

Orange County Transportation Authority

# Maintenance Best Practices

CTA Conference – October 24, 2018

Presenter: Joe Townsend Sr. Fleet Analyst / OCTA

# OCTA Maintenance Best Practices Committee

Transmission Fluid & Filter Change Interval Project

## Allison Service Information Letter (SIL 10-TR-99)

Describes the latest requirements for determining the proper filter and oil change interval for Allison transmissions operating under “severe conditions.”

SIL states that Transmissions under “Severe” operating conditions could use a service interval of 75,000 mile filter change, and 150,000 mile fluid change.

# SIL 10-TR-99, Rev. S November, 2013

Filter Change Intervals, No Prognostics or when Prognostics is NOT Enabled/Turned OFF							
100 Percent Concentration Allison Approved TES 295 or TES 468 Fluids*			Allison Approved Non-TES 295 or Non-TES 468 Fluids*				
Main Filter	Internal Filter	Lube Filter	Main Filter		Internal Filter	Lube Filter	
General** or Severe*** 75,000 Miles (120 000 km) 3000 Hours 36 Months	Overhaul	General** or Severe*** 75,000 Miles (120 000 km) 3000 Hours 36 Months	General** 25,000 Miles (40 000 km) 1000 Hours 12 Months	Severe*** 12,000 Miles (20 000 km) 500 Hours 6 Months	Overhaul	General** 25,000 Miles (40 000 km) 1000 Hours 12 Months	Severe*** 12,000 Miles (20 000 km) 500 Hours 6 Months
Fluid Change Intervals, No Prognostics or when Prognostics is NOT Enabled/Turned OFF							
100 Percent Concentration Allison Approved TES 295 or TES 468 Fluids*				Allison Approved Non-TES 295 or Non-TES 468 Fluids*			
General** 300,000 Miles (480 000 km) 6000 Hours 48 Months		Severe*** 150,000 Miles (240 000 km) 6000 Hours 48 Months		General** 25,000 Miles (40 000 km) 1000 Hours 12 Months		Severe*** 12,000 Miles (20 000 km) 500 Hours 6 Months	
<p>* Less than 100 percent concentration Allison Approved TES 295 or TES 468 fluid is considered a mixture and should utilize Allison Approved Non-TES 295 or Non-TES 468 fluids change intervals.</p> <p>** General Vocation: Intercity Coach with duty cycle less than or equal to one (1) stop per mile and all other vocations not listed in severe vocation.</p> <p>*** Severe Vocation: All Retarders, On/Off Highway, Refuse, Transit, and Intercity Coach with duty cycle greater than one (1) stop per mile.</p>							









# High Capacity Filters & TES 295 Fluid Required

## High Capacity Filters & \*TES 295 Fluid:

- High capacity filters allow extended filter change intervals when used with Allison Approved TES 295 or TES 468 fluid.

\*TES = Transmission Engineering Standard

# TES 295 Approved Fluids Required

 TranSynd™ App Num: AN-011001	 Autran Syn 295™ App Num: AN-031002	 Emgard 2805™ App Num: AN-031003
 Fleetrite Synthetic ATF™ App Num: AN-031004	 Mobil Delvac Synthetic ATF™ / Mobil Delvac 1 ATF™ App Num: AN-051005	 Mack Synthetic ATF™ App Num: AN-1010007
 Shell Spirax S6 ATF A295™ App Num: AN-121008	 CNH HD Synthetic ATF™ App Num: AN-121009	

# Extension of Allison Transmission Fluid Change Interval

1. Previous Allison B400R & B500R fluid & filter change interval was 48K miles for both filter and fluid.
2. Allison was contacted to verify the SIL statement for “Severe” duty cycle vehicles using a 75K mile Filter, and 150K mile fluid change interval.
3. The ***mileage chart*** for determining the oil change interval being a ***requirement only if oil analysis is not being used, was clarified.***
4. The use of prognostics on the new Gen V transmissions.
5. And the fluid analysis program for monitoring the fluid.

# Severe Duty Cycle for Transit

Allison stated that the transit bus shifting ***duty cycle is too severe to use the 75K mile filter and 150K mile fluid change interval.***

So either the ***Allison Fluid and Filter Calculator*** should be used, or ***fluid analysis should be used*** to determine the service intervals.



# Prognostics

## Prognostics:

Allison recommended that ***Prognostics not be used*** on the Gen V transmissions, due to the excessive trouble lights of the system, at the time of our discussions.

# Preventive Maintenance Scheduling

## Hours vs. Miles:

- (4000/6000 Hour Based Maintenance) ***Allison provides a chart to determine the equivalent mileage based on the Allison recommended change intervals for Allison Approved TES 295 or TES 468 approved fluids.***
- A vehicle operating at 12 mph will travel approximately 72,000 miles in 6000 hours. If an odometer is used to determine when to change the transmission fluid and filters, this specific vehicle would change the fluid every 72,000 miles and filters every 36,000 miles.
- Allison provides an online calculator to determine the oil & filter change intervals.

# 4000/6000 Hour Based Maintenance lists the equivalent mileage

(Based on the Allison recommended change intervals for Allison Approved TES 295 approved fluids.)

4000 Hour Based Maintenance				6000 Hour Based Maintenance			
km/h Average	km Equivalent	MPH Average	miles Equivalent	km/h Average	km Equivalent	MPH Average	miles Equivalent
5	20000	3	12000	5	30000	3	18000
6	24000	4	16000	6	36000	4	24000
8	32000	5	20000	8	48000	5	30000
10	40000	6	24000	10	60000	6	36000
11	44000	7	28000	11	66000	7	42000
13	52000	8	32000	13	78000	8	48000
14	56000	9	36000	14	84000	9	54000
16	64000	10	40000	16	96000	10	60000
18	72000	11	44000	18	108000	11	66000
19	76000	12	48000	19	114000	12	72000
21	84000	13	52000	21	126000	13	78000
23	92000	14	56000	23	138000	14	84000
24	96000	15	60000	24	144000	15	90000
26	104000	16	64000	26	156000	16	96000
27	108000	17	68000	27	162000	17	102000
29	116000	18	72000	29	174000	18	108000
31	124000	19	76000	31	186000	19	114000
32	128000	20	80000	32	192000	20	120000
34	136000	21	84000	34	204000	21	126000
35	140000	22	88000	35	210000	22	132000
37	148000	23	92000	37	222000	23	138000
39	156000	24	96000	39	234000	24	144000
40	160000	25	100000	40	240000	25	150000

# Allison Transmission Fluid & Filter Change Based on Average MPH

- Fleet average MPH using Fleetwatch data.
  - This data is comprised of currently available Ellipse and Fleetwatch input.

VEHICLE	DATE RANGE	HOURS (Ave)	MILES (Ave)	MPH (Ave)
2154	7/1/2015 - 8/14/2015	13.1	175.6	13.4
5533	7/1/2015 - 8/14/2015	11.6	162.2	14.0
5544	7/1/2015 - 8/14/2015	11.7	182.7	15.6
5615	7/1/2015 - 8/14/2015	9.9	131.1	13.3
7602	7/1/2015 - 8/14/2015	14.3	161.8	11.3
7605	7/1/2015 - 8/14/2015	13.7	174.1	12.7
			Total Average MPH	13.4

# Allison Transmission Fluid & Filter Change Based on Allison Calculator

## Results

## BUS 5615

Transmission	3000 Product Families (MD 3000, B300-B400, T200, T300)
Fluid Type	<u>100% Allison Approved TES 295 fluid</u>
Vocation	Severe
Hours in Operation	3640
Annual Distance Traveled	47320 miles (75712 KM)
Average Speed	13 MPH (21 KMPH)
Transmission Fluid	78000 MILES (124800 KM) WHICH IS BASED ON 6,000 HOURS OF OPERATION
MAIN FILTER	39000 MILES (62400 KM) WHICH IS BASED ON 3,000 HOURS OF OPERATION
INTERNAL FILTER SCREEN	OVERHAUL
LUBE/AUXILIARY FILTER	39000 MILES (62400 KM) WHICH IS BASED ON 3,000 HOURS OF OPERATION
Notes	

# Transmission Fluid Analysis

- During normal operation, all components within the transmission experience wear, microscopic particles enter the fluid, and pass through the filters.
- Fluid laboratories can determine the elemental composition of the microscopic particles and will report their test results in parts per million (ppm).
- Absolute maximum values cannot be applied to wear metals of an automatic transmission due to the many variables that affect concentration limits.
- Recording the concentration levels of these particles over a period of time provides a “Trend Line” of information on the wear rate of certain internal components.

# Particle & Elemental Analysis

ELEMENT	ELEMENT SOURCE
Aluminum	<b><i>On-Highway: main case, converter, pistons.</i></b>
Barium	Detergent additives.
Boron	Detergent additive, supplementary coolant inhibitor additive.
Calcium	Detergent additive, sometimes present in road salt and “hard” water.
Copper	<b><i>Bushings, thrust washers, bearings, cooler tube bundles.</i></b>
Iron	Wide range of parts throughout transmission. Common source: any rotating part.
Lead	<b><i>Babbitt alloy found in some bushings.</i></b>
Magnesium	Detergent additive, traces in aluminum alloys, frequently present in hard water.
Molybdenum	Friction modifier additive.
Phosphorous	Wear inhibitor additive.
Silicon	Silicone gasket material, silicone anti-foam additive, ingested airborne sand or dust, alloying element in aluminum.
Silver	Specialized applications: sealrings, bearings, hydrostatic components.
Sodium	Detergent additive, supplementary coolant inhibitor additive, road salt.
Tin	<b><i>Babbitt found in some bushings, bronze bushings, thrust washers or some clutch plates.</i></b>
Zinc	Wear and oxidation inhibitor additive, brass components: speedometer gears, fluid couplings, etc.

# Allison requires specific tests that monitor fluid oxidation and viscosity changes.

Oxidation - The process of oxygen attacking petroleum fluids. Accelerates at high temperatures and with increased exposure to air. ***Oxidation creates chemical changes causing acidity and solid matter to form and an increase in viscosity.***

Carbonyl Absorbance - ***An indication of oxidation*** found by measuring the amount of infrared light absorbed at a 5.8 micron IR wavelength.

Solids - An undesirable, ***insoluble substance that forms due to fluid oxidation*** and/or interaction with water.

TAN (Total Acid Number) - TAN is measured by the amount of potassium hydroxide (KOH) needed to neutralize all or part of the fluid's acidity. ***This value is used to determine oxidation and the subsequent corrosion risk to the transmission.***



# Fluid Oxidation Measurement Limits

CONDITION	LIMIT
Viscosity	+/- 25% Change From New Fluid
Carbonyl Absorbance	+ 30* Change From New Fluid
Total Acid Number (TAN)	+ 3.0** Change From New Fluid
Solids	2% By Volume Maximum
* Carbonyl absorbance units/cm	
** mg of KOH required to neutralize a g of fluid	

# OCTA Contracted Oil Analysis Lab

- The Lab added the new oxidations tests and we started the transmission oil analysis program.
- Probylizers were added to the transmissions for extracting oil samples.

# 84,000 Mile Oil Analysis Test Result

7th Oil Analysis Test (84 K miles)						
Bus #	Base	Date of Sample	Viscosity	TAN	Solids	Carbonyl Absorbance (Oxidation)
			+/- 25% Change from new	+ 3.0 Change from new	2% by Volume Max	+ 30 units from new
5510	SA	8/14/2016	7.08	2.1	0	3
5545	SA	11/14/2016	7.15	1.7	0	2
5551	SA	8/31/2016	6.84	1.9	0	2
5625	SA	10/19/2016	6.87	1.8	0	2
5614	GG					
5127	GG	11/14/2016	6.88	1.9	0	1

New Oil	SA	8/3/2016	6.71	0.8	0	0
		Max	5.03 - 8.39	3.8		30

# Current Oil Analysis Driven Service Interval

**Allison Transmission recommends that customers use fluid analysis as the primary method for determining fluid change intervals.**

**Previous Transmission Oil Service using oil analysis:**

- 48,000 mile filter and fluid change

**Current Transmission Oil Service using oil analysis:**

- 42,000 mile filter change (reclaim oil drained during filter change, filtered and put back in bus)
- 84,000 mile filter & fluid change

**Potential future service intervals with oil analysis and Condition Monitoring:**

Oil analysis driven intervals:

- 51,000 mile filter change
- 102,000 mile filter and fluid change

# Oil & Filter Change Interval Savings

B500R 48K	48K	6 years	36 Buses (1 Yr)	36 Buses (6 yrs)	36 Buses (12 yrs)
Oil & Filter Change	\$194	\$ 1,164.00	\$ 6,984.00	\$ 41,904.00	\$ 83,808.00

B500R 84K	84K Oil Change	6 years	36 Buses (1.75 Yr)	36 Buses (6 yrs)	36 Buses (12 yrs)
Oil Change	\$98	\$ 333.20	\$ 3,528.00	\$ 11,995.20	\$ 23,990.40
42 K Filter Change	\$96	\$ 671.16	\$ 3,451.68	\$ 24,161.76	\$ 48,323.52

Totals: \$ 36,156.96 \$ 72,313.92  
**Savings: \$ 5,747.04 \$ 11,494.08**

**Savings on B500R: \$5,747 in 6 years & \$11,494 in 12 years**

B400R 48K	48K	6 years	494 buses (1 Yr)	494 Buses (6 Yrs)	494 Buses (12 Yrs)
Oil & Filter Change	\$194	\$1,164	\$ 95,836.00	\$ 575,016.00	\$ 1,150,032.00

B400R 84K	84K Oil Change	6 Years	494 buses (1 Yr)	494 buses (6 Yrs)	494 buses (12 Yrs)
Oil Change	\$98	\$343.00	\$ 48,412.00	\$ 169,442.00	\$ 338,884.00
42 K Filter Change	\$96	\$672	\$ 47,424.00	\$ 331,968.00	\$ 663,936.00

Totals: \$ 501,410.00 \$ 1,002,820.00  
**Savings: \$ 73,606.00 \$ 147,212.00**

**Savings on B400R: \$73,606 in 6 years & \$147,212 in 12 years.**

*Note: 84K mile interval equates to approximately 1.75 years for each oil change; and 7 filter changes in 6 years.*

# Next Step - Condition Monitoring

## Condition Monitoring

### Current Process

Samples are taken at time of PM Inspection and sent to the laboratory, and results are emailed to bases and reviewed by the Maintenance Supervisor.


### Process being implemented

A csv file of the electronic results of our fluid testing will be sent by the lab, which will be interfaced into the Ellipse Asset Management System when the interface is completed.

- Condition Monitoring is set up with warning and/or alarm values for each of the required analysis parameters.
- If the results go past the set parameters an alarm or warning is triggered and the supervisors are notified.
- A Standard Job is linked to the warning/alarm with instructions depended upon the parameter and analysis level.

We currently are using Condition Monitoring for our coolant testing. For the coolant testing that is currently entered manually we have warnings set if they enter an incorrect value, outside of what an entry for that value would be like a +60 for freeze point, and alarms if they enter a value that is past the alarm range.

# Condition Monitoring History

OCTA - PRD - Production 8.9.9.1 1 of 1 Quick Launch 


MSE345 - Search Condition Monitoring Measurements Search New Search Saved Searches Create or Open Measurements

Search

Equipment Reference: 5124  
Modifier Code:   
Monitoring Type: CO COOLANT ANALYSIS  
Alarm Type:   
Work Group:

Component Code: CO00 COOLING SYSTEM  
Position Code:   
Start Date:   
Work Order:   
Assigned To:

Search Results

Equip Ref	Comp Code	Mod Code	Position	Mon Type	Meas Date	Meas Time	Alarm Indicat	Alarm Dst	Alarm WO
5124	CO00 - COOLING SY			CO - COOLANT AI	09/10/2018	00:00:00		0001 - OCTA PROD	00955592
5124	CO00 - COOLING SY			CO - COOLANT AI	08/02/2018	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	06/16/2018	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	05/01/2018	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	03/09/2018	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	12/14/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	11/07/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	09/01/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	07/20/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	06/10/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	04/20/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	02/28/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	01/11/2017	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	11/19/2016	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	10/04/2016	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	08/31/2016	00:00:00			
5124	CO00 - COOLING SY			CO - COOLANT AI	08/03/2016	00:00:00		0001 - OCTA PROD	00814623
5124	CO00 - COOLING SY			CO - COOLANT AI	04/13/2016	00:00:00			

You can see the history of the analysis being conducted for an individual bus; when there is an alarm icon, you can **click on the icon to see which parameter set the alarm** and the work order and Standard Job for that failure.

# Coolant Condition Monitoring

OCTA - PRD - Production 8.9.9.1 1 of 1 Quick Launch

MSE345 - Search Condition Monitoring Measurements | MSE345 - Update Condition Monitoring Measurements

Submit Refresh New Search Create or Open Measurements Create Work Order Next

Equipment Reference: 5124  
2008 40' NEW FLYER - CUMMINS ISL G NZ  
Component Code: CO00 COOLING SYSTEM  
Position Code:   
Modifier Code:   
Monitoring Type: CO COOLANT ANALYSIS  
C40LFR-SR1273 - VIN: 5FYC5FB188C033782

Condition Monitoring Set Measurements | Condition Monitoring History | Chart

Measure Date: 09/10/2018 Measure Time: 00:00:00

Meas Type	UOM	CM Input	Alarm Indicat	Alarm WO	Std Job	Upper Danger	Lower Danger	Upper Caution	Lower Caution
1FREEZE - FREEZEPOINT [ENTER NEGATIVE VALUES]	F	-60				61	-80	11	-61
2NITRITE - NITRITE[A=1,B=2,C=3,D=4,E=5,F=6,G=7,H=8]	U	7.0				20.0	-10.0	9.0	0.1
3MOLY - MOLYBDATE [0 - 6]	U	3				20	-10	7	-1
4SCA - SCA UNITS	PPM	3.3		00955592	000713	3.1	1.1	3.1	1.1
5PH - COOLANT PH(PASS=1/FAIL=0)	PASS/FAIL	1.0				20.0	0.1	1.1	0.1
6SULF - SULFATES(PASS=1/FAIL=0)	PASS/FAIL	1.0				20.0	0.1	1.1	0.1
7CHLO - CHLORIDE(PASS=1/FAIL=0)	PASS/FAIL	1.0				20.0	0.1	1.1	0.1

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After opening the alarm indicator icon, there is an alarm in the SCA Unit readings, ***the SCA unit maximum allowable limit is 3.1 ppm, and the actual SCA was 3.3 ppm.*** A work order was generated to drain half the coolant, and refill with fresh coolant, which replenish the SCA additives required.



# OCTA Maintenance Best Practices Committee

## Wheel Bearing Repack Interval Extension

# Grease Analysis for Wheel Bearing Repack Interval Extension

1. Front wheel bearing repack required every 36k miles on the MAN V8-65L front axle. Maintenance Best Practices Group discussed the possibility of extending the interval for repacking the bearings with MAN.
2. Grease analysis was discussed with MAN, to determine the condition of the grease over time.
3. SGS Herguth Laboratories, Inc. was used to perform the grease analysis.
  1. A review of water content by Karl Fischer analysis,
  2. Wear metals by Optical Emission Spectrometry
  3. Die extruder flow properties as compared to a reference product, and
  4. Review ferrous debris content.

# Results of Grease Analysis

Test Results	Suggestion
<b>Abnormal:</b> water detected in lubricant	Purge grease
<b>Abnormal:</b> High level of iron, may indicate rust	Purge grease
<b>Abnormal:</b> Silicon and wear indicates there may be dirt in the lubricant. Iron may indicate wear and/or corrosion (rust). PQ index indicates ferrous particulate is high.	Purge grease
<b>Acceptable:</b> Silicone sealant material may be present. Low wear rates suggest this is not dirt (silica). Die Extrusion Index appears acceptable.	Monitor
<b>Monitor:</b> Iron may indicate wear and/or corrosion (rust). Die Extrusion Index appears acceptable.	Monitor
<b>Abnormal:</b> water detected in lubricant	Purge grease
<b>Abnormal:</b> Water detected in lubricant and is higher than acceptable; check for source. Silicon and wear indicates there may be dirt in the lubricant	Purge grease
<b>Abnormal:</b> Water detected in lubricant and is higher than acceptable; Silicon and wear indicates there may be dirt in the lubricant.	Purge grease
<b>Abnormal:</b> Silicon and wear indicates there may be dirt in the lubricant. Bushing / Bearing wear is detected	Purge grease
<b>Abnormal:</b> Water detected in lubricant and is higher than acceptable; check for source. Silicon and wear indicates there may be dirt in the lubricant.	Purge grease
<b>Abnormal:</b> Dirt in the lubricant. Bushing / Bearing wear is detected.	Purge grease

# Summary

## Transmission Fluid & Filter Change Interval Extension

- Severe duty vehicles must use the average miles per hour and the chart or Allison calculator, or fluid analysis to determine the service intervals to prevent voiding warranty.
- Oil analysis allows for an extended service interval for severe duty vehicles, as long as Allison fluid oxidation parameters are not exceeded, and wear metals are not excessive.
- Interval extension testing was successful, and Condition Monitoring will allow this process to be automated.

## Wheel Bearing Repack Interval Extension

- Grease contamination due to water intrusion, and dirt found at the recommended interval
- Interval extension testing failed.

# Questions ?

Thank you. Any Questions?