running the converter efficiency test in the desired gear range. Please contact Application Engineering at least 14 days prior to the start of the cooling test for assistance obtaining iSCAAN runs and a special cooling calibration.

5.4 AIR SPEED

- For dynamometer tests in a wind tunnel, use 24 km/hr (15 mph) for the air speed
- For testing with a tow dynamometer, the air speed is the same as the vehicle speed, which is determined by the converter speed ratio and the transmission range selected.

5.5 TEMPERATURE LIMITS

The transmission maximum allowable transmission temperatures are as follows:

Transmission Sump	121°C (250°F)
Transmission Converter Out (To Cooler)	149°C (300°F)

5.6 AMBIENT CONDITIONS

- Do not conduct cooling tests in the rain or on wet roads.
- Cooling tests should be conducted at 38º C (100º F) ambient temperature. If the vehicle will be operated in an area with an L.A.T. greater than 38º C (100º F), Allison recommends that the tests be conducted in an ambient temperature close to the operational L.A.T. The minimum ambient temperature for the tests is 20°C (68°F).

5.7 ENGINE COOLING SYSTEM

- The engine must be run at its full power capability. **ALL** engine power cutback and derate features must be disabled or set to values that are outside of the operational range for the test. If this is not possible, the test should be run at an ambient temperature that allows the engine to operate at full power below the derate point. The resulting temperatures must then be extrapolated to the correct ambient temperature.
- The engine thermostats must be blocked open.
- The cooling fans must be locked in their maximum speed conditions.
- Testing should begin with the engine and cooling system at operational temperature. The engine water shall be at a minimum temperature of 70°C (158°F). This can be achieved in the thermostats open/fan on condition by temporarily switching the cooling fan off for a period of time to allow the engine to reach the desired temperature or by temporarily blocking air flow to the radiator.
- Coolant should be a 50% antifreeze /50% water mix or that specified by the OEM for vehicle operation.
- In the case where antifreeze is not specified for normal operation, but a corrosion inhibitor is specified, the coolant medium should be the percentage mix or the specific gravity specified.
- Interior heating should be off.

5.8 AIR CONDITIONING

If the vehicle has air conditioning, the following shall apply:

- If the air conditioning condenser is located in front of the engine coolant radiator, the air conditioning must be operated at its maximum capacity for the duration of the test.
- If the air conditioning condenser has a dedicated fan drive independent of the radiator, the air conditioning shall not be operational for the duration of the test.

5.9 STABILIZATION

All conditions are to be run to temperature stabilization. The cooling system is stabilized when temperatures rise less than 0.6ºC (1.0ºF) in successive 5 minute periods. If stabilization can not be achieved without exceeding the maximum engine temperature limits, decrease the ambient temperature and rerun the test.

5.10 EXTRAPOLATION AND INTERPRETATION OF RESULTS

The actual measured oil temperatures must be extrapolated to compensate for the limiting ambient temperature (L.A.T.) applicable to the region in which the vehicle will operate.

Extrapolation Calculations:

1. During testing, record the ambient temperature.
2. During testing, record the maximum, stabilized temperatures for the transmission and the engine.
3. Calculate the difference between the recorded ambient temperature and the L.A.T.
4. To obtain the extrapolated temperatures, add the difference from step 3 to the transmission and engine temperatures which were recorded in step 2.
5. Compare the transmission extrapolated temperatures with the temperature limits in paragraph 5.5.
6. Compare engine extrapolated temperature to the engine manufacturer's limits.

Interpretation of Results:

The transmission cooling system is acceptable if:

- The test conditions meet the conditions described for this test
- The maximum transmission temperatures, extrapolated to the L.A.T., are less than or equal to the limits listed in paragraph 5.5.

Special Case – Engine Top Tank Temperature Exceeds Limit:

For the following conditions:

- The actual or extrapolated transmission temperatures exceed Allison's temperature limits, and
- The actual or extrapolated engine top tank temperature exceeds the engine manufacturer's top tank limit by 5.6º C (10º F) or less,

apply the calculations described below.

1. Calculate the difference between the extrapolated engine temperature and the engine manufacturer's top tank temperature limit.
2. Subtract the difference calculated in step 1 from the extrapolated transmission temperatures.
3. Compare the transmission temperatures calculated in step 2 to the transmission temperature limits in paragraph 5.5. If the calculated transmission temperatures are less than or equal to the limits listed in paragraph 5.5, the transmission cooling system is acceptable.

Refer to Figure 1 for an example of the calculations described in this paragraph.

EXAMPLE OF EXTRAPOLATING COOLING TEST RESULTS – CELSIUS

Ambient temperature during test	32º C	Stabilized transmission sump temperature	118º C
L.A.T.	38º C	Stabilized converter out (to cooler) temperature	146º C
Engine manufacturer's top tank limit	105º C	Stabilized engine top tank temperature	102º C

Calculate difference between the recorded ambient temperature and the L.A.T.
L.A.T. - ambient temperature = 38º C - 32º C = 6º C

Extrapolate the engine and transmission temperatures to the L.A.T. by adding the difference to the recorded transmission and engine temperatures
Extrapolated sump temperature = stabilized sump temperature + 6º C = 118º C + 6º C = 124º C
Extrapolated converter out temperature = stabilized converter out (to cooler) temperature + 6º C = 146º C + 6º C = 152º C
Extrapolated top tank temperature = stabilized top tank temperature + 6º C = 102º C + 6º C = 108º C

The extrapolated transmission temperatures exceed the transmission limits. However, the extrapolated top tank exceeds the engine manufacturer's limit by 3º C, so the special case applies.

Calculate the difference between extrapolated engine top tank temperature and the engine manufacturer's limit
Extrapolated top tank temperature - engine manufacturer's limit = 108º C - 105º C = 3º C

Adjust the extrapolated transmission temperatures by the difference between the extrapolated top tank temperature and the engine manufacturer's limit
Adjusted sump temperature = extrapolated sump temperature - 3º C = 124º C - 3º C = 121º C
Adjusted converter out (to cooler) temperature = extrapolated converter out temperature - 3º C = 152º C - 3º C = 149º C

The adjusted transmission temperatures meet the transmission temperature limits in paragraph 5.5. Therefore, the transmission cooling system is acceptable.

EXAMPLE OF EXTRAPOLATING COOLING TEST RESULTS – FAHRENHEIT

Ambient temperature during test	90º F	Stabilized transmission sump temperature	245º F
L.A.T.	100º F	Stabilized converter out (to cooler) temperature	295º F
Engine manufacturer's top tank limit	220º F	Stabilized engine top tank temperature	215º F

Calculate difference between the recorded ambient temperature and the L.A.T.
L.A.T. - ambient temperature = 100º F - 90º F = 10º F

Extrapolate the engine and transmission temperatures to the L.A.T. by adding the difference to the recorded transmission and engine temperatures
Extrapolated sump temperature = stabilized sump temperature + 10º F = 245º F + 10º F = 255º F
Extrapolated converter out temperature = stabilized converter out (to cooler) temperature + 10º F = 295º F + 10º F = 305º F
Extrapolated top tank temperature = stabilized top tank temperature + 10º F = 215º F + 10º F = 225º F

The extrapolated transmission temperatures exceed the transmission limits. However, the extrapolated top tank exceeds the engine manufacturer's limit by 5º F, so the special case applies.

Calculate the difference between extrapolated engine top tank temperature and the engine manufacturer's limit
Extrapolated top tank temperature - engine manufacturer's limit = 225º F - 220º F = 5º F

Adjust the extrapolated transmission temperatures by the difference between the extrapolated top tank temperature and the engine manufacturer's limit
Adjusted sump temperature = extrapolated sump temperature - 5º F = 255º F - 5º F = 250º F
Adjusted converter out (to cooler) temperature = extrapolated converter out temperature - 5º F = 305º F - 5º F = 300º F

The adjusted transmission temperatures meet the transmission temperature limits in paragraph 5.5.
Therefore, the transmission cooling system is acceptable.

Figure 1: Example of Extrapolating Test Results

6.0 IDLE TEST

Allison Transmission requires that an idle test be performed as a part of the transmission cooling verification for all on-highway and on/off-highway transmissions and vocations. As a precaution, someone should remain in the vehicle for duration of the test.

Idle Test Procedure:

1. Assure that the thermostats and fan are operational. If the thermostats were blocked open and the fan locked on for previous testing, they must be restored to full operation for this test.
2. Record the ambient temperature at which the idle test is conducted.
3. Allison strongly recommends monitoring and recording the engine radiator top tank temperature during the test.
4. Set the Park Brake and block the wheels.
5. Set the engine at normal idle speed. Do not use high idle for air conditioning.
6. Shift the transmission to Drive.
7. Allow the vehicle to idle in range until either the transmission sump temperature limit or the converter out (to cooler) temperature limit has been reached. If neither transmission limit has been reached after 30 minutes, continue to the next step.
8. Record the transmission temperatures. If available, record the engine radiator top tank temperature.
9. After the transmission has reached temperature limits or idled in range for 30 minutes (whichever occurs first), continue to record data.
10. With the brakes applied and while recording data, shift the transmission to neutral and increase the engine speed to 1500–2000 rpm for approximately 30 seconds. This will assure that all of the oil is circulated out of the converter and through the cooling system.
11. Note the highest converter out (to cooler) temperature reached during the previous step, operation in neutral.

6.1 TEMPERATURE LIMITS

The transmission's maximum allowable temperatures are as follows:

Transmission Sump	121°C (250°F)
Transmission Converter Out (To Cooler)	149°C (300°F)

6.2 AMBIENT CONDITIONS

- Do not conduct the idle test in the rain.
- Cooling tests should be conducted at 38º C (100º F) ambient temperature. If the vehicle will be operated in an area with an L.A.T. greater than 38º C (100º F), Allison recommends that the tests be conducted in an ambient temperature close to the operational L.A.T. The minimum ambient temperature for the test is 20°C (68°F).

6.3 ENGINE COOLING SYSTEM

- Thermostats and fan must be operational.
- Coolant shall be a 50% antifreeze / 50% water mix or that specified by the OEM for vehicle operation.
- In the case where antifreeze is not specified for normal operation, but a corrosion inhibitor is specified, the coolant medium shall be at the percentage mix or the specific gravity specified.

6.4 AIR CONDITIONING

If the vehicle has air conditioning, the air conditioning must be operated at its maximum capacity for the duration of the test if **both** of the following apply:

- The air conditioning condenser is located in front of the engine coolant radiator
- The radiator fan operates normally, turning on and off based on coolant temperature

The air conditioning shall not be operational for the duration of the test if **one** of the following applies:

- The air conditioning condenser has a dedicated fan drive independent of the radiator
- The radiator fan is locked on whenever the air conditioning is on

6.5 TRANSMISSION SYSTEM

WARNING: When operating a transmission at stall conditions as instructed below, the vehicle must be prevented from moving. Both the parking and service brakes must be applied and the vehicle should be blocked to prevent movement. Warn personnel to keep clear of the vehicle and its travel path. Failure to do so may cause serious injury.

At the start of the IDLE test the transmission sump oil temperature shall be at a minimum of 90-100°C (194-212°F). This can be achieved by performing consecutive static stalls lasting no longer than 30 seconds in duration with Neutral breaks of 1 minute in between.

6.6 INTERPRETATION OF RESULTS

At the conclusion of the idle test, the transmission temperatures must be within the limits defined in paragraph 6.1. If the transmission temperatures exceed Allison's limits, a thermostat bypass may be required to provide coolant flow to the transmission cooler when the engine thermostat is closed.

For the IDLE Test, extrapolation of the results to the desired ambient temperature or L.A.T. is inappropriate because the engine thermostat is operational.

7.0 START/STOP TESTING REQUIREMENTS – RETARDER ONLY

0-20mph-0 Test:

1. Setup the retarder controls to provide 100% retarder apply automatically at closed throttle.
2. Accelerate at full throttle to 32 km/hr (20 mph).
3. Release accelerator, automatically applying retarder, bringing vehicle speed down to 16 km/hr (10 mph).
4. Apply service brakes to bring vehicle to stop.
5. Repeat test until sump temperature stabilizes. Stabilization typically requires 30 minutes to 1 hour of testing. Stabilization is attained when temperatures rise less than 0.6ºC (1.0ºF) in successive 5 minute periods.

0-30mph-0 Test:

1. Setup the retarder controls to provide 100% retarder apply automatically at closed throttle.
2. Accelerate at full throttle to 48 km/hr (30 mph).
3. Release accelerator, automatically applying retarder, bringing vehicle speed down to 16 km/hr (10 mph).
4. Apply service brakes to bring vehicle to stop.
5. Repeat test until sump temperature stabilizes. Stabilization typically requires 30 minutes to 1 hour of testing. Stabilization is attained when temperatures rise less than 0.6ºC (1.0ºF) in successive 5 minute periods.

0-40mph-0 Test:

1. Setup the retarder controls to provide 100% retarder apply automatically at closed throttle.
2. Accelerate at full throttle to 64 km/hr (40 mph).
3. Release accelerator, automatically applying retarder, bringing vehicle speed down to 16 km/hr (10 mph).
4. Apply service brakes to bring vehicle to stop.
5. Repeat test until sump temperature stabilizes. Stabilization typically requires 30 minutes to 1 hour of testing. Stabilization is attained when temperatures rise less than 0.6ºC (1.0ºF) in successive 5 minute periods.

Allison Transmission requires more than one test for the most severe start/stop duty cycles. Refer to Appendix A. If more than one test is required, the extrapolated temperatures from all tests must not exceed the transmission temperature limits.

7.1 TEMPERATURE LIMITS

The transmission's maximum allowable temperatures are as follows:

Transmission Sump	121°C (250°F)
Transmission Converter Out (To Cooler)	149°C (300°F)
Transmission Retarder Out – General Truck	165°C (330°F)
Transmission Retarder Out – Bus & Coach	149°C (300°F)

7.2 AMBIENT CONDITIONS

- Do not conduct cooling tests in the rain or on wet roads.
- Cooling tests should be conducted at 38º C (100º F) ambient temperature. If the vehicle will be operated in an area with an L.A.T. greater than 38º C (100º F), Allison recommends that the tests be conducted in an ambient temperature close to the operational L.A.T. The recommended minimum ambient temperature for the tests is 20°C (68°F).

7.3 ENGINE COOLING SYSTEM

- The engine must be run at its full power capability. All engine power cutback and derate features must be disabled or set to values that are outside of the operational range for the test. If this is not possible, the test should be run at an ambient temperature that allows the engine to operate at full power below the derate point. The resulting temperatures must then be extrapolated to the correct ambient temperature.
- The engine thermostats must be blocked open.
- The cooling fans must be locked in their maximum speed conditions.
- Testing should begin with the engine and cooling system at operational temperature. The engine water shall be at a minimum temperature of 70°C (158°F). This can be achieved in the thermostats open/fan on condition by temporarily switching the cooling fan off for a period of time to allow the engine to reach the desired temperature or by temporarily blocking air flow to the radiator.
- Coolant should be a 50% antifreeze / 50% water mix or that specified by the OEM for vehicle operation.
- In the case where antifreeze is not specified for normal operation, but a corrosion inhibitor is specified, the coolant medium should be the percentage mix or the specific gravity specified.
- Interior heating should be off.

7.4 AIR CONDITIONING

If the vehicle has air conditioning, the following shall apply:

- If the air conditioning condenser is located in front of the engine coolant radiator, the air conditioning must be operated at its maximum capacity for the duration of the test.

7.5 TRANSMISSION SYSTEM

WARNING: When operating a transmission at stall conditions as instructed below, the vehicle must be prevented from moving. Both the parking and service brakes must be applied and the vehicle should be blocked to prevent movement. Warn personnel to keep clear of the vehicle and its travel path. Failure to do so may cause serious injury.

At the start of the test the transmission sump oil temperature shall be at a minimum of 90-100°C (194-212°F). This can be achieved by performing consecutive static stalls lasting no longer than 30 seconds in duration with Neutral breaks of 1 minute in between.

Retarder Capacity Cutbacks

- Bus & Coach Vocations: No transmission oil temperature or engine water temperature based retarder capacity reduction shall be in operation during the tests. Extrapolated engine water temperature must not exceed the engine coolant trigger temperature for the cutback feature. This may require a calibration with this feature turned off or careful monitoring of the engine water to assure that it does not exceed the trigger temperature.

- Truck Vocations: All available retarder capacity cutback features may be utilized during the test. Normal transmission temperature limits apply, refer to paragraph 7.1.

7.6 VEHICLE

- The vehicle should be fully loaded to the maximum GVW or GCW.
- If the vehicle may be specified with a number of different axle ratios, the tests shall be conducted with the highest and lowest numerical values available. Acceptable test results from both low and high ratios cover the intermediate ratios.

7.7 EXTRAPOLATION AND INTERPRETATION OF RESULTS

In all cases the ambient temperature is to be noted during the tests and the actual measured oil temperatures extrapolated to compensate for the limiting ambient temperature (L.A.T.) applicable to the region in which the vehicle will operate.

Extrapolation Calculations:

1. During testing, record the ambient temperature.
2. During testing, record the maximum, stabilized temperatures for the transmission and the engine.
3. Calculate the difference between the recorded ambient temperature and the L.A.T.
4. To obtain the extrapolated temperatures, add the difference from step 3 to the transmission and engine temperatures which were recorded in step 2.
5. Compare the transmission extrapolated temperatures with the temperature limits in paragraph 7.1.
6. Compare engine extrapolated temperature to the engine manufacturer's limits.
7. If sump temperature exceeds 121°C (250°F) contact Application Engineering.

Interpretation of Results:

The transmission cooling system is acceptable if:

- The test conditions meet the conditions described for this test
- The maximum transmission temperatures, extrapolated to the L.A.T., are less than or equal to the limits listed in paragraph 7.1.

8.0 DOWNGRADE TESTING REQUIREMENTS – RETARDER ONLY

- Appendix A indicates which vocations require a Downhill retarder cooling test. If the vehicle is expected to operate on grades in the intended duty cycle, Allison strongly recommends that the vehicle builder perform retarder cooling tests on grades so that the cooling system limitation is known. The vehicle builder is responsible for designing a cooling system capable of retarder cooling on known grades.
- Using the applicable route as outlined in the regional requirements below. The vehicle shall negotiate the route maintaining as close as possible the permitted road speed limits.
- It is recommended that the lowest transmission range applicable to the route be engaged by pre-selecting prior to starting the test.
- Service brakes are allowed in addition to retarder where necessary to maintain safe road speeds.
- **It is recommended that the retarder be controlled by using a retarder apply lever.**
- ON GRADE SIMULATION WITH TOW BAR: Tow the vehicle at Draw Bar Pull equivalent to the regional grade and speed requirements as specified in 8.1 for a fully loaded vehicle. **It is recommended that the retarder be controlled by an infinitely variable pedal.**

8.1 DOWNGRADE TEST ROUTES BY REGION

The following routes are to be used for the downgrade retarder testing portion of the cooling test procedure. These routes have been defined regionally to adhere to the locally accepted or legislated practices.

8.1.1 NORTH AMERICA, SOUTH AMERICA & MEXICO REGION

Maintain 64 kph (40 mph) on a 6% grade for 20 minutes.
Alternate: If required to test at an alternate speed, maintain speed for 20 minutes on the grade as defined in Figure 2.

North America Alternate: Use Death Valley route from Town Pass to Stovepipe Wells maintaining the fully loaded vehicle at road speed limits by means of the retarder. Pre-selecting down to a lower gear is recommended. Service brakes are allowed in addition to retarder where necessary.

South America & Mexico Alternate: A test route agreed upon by Allison Transmission and the OEM which best simulates the above specification, except when the actual route in which the vehicle will operate is deemed to be more severe than the specification, then testing must be conducted on the actual route.

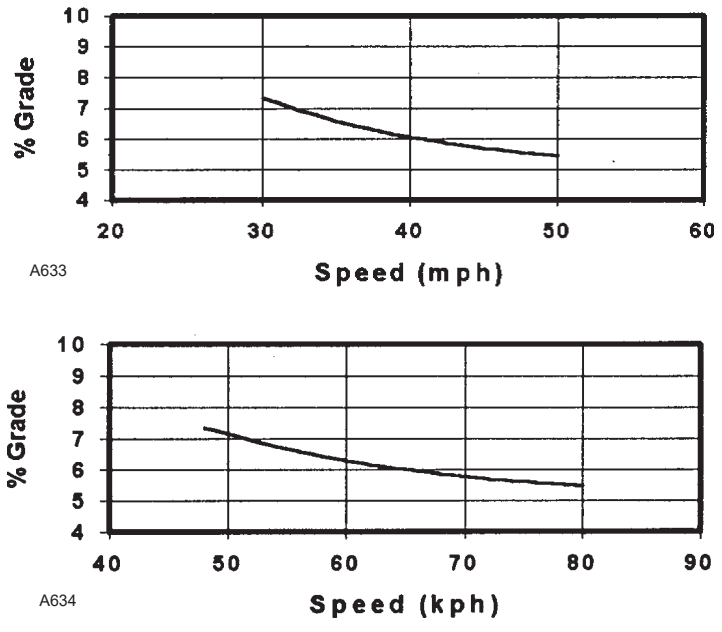

Figure 2: Percent Grade Verses Speed - N. America

8.1.2 ASIA PACIFIC REGION

Maintain 60 kph (38 mph) on an 8% grade for 15 minutes.

Japan Alternate: Run fully loaded vehicle downhill at Hakone Shindo maintaining speed limits with retarder only.

Taiwan Alternate: Run fully loaded vehicle down Yang Ming mountain maintaining speed limits with minimum possible service brake usage.

Other Asia Pacific Alternate: Operate fully loaded vehicle on the most severe grades it is expected to encounter in actual service.

8.1.3 EUROPE, MIDDLE EAST & AFRICA REGION

No one downhill test route is universally acceptable for Europe. If a downhill test route is desired, select a route where the test will conform to the speeds on grades as indicated in Figure 3.

The recommended test method is a tow test as described below:

- Choose the speed at which the vehicle can safely be towed. For test repeatability and comparison purposes, it is advantageous to conduct the test as close to the 64 km/hr point (equivalent to 6% grade) as possible.

NOTE: An output speed of at least 750 rpm must be maintained at all times.

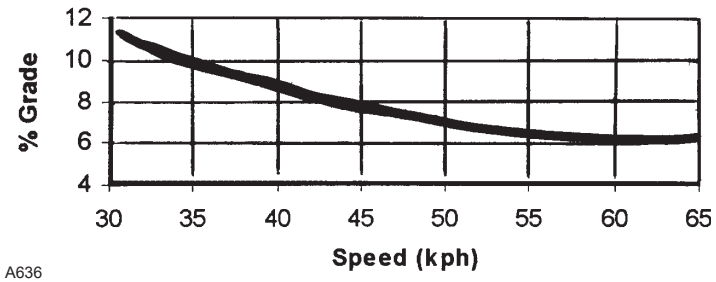

Figure 3: Percent Grade Verses Speed - Europe And Africa

- For slower towing speeds, determine the equivalent % grade from the chart in Figure 3.
- Calculate the equivalent drawbar pull using the following formula :

  Drawbar Pull = GVW x Grade x 0.009807 [kN]

- During the test, pre-select to a lower gear to bring engine speed up to that speed which would have prevailed on a 6% downgrade at 64 km/hr.
- The test is to be performed at the specified speed for 20 minutes.

Europe, Middle East & Africa Alternate: Where it is impractical to conduct a test on the approved grade as outlined above, a drawbar test shall be conducted as follows:

The vehicle being tested shall be towed with a rigid drawbar which is equipped with means of measuring the tensile load induced by the test vehicle's retarder. The test vehicle shall be towed at a speed of 64 km/hr (40 mph) with an induced drawbar load equal to 6% of the GVW for a period of 20 minutes. Pre-selecting down to a lower gear is recommended.

The following is an example of how to calculate tow (drawbar) load.

Metric units:

Drawbar Pull = GVW (kg) x Grade x .009807
= 20,000 kg x 0.06 x .009807
= 11.77 kN

English units:

Drawbar Pull = GVW (lb) x Grade
= 44000 lbs x 0.06
= 2640 lbs

8.2 TEMPERATURE LIMITS

The transmission's maximum allowable temperatures are as follows:

Transmission Sump	121°C (250°F)
Transmission Converter Out (To Cooler)	149°C (300°F)
Transmission Retarder Out – General Truck	165°C (330°F)
Transmission Retarder Out – Bus & Coach	149°C (300°F)

8.3 AMBIENT CONDITIONS

- Do not conduct cooling tests in the rain or on wet roads.
- Cooling tests should be conducted at 38° C (100° F) ambient temperature. If the vehicle will be operated in an area with an L.A.T. greater than 38° C (100° F), Allison recommends that the tests be conducted in an ambient temperature close to the operational L.A.T. The recommended minimum ambient temperature for the tests is 20°C (68°F).

8.4 ENGINE COOLING SYSTEM

- The engine must be run at its full power capability. All engine power cutback and derate features must be disabled.
- The engine thermostats must be blocked open.
- The cooling fans must be locked in their maximum speed conditions.
- Testing should begin with the engine and cooling system at operational temperature. The engine water shall be at a minimum temperature of 70°C (158°F). This can be achieved in the thermostats open/fan on condition by temporarily switching the cooling fan off for a period of time to allow the engine to reach the desired temperature or by temporarily blocking air flow to the radiator.
- Coolant should be a 50% antifreeze / 50% water mix or that specified by the OEM for vehicle operation.
- In the case where antifreeze is not specified for normal operation, but a corrosion inhibitor is specified, the coolant medium should be the percentage mix or the specific gravity specified.
- Interior heating should be off.

8.5 AIR CONDITIONING

If the vehicle has air conditioning, the following shall apply:

- If the air conditioning condenser is located in front of the engine coolant radiator, the air conditioning must be operated at its maximum capacity for the duration of the test.

8.6 TRANSMISSION SYSTEM

WARNING: When operating a transmission at stall conditions as instructed below, the vehicle must be prevented from moving. Both the parking and service brakes must be applied and the vehicle should be blocked to prevent movement. Warn personnel to keep clear of the vehicle and its travel path. Failure to do so may cause serious injury.

At the start of the test the transmission sump oil temperature shall be at a minimum of 90-100°C (194-212°F). This can be achieved by performing consecutive static stalls lasting no longer than 30 seconds in duration with Neutral breaks of 1 minute in between.

Retarder Capacity Cutbacks

- Bus & Coach Vocations: No transmission oil temperature or engine water temperature based retarder capacity reduction shall be in operation during the tests. Extrapolated engine water temperature must not exceed the engine coolant trigger temperature for the cutback feature. This may require a calibration with this feature turned off or careful monitoring of the engine water to assure that it does not exceed the trigger temperature.

• Truck Vocations: All available retarder capacity cutback features may be utilized during the test. Normal transmission temperature limits apply, refer to paragraph 8.2.

8.7 VEHICLE

• The vehicle should be fully loaded to the maximum GVW or GCW.
• If the vehicle may be specified with a number of different axle ratios, the tests shall be conducted with the highest and lowest numerical values available. Acceptable test results from both low and high ratios cover the intermediate ratios.

8.8 EXTRAPOLATION AND INTERPRETATION OF RESULTS

The actual measured oil temperatures must be extrapolated to compensate for the limiting ambient temperature (L.A.T.) applicable to the region in which the vehicle will operate.

Extrapolation Calculations:

1. During testing, record the ambient temperature.
2. During testing, record the maximum, stabilized temperatures for the transmission and the engine.
3. Calculate the difference between the recorded ambient temperature and the L.A.T.
4. Add the difference to the transmission and engine recorded temperatures during testing to obtain the extrapolated temperatures.
5. Compare the transmission extrapolated temperatures with the temperature limits in paragraph 8.2.
6. Compare engine extrapolated temperature to the engine manufacturer's limits.

Interpretation of Results:

The transmission cooling system is acceptable if:

• The test conditions meet the conditions described for this test
• The maximum transmission temperatures, extrapolated to the L.A.T., are less than or equal to the limits listed in paragraph 8.2.

APPENDICIES

• Appendix A - Cooling Requirements by Vocation
• Appendix B - Recommended Design Ambient Temperatures
• Appendix C - Cooling Test Instrumentation

Appendix A: Cooling Requirements by Vocation

SERVICE CATEGORY	APPLICATION CATEGORY	CONFIGURATION CATEGORY	iSCAAN VOCATION NUMBER	Required Converter Efficiency Cooling Point (Paragraph 5.0)	Idle Test (Paragraph 6.0)	Start/Stop Retarder Tests (Paragraph 7.0)			Downgrade Retarder Test (Paragraph 8.0)	Sump Cooling Required (Retarder Only)
						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Airport / Airport Support	Aircraft De-Icer	Straight Truck	10-10-10	85	X		X		see paragraph 8.0	
Airport / Airport Support	Aircraft Refueler	Straight Truck	10-15-10	85	X		X		see paragraph 8.0	
Airport / Airport Support	Aircraft Refueler	Tractor Trailer	10-15-20	85	X		X		see paragraph 8.0	
Airport / Airport Support	Aircraft Service Vehicle	Straight Truck	10-20-10	85	X		X		see paragraph 8.0	
Airport / Airport Support	Aircraft Service Vehicle	Tractor Trailer	10-20-20	85	X		X		see paragraph 8.0	
Airport / Airport Support	Aircraft Towing Vehicle	Tow Tractor	10-25-22	80	X		X		see paragraph 8.0	
Airport / Airport Support	Baggage Transport Vehicle	Straight Truck	10-35-10	85	X		X		see paragraph 8.0	
Airport / Airport Support	Baggage Transport Vehicle	Tow Tractor with Trailers	10-35-23	85	X		X		see paragraph 8.0	
Airport / Airport Support	Dump Truck - On-Highway	Straight Truck - with Snow Plow	10-40-11	85	X		X		see paragraph 8.0	
Airport / Airport Support	Dump Truck - On-Highway	Straight Truck - No Snow Plow	10-40-12	85	X		X		see paragraph 8.0	
Airport / Airport Support	Special Snow Removal Vehicle	Straight Truck - with Snow Plow	10-45-11	80	X		X		see paragraph 8.0	
Airport / Airport Support	Special Snow Removal Vehicle	Straight Truck - with Snow Blower	10-45-13	80	X		X		see paragraph 8.0	
Bus	Airfield Bus	Straight Vehicle	44-10-14	85	X		X		see paragraph 8.0	
Bus	Airfield Bus	Articulated Vehicle	44-10-30	85	X		X		see paragraph 8.0	
Bus	City / Transit Bus	Straight Vehicle	44-20-14	80	X		X	X	see paragraph 8.0	
Bus	City / Transit Bus	Articulated Vehicle	44-20-30	80	X		X	X	see paragraph 8.0	
Bus	City / Transit Bus - U.S. APTA	Straight Vehicle	44-65-14	80	X		X	X	see paragraph 8.0	
Bus	City / Transit Bus - U.S. APTA	Articulated Vehicle	44-65-30	80	X		X	X	see paragraph 8.0	
Bus	Intercity Bus	Straight Vehicle	44-25-14	80	X		X		X	X
Bus	Intercity Bus	Articulated Vehicle	44-25-30	80	X		X		X	X
Bus	Shuttle Bus	Straight Vehicle	44-30-14	80	X		X	X	see paragraph 8.0	
Bus	Suburban/Commuter	Straight Vehicle	44-15-14	80	X		X	X	see paragraph 8.0	
Bus	Tour Coach - City	Straight Vehicle	44-35-14	80	X		X	X	X	X
Bus	Tour Coach - City	Articulated Vehicle	44-35-30	80	X		X	X	X	X
Bus	Tour Coach - Cross Country	Straight Vehicle	44-40-14	80	X		X		X	X
Bus	Tour Coach - Cross Country	Articulated Vehicle	44-40-30	80	X		X		X	X
Bus - School	School Bus - North America	Straight Vehicle	42-10-14	85	X		X		see paragraph 8.0	
Bus - School	Non-School Use - North America	Straight Vehicle	42-20-14	85	X		X		see paragraph 8.0	
Bus - School	School Bus - Non-North America	Straight Vehicle	42-15-14	85	X		X		see paragraph 8.0	
Bus - School	Non-School Use - Non-North America	Straight Vehicle	42-25-14	85	X		X		see paragraph 8.0	
See Section 3.2 for 2900 Product Family cooling system requirements										

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SERVICE CATEGORY	APPLICATION CATEGORY	CONFIGURATION CATEGORY	iSCAAN VOCATION NUMBER	Required Converter Efficiency Cooling Point (Paragraph 5.0)	Idle Test (Paragraph 6.0)	Start/Stop Retarder Tests (Paragraph 7.0)			Downgrade Retarder Test (Paragraph 8.0)	Sump Cooling Required (Retarder Only)
						0-20-0 mph	0-30-0 mph	0-40-0 mph		
City Delivery	Armored Car	Straight Truck	12-10-10	85	X		X		see paragraph 8.0	
City Delivery	Beverage Delivery	Straight Truck	12-15-10	85	X		X		see paragraph 8.0	
City Delivery	Beverage Delivery	Tractor Trailer	12-15-20	85	X		X		see paragraph 8.0	
City Delivery	Flatbed	Straight Truck	12-20-10	85	X		X		see paragraph 8.0	
City Delivery	Flatbed	Tractor Trailer	12-20-20	85	X		X		see paragraph 8.0	
City Delivery	One Way Rental Truck	Straight Truck	12-25-10	85	X		X		see paragraph 8.0	
City Delivery	Stake Truck	Straight Truck	12-30-10	85	X		X		see paragraph 8.0	
City Delivery	Stake Truck	Tractor Trailer	12-30-20	85	X		X		see paragraph 8.0	
City Delivery	Tanker	Straight Truck	12-35-10	85	X		X		see paragraph 8.0	
City Delivery	Tanker	Tractor Trailer	12-35-20	85	X		X		see paragraph 8.0	
City Delivery	Van	Straight Truck	12-40-10	85	X		X		see paragraph 8.0	
City Delivery	Van	Tractor Trailer	12-40-20	85	X		X		see paragraph 8.0	
City Delivery	Walk-In Van	Straight Truck	12-45-10	85	X		X		see paragraph 8.0	
Construction	Backhoe - Mobile	Rigid Frame Vehicle	14-10-50	70	X				see paragraph 8.0	
Construction	Concrete Mixer	Straight Truck	14-15-10	85	X		X		see paragraph 8.0	
Construction	Concrete Pumper	Straight Truck	14-20-10	85	X		X		see paragraph 8.0	
Construction	Crane Carrier - Light	Rigid Frame Vehicle	14-25-50	80	X				see paragraph 8.0	
Construction	Crane Carrier - Heavy	Rigid Frame Vehicle	14-30-50	80	X				see paragraph 8.0	
Construction	Ditcher / Trencher	Rigid Frame Vehicle	14-35-50	70	X				see paragraph 8.0	
Construction	Dry Bulk - On/Off-Highway	Tractor Trailer	14-45-20	85	X				see paragraph 8.0	
Construction	Dump Truck - On/Off-Highway	Straight Truck - with Snow Plow	14-55-11	85	X		X		see paragraph 8.0	
Construction	Dump Truck - On/Off-Highway	Straight Truck - No Snow Plow	14-55-12	85	X		X		see paragraph 8.0	
Construction	Dump Truck - On/Off-Highway	Tractor Trailer	14-55-20	85	X		X		see paragraph 8.0	
Construction	Equipment Hauler - On/Off-Highway	Straight Truck	14-65-10	85	X		X		see paragraph 8.0	
Construction	Equipment Hauler - On/Off-Highway	Tractor Trailer	14-65-20	85	X		X		see paragraph 8.0	
Construction	Materials Hauler - On/Off-Highway	Straight Truck	14-75-10	85	X		X		see paragraph 8.0	
Construction	Materials Hauler - On/Off-Highway	Tractor Trailer	14-75-20	85	X		X		see paragraph 8.0	
Construction	Tanker - On/Off-Highway	Straight Truck	14-85-10	85	X		X		see paragraph 8.0	
Construction	Tanker - On/Off-Highway	Tractor Trailer	14-85-20	85	X		X		see paragraph 8.0	
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SERVICE CATEGORY	APPLICATION CATEGORY	CONFIGURATION CATEGORY	iSCAAN VOCATION NUMBER	Required Converter Efficiency Cooling Point (Paragraph 5.0)	Idle Test (Paragraph 6.0)	Start/Stop Retarder Tests (Paragraph 7.0)			Downgrade Retarder Test (Paragraph 8.0)	Sump Cooling Required (Retarder Only)
						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Crash / Rescue	Airport Crash / Fire / Rescue Vehicle	Straight Truck	16-10-10	85	X		X		see paragraph 8.0	
Crash / Rescue	Ambulance / Rescue Vehicle	Straight Truck	16-15-10	85	X		X		see paragraph 8.0	
Crash / Rescue	Mobile Command Center	Straight Truck	16-20-10	85	X		X		see paragraph 8.0	
Crash / Rescue	Mobile Command Center	Tractor Trailer	16-20-20	85	X		X		see paragraph 8.0	
Crash / Rescue	Support Vehicle	Straight Truck	16-25-10	85	X		X		see paragraph 8.0	
Crash / Rescue	Support Vehicle	Tractor Trailer	16-25-20	85	X		X		see paragraph 8.0	
Farm / Agriculture	Agricultural Blower	Rigid Frame Vehicle	18-10-50	70	X				see paragraph 8.0	
Farm / Agriculture	Agricultural Blower	Straight Truck	18-10-10	70	X				see paragraph 8.0	
Farm / Agriculture	Agricultural Hauler	Tractor with Trailers	18-15-24	70	X				see paragraph 8.0	
Farm / Agriculture	Agricultural Sprayer	Rigid Frame Vehicle	18-70-50	70	X				see paragraph 8.0	
Farm / Agriculture	Agricultural Sprayer	Straight Truck	18-70-10	70	X				see paragraph 8.0	
Farm / Agriculture	Agricultural Spreader	Rigid Frame Vehicle	18-75-50	70	X				see paragraph 8.0	
Farm / Agriculture	Agricultural Spreader	Straight Truck	18-75-10	70	X				see paragraph 8.0	
Farm / Agriculture	Cane Hauler	Tractor with Trailers	18-20-24	70	X		X		see paragraph 8.0	
Farm / Agriculture	Dump Truck - On/Off-Highway	Straight Truck	18-25-10	85	X		X		see paragraph 8.0	
Farm / Agriculture	Dump Truck - On/Off-Highway	Tractor Trailer	18-25-20	85	X		X		see paragraph 8.0	
Farm / Agriculture	Farm Tractor Field Operation	Articulated Vehicle	18-30-30	70	X				see paragraph 8.0	
Farm / Agriculture	Farm Tractor Field Operation	Rigid Frame Vehicle	18-30-50	70	X				see paragraph 8.0	
Farm / Agriculture	Feedlot Truck	Straight Truck	18-85-10	85	X		X		see paragraph 8.0	
Farm / Agriculture	Flatbed	Straight Truck	18-35-10	85	X		X		see paragraph 8.0	
Farm / Agriculture	Flatbed	Tractor Trailer	18-35-20	85	X		X		see paragraph 8.0	
Farm / Agriculture	Grain Truck	Straight Truck	18-40-10	85	X		X		see paragraph 8.0	
Farm / Agriculture	Grain Truck	Tractor Trailer	18-40-20	85	X		X		see paragraph 8.0	
Farm / Agriculture	Hay Squeezer	Rigid Frame Vehicle	18-45-50	80	X				see paragraph 8.0	
Farm / Agriculture	Immersion Applicator	Rigid Frame Vehicle	18-50-50	70	X				see paragraph 8.0	
Farm / Agriculture	Livestock Truck	Straight Truck	18-55-10	85	X		X		see paragraph 8.0	
Farm / Agriculture	Livestock Truck	Tractor Trailer	18-55-20	85	X		X		see paragraph 8.0	
Farm / Agriculture	Milk Tanker	Straight Truck	18-60-10	85	X		X		see paragraph 8.0	
Farm / Agriculture	Milk Tanker	Tractor Trailer	18-60-20	85	X		X		see paragraph 8.0	
Farm / Agriculture	Stake Truck	Straight Truck	18-80-10	85	X		X		see paragraph 8.0	
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						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Fire Service	Aerial Ladder / Platform	Straight Truck	20-10-10	85	X		X		see paragraph 8.0	
Fire Service	Aerial Ladder / Platform	Tractor Trailer	20-10-20	85	X		X		see paragraph 8.0	
Fire Service	Hazardous Material Vehicle	Straight Truck	20-15-10	85	X		X		see paragraph 8.0	
Fire Service	Hazardous Material Vehicle	Tractor Trailer	20-15-20	85	X		X		see paragraph 8.0	
Fire Service	Pumper - with Split Shaft PTO	Straight Truck	20-20-10	85	X		X		see paragraph 8.0	
Fire Service	Pumper - without Split Shaft PTO	Straight Truck	20-25-10	85	X		X		see paragraph 8.0	
Fire Service	Tanker	Straight Truck	20-30-10	85	X		X		see paragraph 8.0	
Fire Service	Tanker	Tractor Trailer	20-30-20	85	X		X		see paragraph 8.0	
Generic	On-Highway	Straight Truck - with Snow Plow	54-10-11	85	X		X		see paragraph 8.0	
Generic	On-Highway	Straight Truck - No Snow Plow	54-10-12	85	X		X		see paragraph 8.0	
Generic	On-Highway	Tractor Trailer	54-10-20	85	X		X		see paragraph 8.0	
Generic	On/Off-Highway	Straight Truck - with Snow Plow	54-15-11	85	X		X		see paragraph 8.0	
Generic	On/Off-Highway	Straight Truck - No Snow Plow	54-15-12	85	X		X		see paragraph 8.0	
Generic	On/Off-Highway	Tractor Trailer	54-15-20	85	X		X		see paragraph 8.0	
Heavy Haul	Equipment Hauler with Escort or Permit	Tractor Trailer	22-10-20	80	X				see paragraph 8.0	
Heavy Haul	Molten Metal / Slag Hauler	Articulated Vehicle	22-15-30	80	X				see paragraph 8.0	
Heavy Haul	Molten Metal / Slag Hauler	Rigid Frame Vehicle	22-15-50	80	X				see paragraph 8.0	
Heavy Haul	Power Plant Generator Hauler	Tractor Trailer	22-20-20	80	X				see paragraph 8.0	
Industrial	Hoist / Winch	Vehicle Mounted	24-15-51	70	X					
Industrial	Hoist / Winch	Stationary	24-15-52	70	X					
Industrial	Mobile Crane	Rigid Frame Vehicle	24-20-50	70	X				see paragraph 8.0	
Industrial	Railway Vehicle	Locomotive	24-30-60	70	X				see paragraph 8.0	
Industrial	Railway Vehicle	Maintenance Vehicle	24-30-61	70	X				see paragraph 8.0	
Industrial	Railway Vehicle	Powered Railcar	24-30-62	70	X				see paragraph 8.0	
Industrial	Railway Vehicle	Switcher	24-30-63	70	X				see paragraph 8.0	
Industrial	Snow Blower	Vehicle Mounted	24-35-51	70	X					
Industrial	Straddle Carrier	Rigid Frame Vehicle	24-40-50	80	X				see paragraph 8.0	
Industrial	Tracked Vehicle	Rigid Frame Vehicle	24-45-50	70	X				see paragraph 8.0	
See Section 3.2 for 2900 Product Family cooling system requirements										

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						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Line Haul	Automobile Transporter	Tractor Trailer	28-10-20	85	X				see paragraph 8.0	
Line Haul	Dry Bulk - Europe & South Africa	Tractor Trailer	28-35-20	85	X				see paragraph 8.0	
Line Haul	Dry Bulk - North America & Australia	Tractor Trailer	28-40-20	85	X				see paragraph 8.0	
Line Haul	Equipment Hauler No Permit/Escort - Europe & S. Africa	Tractor Trailer	28-15-20	85	X				see paragraph 8.0	
Line Haul	Equipment Hauler No Permit/Escort - N. Am & Australia	Tractor Trailer	28-20-20	85	X				see paragraph 8.0	
Line Haul	Flatbed - Europe & South Africa	Tractor Trailer	28-25-20	85	X				see paragraph 8.0	
Line Haul	Flatbed - North America & Australia	Tractor Trailer	28-30-20	85	X				see paragraph 8.0	
Line Haul	Livestock Hauler - Europe & South Africa	Tractor Trailer	28-45-20	85	X				see paragraph 8.0	
Line Haul	Livestock Hauler - North America & Australia	Tractor Trailer	28-50-20	85	X				see paragraph 8.0	
Line Haul	One Way Rental Truck	Straight Truck	28-55-10	85	X				see paragraph 8.0	
Line Haul	Tanker - Europe & South Africa	Tractor Trailer	28-60-20	85	X				see paragraph 8.0	
Line Haul	Tanker - North America & Australia	Tractor Trailer	28-65-20	85	X				see paragraph 8.0	
Line Haul	Van	Straight Truck	28-70-10	85	X				see paragraph 8.0	
Line Haul	Van - Europe & South Africa	Tractor Trailer	28-75-20	85	X				see paragraph 8.0	
Line Haul	Van - North America & Australia	Tractor Trailer	28-80-20	85	X				see paragraph 8.0	
Logging	Flatbed	Straight Truck	30-10-10	85	X		X		see paragraph 8.0	
Logging	Flatbed	Tractor Trailer	30-10-20	85	X		X		see paragraph 8.0	
Logging	Log Hauler - Off-Highway	Tractor Trailer	30-25-20	70	X				see paragraph 8.0	
Logging	Log Yarder	Stationary	30-15-52	70	X					
Logging	Wood Chip Hauler	Straight Truck	30-20-10	85	X		X		see paragraph 8.0	
Logging	Wood Chip Hauler	Tractor Trailer	30-20-20	85	X		X		see paragraph 8.0	
Military*	Wheeled - Combat	Straight Truck	52-15-10	80	X		X		see paragraph 8.0	
Military*	Wheeled - Support	Straight Truck	52-20-10	85	X		X		see paragraph 8.0	
Military*	Wheeled - Support	Tractor Trailer	52-20-20	85	X		X		see paragraph 8.0	
Military*	Wheeled - Tactical	Straight Truck	52-25-10	80	X		X		see paragraph 8.0	
* Refer to *TD147, Application Guidelines for Commercial Transmissions in Military Vehicles*										
See Section 3.2 for 2900 Product Family cooling system requirements										

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						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Mining	Dump Truck - On/Off-Highway	Straight Truck	32-10-10	85	X		X		see paragraph 8.0	
Mining	Dump Truck - On/Off-Highway	Tractor Trailer	32-10-20	85	X		X		see paragraph 8.0	
Mining	Hopper - On/Off-Highway	Tractor Trailer	32-15-20	85	X		X		see paragraph 8.0	
Off-Highway	Deep Pit Mine Truck	Rigid Frame Vehicle	36-15-50	70	X				X	
Off-Highway	High Gradeability Truck	Articulated Vehicle	36-10-30	70	X				X	
Off-Highway	Power Auger	Vehicle Mounted	36-30-51	70	X					
Off-Highway	Power Auger	Stationary	36-30-52	70	X					
Off-Highway	Scraper	Articulated Vehicle	36-20-30	70	X				X	
Off-Highway	Shallow Grade Long Haul Mining Truck	Tractor Trailer	36-25-20	70	X				X	
Off-Highway	Shallow Grade Long Haul Mining Truck	Rigid Frame Vehicle	36-25-50	70	X				X	
Off-Highway	Trencher	Vehicle Mounted	36-35-51	70	X					
Oil Field	Draw Works - Dual Mode	Straight Truck	38-10-10	80	X				see paragraph 8.0	
Oil Field	Draw Works - Dual Mode	Tractor Trailer	38-10-20	80	X				see paragraph 8.0	
Oil Field	Draw Works / Tubing - Winch Only	Vehicle Mounted	38-15-51	80	X					
Oil Field	Draw Works / Tubing - Winch Only	Stationary	38-15-52	80	X					
Oil Field	Pumping Equipment - Dual Mode	Straight Truck	38-20-10	80	X				see paragraph 8.0	
Oil Field	Pumping Equipment - Dual Mode	Tractor Trailer	38-20-20	80	X				see paragraph 8.0	
Oil Field	Pumping Equipment - Pump Only	Vehicle Mounted	38-25-51	80 *	X					
Oil Field	Pumping Equipment - Pump Only	Stationary	38-25-52	80 *	X					
Oil Field	Pumping Equipment - Twin Pump Only	Vehicle Mounted	38-35-51	80	X					
Oil Field	Pumping Equipment - Twin Pump Only	Stationary	38-35-52	80	X					
Oil Field	Service Truck - Vehicle Powertrain Only	Straight Truck	38-30-10	85	X		X		see paragraph 8.0	
Oil Field	Service Truck - Vehicle Powertrain Only	Tractor Trailer	38-30-20	85	X				see paragraph 8.0	
Oil Field	Tubing Only - Dual Mode	Straight Truck	38-40-10	80	X				see paragraph 8.0	
Oil Field	Tubing Only - Dual Mode	Tractor Trailer	38-40-20	80	X				see paragraph 8.0	
* The 4750 OFS has special cooling requirements; refer to *TD183, Application Requirements for the Oil Field Series (OFS) Transmissions*.										
See Section 3.2 for 2900 Product Family cooling system requirements										

Appendix A: Cooling Requirements by Vocation

SERVICE CATEGORY	APPLICATION CATEGORY	CONFIGURATION CATEGORY	iSCAAN VOCATION NUMBER	Required Converter Efficiency Cooling Point (Paragraph 5.0)	Idle Test (Paragraph 6.0)	Start/Stop Retarder Tests (Paragraph 7.0)			Downgrade Retarder Test (Paragraph 8.0)	Sump Cooling Required (Retarder Only)
						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Recreational	Motor Home	Straight Vehicle	34-10-14	85	X		X		see paragraph 8.0	
Recreational	Travel Coach	Straight Vehicle	34-15-14	85	X		X		see paragraph 8.0	
Recreational	Truck Based Recreational Vehicle	Straight Truck	34-20-10	85	X		X		see paragraph 8.0	
Recreational	Truck Based Recreational Vehicle	Tractor Trailer	34-20-20	85	X		X		see paragraph 8.0	
Refuse / Recycling	Front Loader - Landfill	Straight Truck - No Snow Plow	40-10-12	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Front Loader - No Landfill	Straight Truck - No Snow Plow	40-15-12	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Liquid Waste Hauler	Straight Truck	40-20-10	80	X		X		see paragraph 8.0	
Refuse / Recycling	Liquid Waste Hauler	Tractor Trailer	40-20-20	85	X				see paragraph 8.0	
Refuse / Recycling	Rear Loader - Landfill	Straight Truck - with Snow Plow	40-25-11	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Rear Loader - Landfill	Straight Truck - No Snow Plow	40-25-12	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Rear Loader - No Landfill	Straight Truck - with Snow Plow	40-30-11	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Rear Loader - No Landfill	Straight Truck - No Snow Plow	40-30-12	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Recycling Truck	Straight Truck	40-35-10	85	X		X		see paragraph 8.0	
Refuse / Recycling	Roll On / Roll Off - Landfill	Straight Truck - with Snow Plow	40-40-11	80	X		X		see paragraph 8.0	
Refuse / Recycling	Roll On / Roll Off - Landfill	Straight Truck - No Snow Plow	40-40-12	80	X		X		see paragraph 8.0	
Refuse / Recycling	Roll On / Roll Off - No Landfill	Straight Truck - with Snow Plow	40-45-11	80	X		X		see paragraph 8.0	
Refuse / Recycling	Roll On / Roll Off - No Landfill	Straight Truck - No Snow Plow	40-45-12	80	X		X		see paragraph 8.0	
Refuse / Recycling	Sewer / Septic Vacuum - Landfill	Straight Truck	40-50-10	80	X		X		see paragraph 8.0	
Refuse / Recycling	Sewer / Septic Vacuum - No Landfill	Straight Truck	40-55-10	80	X		X		see paragraph 8.0	
Refuse / Recycling	Side Loader - Landfill	Straight Truck - with Snow Plow	40-60-11	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Side Loader - Landfill	Straight Truck - No Snow Plow	40-60-12	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Side Loader - No Landfill	Straight Truck - with Snow Plow	40-65-11	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Side Loader - No Landfill	Straight Truck - No Snow Plow	40-65-12	80	X	X	X		see paragraph 8.0	
Refuse / Recycling	Transfer / Relocation Vehicle	Tractor Trailer	40-70-20	85	X				see paragraph 8.0	
See Section 3.2 for 2900 Product Family cooling system requirements										

Appendix A: Cooling Requirements by Vocation

SERVICE CATEGORY	APPLICATION CATEGORY	CONFIGURATION CATEGORY	iSCAAN VOCATION NUMBER	Required Converter Efficiency Cooling Point (Paragraph 5.0)	Idle Test (Paragraph 6.0)	Start/Stop Retarder Tests (Paragraph 7.0)			Downgrade Retarder Test (Paragraph 8.0)	Sump Cooling Required (Retarder Only)
						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Utility / Repair / Maintenance	Dump Truck - On-Highway	Straight Truck - with Snow Plow	46-10-11	85	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Dump Truck - On-Highway	Straight Truck - No Snow Plow	46-10-12	85	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Dump Truck - On-Highway	Tractor Trailer	46-10-20	85	x				see paragraph 8.0	
Utility / Repair / Maintenance	Dump Truck - On/Off-Highway	Straight Truck - with Snow Plow	46-15-11	85	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Dump Truck - On/Off-Highway	Straight Truck - No Snow Plow	46-15-12	85	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Dump Truck - On/Off-Highway	Tractor Trailer	46-15-20	85	x				see paragraph 8.0	
Utility / Repair / Maintenance	Municipal Services Maintenance Vehicle	Straight Truck	46-20-10	85	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Public Utility Vehicle - On-Highway	Straight Truck	46-25-10	85	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Public Utility Vehicle - On/Off-Highway	Straight Truck	46-30-10	85	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Special Snow Removal Vehicle	Straight Truck - with Snow Plow	46-35-11	80	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Special Snow Removal Vehicle	Straight Truck - with Snow Blower	46-35-13	80	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Street Cleaning Vehicle	Sweeper	46-40-40	80	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Street Cleaning Vehicle	Scrubber	46-40-41	80	x		x		see paragraph 8.0	
Utility / Repair / Maintenance	Street Cleaning Vehicle	Sprinkler	46-40-42	80	x		x		see paragraph 8.0	
Wrecker / Recovery	Platform Tilt Body	Straight Truck	48-10-10	85	x		x		see paragraph 8.0	
Wrecker / Recovery	Wrecker	Straight Truck	48-15-10	85	x		x		see paragraph 8.0	
See Section 3.2 for 2900 Product Family cooling system requirements										

Appendix A: Cooling Requirements by Vocation

SERVICE CATEGORY	APPLICATION CATEGORY	CONFIGURATION CATEGORY	iSCAAN VOCATION NUMBER	Required Converter Efficiency Cooling Point (Paragraph 5.0)	Idle Test (Paragraph 6.0)	Start/Stop Retarder Tests (Paragraph 7.0)			Downgrade Retarder Test (Paragraph 8.0)	Sump Cooling Required (Retarder Only)
						0-20-0 mph	0-30-0 mph	0-40-0 mph		
Yard Tractor / Spotter / Stevedoring	Dock Spotter	Tractor Trailer	50-10-20	80	x		x			
Yard Tractor / Spotter / Stevedoring	Port Tractor	Tractor Trailer	50-15-20	80	x		x			
Yard Tractor / Spotter / Stevedoring	Rail Yard Spotter - Improved and Level Surfaces	Tractor Trailer	50-20-20	80	x		x			
Yard Tractor / Spotter / Stevedoring	Rail Yard Spotter - Unimproved or Undulating Surfaces	Tractor Trailer	50-25-20	80	x		x			
Yard Tractor / Spotter / Stevedoring	Trailer Spotter - Improved and Level Surfaces	Tractor Trailer	50-30-20	80	x		x			
Yard Tractor / Spotter / Stevedoring	Trailer Spotter - Unimproved or Undulating Surfaces	Tractor Trailer	50-35-20	80	x		x			
Yard Tractor / Spotter / Stevedoring	Yard Tractor - Improved and Level Surfaces	Tractor Trailer	50-40-20	80	x		x			
Yard Tractor / Spotter / Stevedoring	Yard Tractor - Unimproved or Undulating Surfaces	Tractor Trailer	50-45-20	80	x		x			
See Section 3.2 for 2900 Product Family cooling system requirements										

APPENDIX B: RECOMMENDED DESIGN AMBIENT TEMPERATURES

SELECT AMBIENT (°C) FOR LOCATION OF VEHICLE USAGE

AFRICA

Algeria	50	Equatorial Guinea	38	Malawi	45	South Africa	38
Angola	38	Ethiopia	45	Mali	50	Sudan	50
Benin	45	Gabon	38	Mauritania	45	Swaziland	38
Bothuthatswana	38	Gambia	38	Morocco	45	Tanzania	38
Botswana	38	Ghana	45	Mozambique	45	Togo	45
Burundi	38	Guinea	45	Namibia	38	Transkei	38
Cameroon	45	Guinea Bissau	38	Niger	45	Tunisia	45
Central African Rep.	45	Ivory Coast	45	Nigeria	45	Uganda	38
Chad	50	Kenya	38	Rwanda	38	Upper Volta Rep.	45
Ciskei	38	Lesotho	38	Senegal	38	Venda	38
Congo Republic	38	Liberia	38	Seychelles	38	West Sahara	45
Dem. Rep. of Congo	38	Libya	50	Sierra Leone	38	Zambia	38
Djibouti	45	Madagascar	38	Somalia	45	Zimbabwe	38
Egypt	50						

ASIA

Afghanistan	45	Iraq	50	Nepal	38	Sri Lanka	38
Bahrain	50	Israel	45	North Korea	38	Syria	45
Bangladesh	45	Japan	38	Oman	50	Taiwan	38
Bhutan	38	Jordan	45	Pakistan	50	Thailand	45
Burma	45	Kampuchea	38	Phillipines	38	United Arab	50
China	38 (1)	Kuwait	50	Qatar	50	Vietnam	38
Hong Kong	38	Laos	45	Saudi Arabia	50	Yemen Arab Rep.	50
India	45 (2)	Lebanon	45	Sikkin	38	Yemen, People's Democratic Rep.	50
Indonesia	38	Malaysia	38	Singapore	38		
Iran	50	Mongolia	38	South Korea	38		

AUSTRALIA

Australia	45	New Guinea	38	New Zealand	38

CARIBBEAN ISLANDS

The Bahamas	38	Haiti	38	The Netherlands Antilles	38	Trinidad	38
Cuba	38	Jamaica	38			The Windward Islands	38
Dominican Repub.	38	Leeward Islands	38	Puerto Rico	38		

CENTRAL and SOUTH AMERICA

Argentina	38 (3)	Colombia	38	Guatemala	38	Paraguay	45
Belize	38	Costa Rica	38	Guyana	38	Peru	38
Bolivia	45	Ecuador	38	Honduras	38	Surinam	38
Brazil	38	El Salvador	38	Nicaragua	38	Uruguay	38
Chile	38	French Guiana	38	Panama	38	Venezuela	38

EUROPE

Albania	38	Denmark	38	Italy	38	San Marino	38
Andorra	38	The Faeroe Islands	38	Liechtenstein	38	Solvakia	38
Austria	38	Finland	38	Luxembourg	38	Spain	38
Belgium	38	France	38	Malta	38	Sweden	38
Bosnia-H'zogovina	38	Germany	38	Monaco	38	Switzerland	38
Bulgaria	38	Gibraltar	38	The Netherlands	38	Turkey	38
Conf. Indep. States	38	Greece	38	Norway	38	United Kingdom	38
Croatia	38	Hungary	38	Poland	38	Yugoslavia	38
Cyprus	38	Iceland	38	Portugal	38		
Czech Republic	38	Ireland (Eire)	38	Rumania	38		

NORTH AMERICA

Canada	38	Greenland	38	Mexico	33, 38, 45 (4)	United States	38 (5)

OCEANIC ISLANDS

Ascension Island	38	Galapagos Islands	38	Mauritius	38	Sao Tome & Principe	38
The Azores	38	Gilbert Islands	38	New Caledonia	38		
Bermuda	38	Graham Island	38	New Hebrides	38	Seychelles	38
Canary Islands	38	Madeira	38	Reunion	38	Society Islands	38
Cape Verde Islands	38	Maldive Islands	38	St. Helena	38	Solomon Islands	38
Falkland Islands	38	Marianas Islands	38	Samoa & Tonga	38	Tuamotu Islands	38
Fiji	38	Marshall Islands	38				

(1) Inland areas of central China (ex., Chungking) recommendation is 45°C.
(2) Northern plains area of Rajasthan Desert of India, recommendation is 50°C.
(3) Northern interior (ex., Santiago del Estero) of Argentina, recommendation is 45°C.
(4) For areas higher than 2,000 meters above sea level, the recommendation is 33°C.
For areas between 1,000 and 2,000 meters above sea level, the recommendation is 38°C.
For areas with altitude less than 1,000 meters above sea level and the Northern inland areas, the recommendation is 45°C.
(5) Certain areas of the Southwest region of the USA may require higher ambient capability.

38°C = 100°F
45°C = 113°F
50°C = 122°F

APPENDIX C-1: CONVERTER EFFICIENCY COOLING TEST INSTRUMENTATION

MINIMUM REQUIRED INSTRUMENTATION FOR PASS/FAIL COOLING TEST

Temperatures
- Ambient Air (38°C / 100° F or L.A.T. requested)
- Transmission Oil Sump
- Converter Oil Out or To Cooler Oil

Pressures
- Transmission Out (Converter out, to cooler)
- Transmission In

Speeds
- Engine Speed (rpm)
- Transmission Output Speed or Turbine Speed

NOTE: This level of instrumentation is sufficient to determine if the transmission temperature limits have been met. However, if there is a problem with the test or the test data, this level of instrumentation is insufficient for data analysis and troubleshooting. See paragraph 4.0.

RECOMMENDED INSTRUMENTATION

Temperatures
- Ambient Air
- Transmission Converter Out (To Cooler) Oil
- Transmission In Oil
- Transmission Sump Oil
- Radiator Coolant In (Engine Top Tank)
- Radiator Coolant Out (Engine Bottom Tank)
- Transmission Cooler Water (Coolant) In (remote transmission cooler only)

NOTE: Allison Transmission strongly recommends using this level of instrumentation. This level of instrumentation will allow data analysis and troubleshooting if there is a problem with the test, the test data, or the cooling system. See paragraph 4.0.

Pressures
- Transmission Converter Out (To Cooler)
- Transmission In

Speeds
- Engine Speed (rpm)
- Transmission Output Speed (rpm)

Flows
- Transmission Cooler Circuit Oil Flow
- Engine Coolant Circuit Flow
- Coolant Flow into Remote Oil-to-Water Cooler (if different than coolant circuit flow)

ADDITIONAL RECOMMENDED INSTRUMENTATION

Temperatures
- Transmission Cooler Water (Coolant) Out (remote transmission cooler only)
- Transmission Cooler Air Inlet Temperature (oil-to-air cooler only)
- Transmission Cooler Oil In
- Transmission Cooler Oil Out
- Air Temperature in Compartment Surrounding the Transmission
- Transmission Main Case Temperature at Point Closest to Exhaust

For a complete understanding of the transmission cooling system, add this instrumentation to the Recommended Instrumentation listed above.

Pressures
- Transmission Cooler Inlet
- Transmission Cooler Outlet

Speeds
- Transmission Turbine Speed
- Air Speed

Power
- For Chassis Dynamometer: Wheel Power
- For Driveline Dynamometer: Transmission Output Power or Torque
- For Towing Dynamometer: Absorption Power

NOTE: For all levels of instrumentation, the transmission temperatures must be measured by thermocouples inserted into the oil flow. The use of heat guns or thermocouples taped to the exterior of hoses or fittings is unacceptable.

APPENDIX C-2: RETARDER COOLING TEST INSTRUMENTATION

MINIMUM REQUIRED INSTRUMENTATION FOR PASS/FAIL COOLING TEST

Temperatures
- Ambient Air (38°C / 100° F or L.A.T. requested)
- Transmission Oil Sump
- Transmission Retarder Oil Out or To Cooler Oil

Pressures
- Transmission Out (Retarder out)
- Transmission In

Speeds
- Transmission Output Speed or Turbine Speed (rpm)

NOTE: This level of instrumentation is sufficient to determine if the transmission temperature limits have been met. However, if there is a problem with the test or the test data, this level of instrumentation is insufficient for data analysis and troubleshooting. See paragraph 4.0.

RECOMMENDED INSTRUMENTATION

NOTE: Allison Transmission strongly recommends using this level of instrumentation. This level of instrumentation will allow data analysis and troubleshooting if there is a problem with the test, the test data, or the cooling system. See paragraph 4.0.

Temperatures
- Ambient Air
- Transmission Retarder Out Oil
- Transmission Retarder In Oil
- Transmission Sump Oil
- Radiator Coolant In (Engine Top Tank)
- Radiator Coolant Out (Engine Bottom Tank)
- Transmission Retarder Cooler Water (Coolant) In
- Transmission Retarder Cooler Water (Coolant) Out
- Transmission Retarder Cooler Air Inlet (oil-to-air cooler only)

Pressures
- Transmission Retarder Oil Out
- Transmission Retarder Oil In

Speeds
- Engine Speed (rpm)
- Transmission Output Speed (rpm)

Flows
- Transmission Cooler Circuit Oil Flow
- Engine Coolant Circuit Flow
- Coolant Flow into Remote Oil-to-Water Cooler (if different than coolant circuit flow)

ADDITIONAL RECOMMENDED INSTRUMENTATION

Temperatures
- Transmission Retarder Cooler Oil In
- Transmission Retarder Cooler Oil Out
- Transmission Sump Cooler Oil In
- Transmission Sump Cooler Oil Out
- Transmission Sump Cooler Water (Coolant) In
- Transmission Sump Cooler Water (Coolant) Out

For a complete understanding of the transmission cooling system, add this instrumentation to the Recommended Instrumentation listed above.

Pressures
- Transmission Cooler Inlet
- Transmission Cooler Outlet

Speeds
- Transmission Turbine Speed

Power
- For Chassis Dynamometer: Wheel Power
- For Driveline Dynamometer: Transmission Output Power or Torque
- For Towing Dynamometer: Absorption Power

NOTE: For all levels of instrumentation, the transmission temperatures must be measured by thermocouples inserted into the oil flow. The use of heat guns or thermocouples taped to the exterior of hoses or fittings is unacceptable.

LIST OF REFERENCED DOCUMENTS

- *Transmission Cooling – Basic*
- *Transmission Cooling – Retarder*

- Transmission Data
  - *1000/2000 Product Family Transmission Data*
  - *2900 Product Family Transmission Data*
  - *3000 Product Family Transmission Data*
  - *4000 Product Family Transmission Data*

REVISION HISTORY

REVISION R, OCTOBER 4, 2022

- Added 3.2, 2900 Series Transmission Cooling System Requirements

REVISION Q, MAY 29, 2018

- Appendix A: Updated Military 52-15-10, 52-20-10, 52-20-20, and 52-25-10. Added Required Converter Efficiency Cooling Point, Idle Test, Start/Stop Retarder Tests, and Downgrade Retarder Test.

REVISION P, APRIL 28, 2017

- In various locations, added "To Cooler" to the description where previously Converter Out was used

REVISION N, OCTOBER 18, 2016

- In 7.4 and 8.5, remove sentence stating:
  "If the air conditioning condenser has a dedicated fan drive independent of the radiator, the air conditioning shall not be operational for the duration of the test."

REVISION M, MARCH 4, 2015

- In 7.0, remove two sentences stating:
  The 0-20mph-0 retarder cooling test is required for North America.
  The 0-20mph-0 retarder cooling test is recommended for all regions other than North America.

REVISION L, JANUARY 5, 2012

- In 6.0, Idle Test, added new step 3 to the Idle Test Procedure, recommending the monitoring and recording of the engine radiator top tank temperature.
- In 6.6, Interpretation of Results, added that extrapolation of results to the desired ambient or L.A.T. is inappropriate for the Idle Test because the engine thermostat is operational.

REVISION K, MARCH 9, 2011

- In 5.0, added reference to *Transmission Cooling – Basic* for converter matches with the 85% converter efficiency point near or at engine governed speed.
- In Appendix A, to the Oil Field / Pumping Equipment - Pump Only vocations, added footnote that the 4750 OFS has special cooling requirements.

REVISION J, JULY 17, 2008

- Added 3.1, Cooler Circuit Pressure Drop
- Modified 6.4, Air Conditioning for the Idle Stall Test, to require air conditioning off if the radiator fan is locked on whenever the air conditioning is on
- Updated references to new documents
- Added 2.0, Referenced Documents, and List of Referenced Documents; changed *Transmission Specifications* to *Transmission Data*.

REVISION H, JULY 24, 2007

- Appendix A: for the Farm/Agriculture Hay Squeezer vocation, 18-45-50, changed the required converter efficiency cooling point from 70% to 80%.