



## **Committee D-2 ON PETROLEUM PRODUCTS AND LUBRICANTS**

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September 9, 1999

Reply to:  
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**UNAPPROVED MINUTES**

**OF THE**

**T-10 OPERATIONS AND HARDWARE**

**TASK FORCE MEETING #2**

**Richmond, Va**

Chairman Jim Collum convened the second meeting of the T-10 Operations and Hardware Task Force at 10:00 am at Ethyl Corporation in Richmond, Va. The attendance roster is included as Attachment 1. The meeting agenda is included as Attachment 2.

#### MEMBERSHIP

No changes were announced.

#### MINUTES OF JULY 22, 1999 MEETING

The minutes of meeting #1 were approved without modification.

#### OIL TEMPERATURE CONTROL

Bob Campbell of Ethyl presented a design modification for the oil cooler temperature control. The design divorces the oil cooler from the engine coolant so that process water can be used for the oil temperature control loop. Labs will need to cut away the section of the oil cooler water inlet pipe that contains the thermostat bypass. The oil cooler water outlet connection uses only an O-ring and therefore the water outlet pipe needs to be secured either to the engine block or to the water inlet pipe. A motion to adopt this design passed unanimously. A sketch of the design is included as Attachment 3.

#### INLET AIR HUMIDITY

The task force resumed its July discussion of humidity, its possible effects on the test, and the possibility of controlling humidity levels. Riccardo Conti of Mobil stated that humidity is not just an intake air control issue, but that it will be impacted by the EGR gas as well (Riccardo's overhead is Attachment 4). A long discussion followed Riccardo's comments. After a lot of speculation as to the possible effects of humidity, the general consensus was that, due to the lack of data at various humidity levels, the discussion might be premature. The group then attempted to plot a strategy for handling the issue. It was agreed that staying away from condensation was a must. The labs agreed to measure inlet air dew point. Mack agreed to investigate humidity data from the exhaust gas. A quick survey of laboratory humidity control capabilities was taken: LZ can control humidity; SR would like to run at different humidity levels using chillers; EG would also use chillers to control humidity; AL can avoid extremes in humidity but is not prepared to hold control. John Graham stated that Cummins has found that a change in manifold temperature from 140° to 115° might produce a tenfold increase in wear and that water from combustion is a controlling factor. The discussion concluded with the understanding that data from various humidity levels was needed and that this issue needs to be revisited in the near future so that the strategy regarding humidity can be put in place as soon as possible.

#### AIR/FUEL RATIO

The group recalled the July discussion of AFR. Fuel flow is to meet the spec (controlled either directly or from torque) and air mass flow is to be measured. The AFR is then used as the

feedback control for EGR mass flow. The discussion then centered on how to measure AFR. It was decided that both air mass and exhaust O<sub>2</sub> would be measured. The hope is that a quantifiable relationship exists between the two that would allow the use of only the O<sub>2</sub> sensor. There was concern about the difficulty of measuring air mass flow. The J-TEC device that was recommended at the July meeting might not be sufficiently accurate. The group decided not to specify any measurement device until data was available.

#### LAB VISITATION GROUP PROTOCOL

Jim Collum and Jeff Clark presented a draft of the lab visit checklist (Attachment 5). It was noted that some significant portions of the checklist would not be finalized until the procedure is available. The lab visit group was formed with the following members: Jeff Clark, Jim Collum, Bob Campbell, Ken Goshorn, Mark Cooper, Dino Righi, and Jim Wells (or designate).

#### PARTS LIST

Ken Goshorn presented the parts list (Attachment 6). The camshaft is an experimental part and is not available from a dealer. It must be obtained through Ken. The EGR part are also available only through Ken. These parts may eventually be available from Test Engineering.

#### OIL CHARGE

Jim Collum opened a discussion on reducing the oil charge from the T-9 quantity of 48 quarts to 40 quarts. The motivation is to keep a shorter test length. Greg Shank stated that a sump level reduction would create a closer reflection of field sump levels. The reduction in oil charge is accomplished by lowering the aux. oil system suction line tap by an inch on the oil pan. A motion to adopt was passed without objection. Note, the oil charge amounts will be converted to mass in the procedure.

#### FORCED OIL ADDITION AND OIL SAMPLES

The panel discussed several options on oil sampling and oil additions. Most of the debate was comparing the benefits of a forced oil addition, an oil makeup addition, or no addition at all. At the end of the discussion, the following motions were adopted without objection: 4 oz. oil samples are to be taken every 25 hours; forced oil additions (same manner as T-8 and T-9) of 3 lbs. are to be performed every 50 hours. The oil sample volume is not to be replaced and oil samples are to be taken before the forced oil addition.

#### NEXT MEETING

The next meeting is to occur in mid or early October.

POST MEETING NOTES

The O&H group quickly reconvened the afternoon of September 9<sup>th</sup> in Ethyl's T-10 test cell. Upon reviewing the test stand, the group agreed to the following: the EGR coolant return is to be piped to the elbow just before the water pump inlet; the temperature and pressure measurement locations just before the venturi are to be arranged so that the pressure tap is located upstream of the thermocouple (Attachment 7).

# Attachment 1

## T-10 Operations and Hardware Task Force Meeting Attendance: September 9, 1999

Name	Company	Mailing Address	Phone	Fax	E-mail
Ron Buck	Test Engineering, Inc.	12758 Cimarron Path, Suite 102, San Antonio, TX 78249-3417	210-690-1958	210-690-1959	rbuck@testeng.com
Bill Buscher	Texaco Global Products	P.O. Box 112, Hopewell Jct., NY 12533	914-897-9659	914-897-8069	buschwa@aol.com
Bob Campbell	Ethyl Corporation	500 Spring Street, Richmond, VA 23218-2158	804-788-5340	804-788-6358	Bob_Campbell@ethyl.com
Jeff Clark	ASTM TMC	6555 Penn Ave., Pittsburgh, PA 15206	412-365-1032	412-365-1047	jaclark@andrew.cmu.edu
Gil Clark	Specified Fuels & Chemicals	7 W. Square Lake Rd., Bloomfield Hills, MI 48302	248-452-5659	248-333-7999	gclark@americenters.com
Jim Collum	EG&G Automotive Research Inc.	5404 Bandera Rd., San Antonio, TX 78238-1993	210-523-4681	210-523-4607	Jim_Collum@egginc.com
Riccardo Conti	Mobil Technology Company	Paulsboro Tech. Center, 600 Billingsport Rd., Paulsboro, NJ 08066-0480	609-224-2681	609-224-3628	riccardo_conti@email.mobil.com
Mark Cooper	Chevron Chemical Company	4502 Centerview Dr., Suite 210, San Antonio, TX 78228	210-731-5606	210-731-5699	mawc@chevron.com
Ken Goshorn	Mack Trucks, Inc.	13302 Pennsylvania Ave., Hagerstown, MD 21742	301-790-5848	301-790-5605	kenneth.goshorn@macktrucks.com
John Graham	Cummins Engine Co.	Mail Code 50184, 1900 McKinley Ave., Columbus, IN 47201	812-377-6559	812-377-7808	j.p.graham@ctc.cummins.com
Aimin Huang	Equilon Enterprises LLC	P.O. Box 1380, Houston, TX 77251-1380	281-544-8972	281-544-8150	ahuang@equilon.com
Steve Kennedy	Mobil Technology Company	Paulsboro Tech. Center, 600 Billingsport Rd., Paulsboro, NJ 08066-0480	609-224-2432	609-224-3678	steven_kennedy@email.mobil.com
Rick Klein	Chevron Chemical Company	Oromite, 30150 Telegraph Rd., Suite 416, Bingham Farms, MI 48205	248-540-3277	248-540-3279	rmkl@chevron.com
Bill Larch	Lubrizon Corp.	29400 Lakeland Blvd., Wickliffe, OH 44092-2298	440-943-1200	440-943-9013	wtl@lubrizon.com
Brian Lawrence	Infineum	4335 Predras Dr. W., Suite 101, San Antonio, TX 78228	210-732-8123	210-732-8480	BJLRoyal@aol.com
Don Marn	Lubrizon Corp.	29400 Lakeland Blvd., Wickliffe, OH 44092-2298	440-943-1200 x 1481	440-943-2360	djm@lubrizon.com
Charlie Passut	Ethyl Corporation	500 Spring Street, Richmond, VA 23218-2158	804-788-6372	804-788-6388	Charlie_Passut@ethyl.com
Dino Righi	Lubrizon Corp.	29400 Lakeland Blvd., Wickliffe, OH 44092-2298	440-943-1200 x4436	440-943-9013	dwri@lubrizon.com
Jerry Schaus	AutoResearch Laboratories, Inc.	6735 S. Old Hartlem Ave., Chicago, IL 60638	708-563-4257	708-563-0087	schaus.ali@cwixmail.com
Greg Shank	Mack Trucks, Inc.	13302 Pennsylvania Ave., Hagerstown, MD 21742	301-790-5817	301-790-5815	greg.shank@macktrucks.com
Mark Sutherland	Ethyl Corporation	9901 IH 10 West, Suite 800, San Antonio, TX 78230	210-558-2818	210-696-4029	mark_sutherland@ethyl.com
Gary Tietze	Test Engineering, Inc.	12758 Cimarron Path, Suite 102, San Antonio, TX 78249-3417	210-877-0223	210-690-1959	gtietze@testeng.com
Wim Van Dam	Chevron Chemical Company	100 Chevron Way, Richmond, CA 94802	510-242-1404	510-242-3173	WVDA@chevron.com
Jim Wells	Southwest Research Institute	6220 Culebra Rd., P.O. Drawer 28510, San Antonio, TX 78228-0510	210-522-5918	210-523-6919	jwells@swri.edu

# Attachment 2

## Mack T-10 Operations and Hardware Task Force Meeting

**Date: September 3, 1999**

**Time: 10:00 AM**

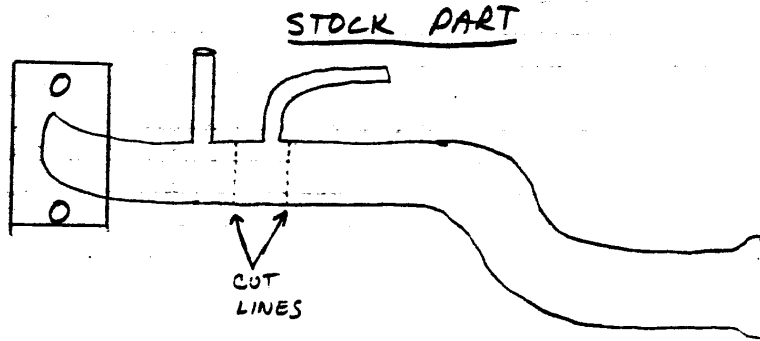
**Location: Ethyl Petroleum Additives, Richmond, VA**

### Agenda:

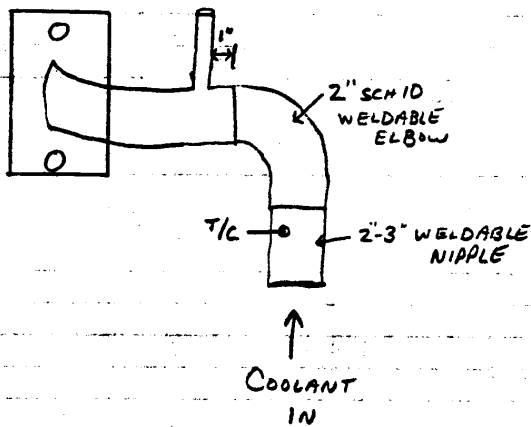
1. **Membership**
2. **Minutes of 7/22/99**
3. **Oil Temperature Control                      Group**
4. **Inlet Air Humidity                              Group**
5. **AFR    Group**
6. **Lab Visitation Checklist                      Group**
7. **New Business**
8. **Next Meeting**

# Attachment 3

## WATER INLET/OIL COOLER TEMP MODIFICATION



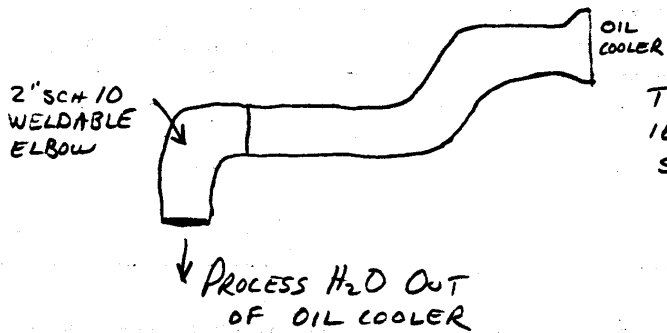
### WATER INLET



NOTE:

SINCE THE OIL COOLER OUTLET PIPE IS ONLY AN "O" RING SEAL, THIS PIECE WILL NEED TO BE SECURED EITHER TO THE BLOCK OR THE WATER INLET PIPE.

### OIL COOLER OUTLET



THIS PIECE IS ROTATED 160°-180° DOWN FROM STOCK ORIENTATION

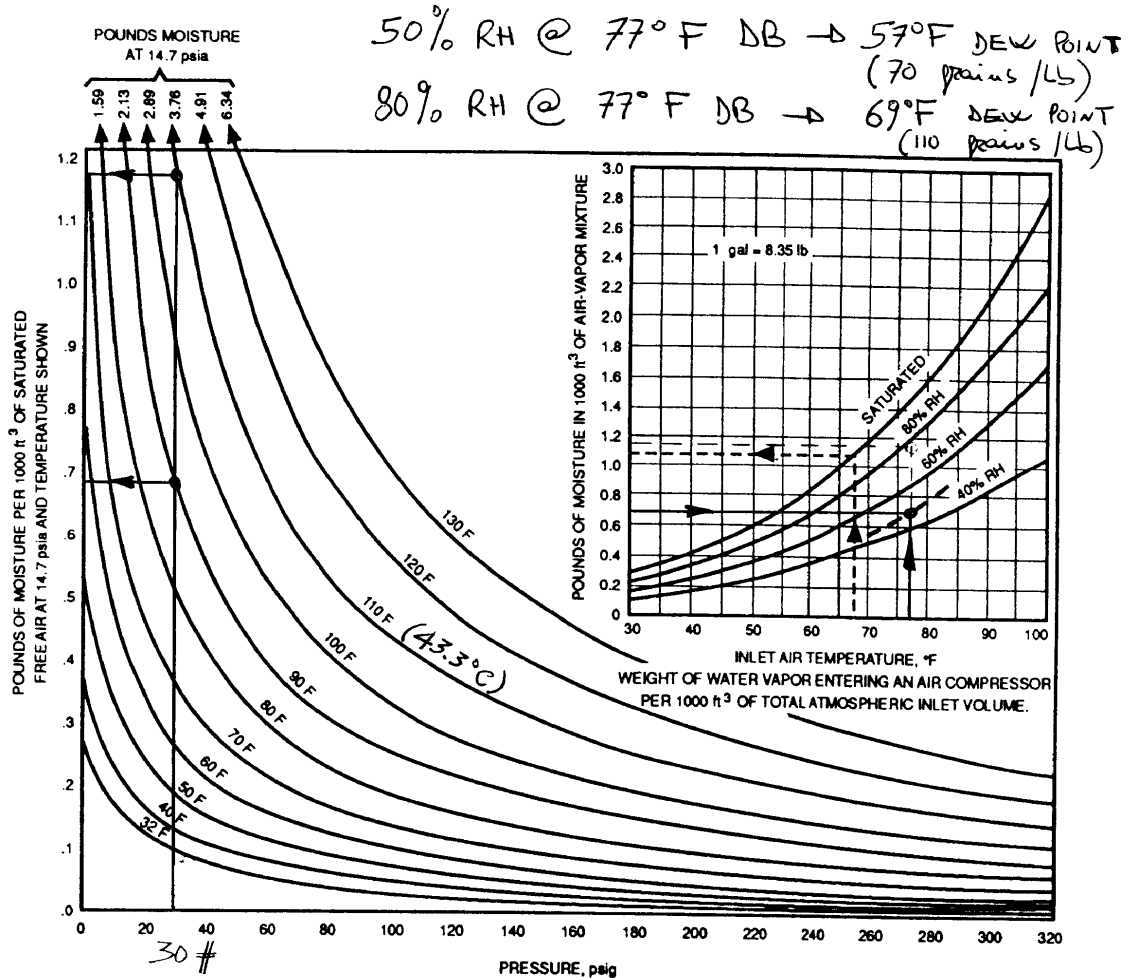
# Attachment 4

## MOBIL ENGINEERING GUIDE

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**FIGURE 3**  
**AMOUNT OF MOISTURE IN ISOTHERMALLY COMPRESSED AIR**

Each application will differ in requirements of time and capacity. Should the air receiver sizing precede the establishment of the plant shutdown logic, it is suggested that the receiver be sized for the total requirements of the critical air system plus 20 percent margin for a period of at least five minutes. For reasons of economy, the receiver length-to-diameter ratio varies from 3 to 5.

6.5.2 Air receivers shall be designed for a minimum pressure of 1.03 MPa gage (150 psig). Receivers shall be of welded steel construction and shall conform to the requirements of ASME Code, Section VIII,

and EGE 00-B-21. Standardized vessels that conform to the ASME Code and are manufactured on a production line basis may be used, provided prior Mobil approval is obtained.

6.5.3 As a minimum, the design of each receiver shall include the following:

- (a) Corrosion allowance of 2.5 mm (0.10 in.).
- (b) Internal baffling or demisters to minimize carryover of entrained moisture. Demisters shall be readily removable for maintenance.



# Attachment 5

## T-10 LAB VISITATION GROUP CHECKLIST

A. INSTRUMENTATION – Documentation for instrumentation will be reviewed for compliance.

1. System ACCURACY
2. System RESPONSE

B. CONTROL

1. Provide documentation of control strategy including drawings and startup, shutdown and ramps.

C. DATA ACQUISITION

1. SAMPLING FREQUENCY – Provide documentation of sampling frequency.
2. CALCULATIONS AND MANIPULATION (IF USED) – filter, emissions, EGR rates, mass air flow if calculated. Provide documentation of any calculations (averages, etc) if used

D. CELL CONFIGURATION

EACH LAB WILL PROVIDE PHOTOGRAPHS OF THE CELL PRIOR TO THE VISITATION

1. FUEL SYSTEM – See procedure for details.

- a. MEASUREMENT SYSTEM
- b. LINE ID
- c. LINE LENGTHS
- d. HEAT EXCHANGER LOCATION
- e. PRESSURE TAP LOCATION
- f. THERMOCOUPLES - location, diameters and lengths
- g. REGULATOR LOCATION

2. INLET AIR SYSTEM – See procedure for details.

- a. ENGINE PIPING
- b. HUMIDITY TAP LOCATION
- c. HUMIDIFICATION SYSTEM
- d. PRESSURE TAP LOCATION
- e. THERMOCOUPLES – location, insertion depth
- f. AIR FLOW MEASUREMENT DEVICE – installation, calculation
- g. AIR FILTER
- h. AIR HEATING SYSTEM
- i. AFR CALCULATION
- j. HEATER LOCATION

3. EXHAUST SYSTEM – See procedure for details

- a. ENGINE PIPING
- b. PRESSURE TAP LOCATION
- c. THERMOCOUPLE – location, insertion depth, diameter and length

## **T-10 LAB VISIT CHECKLIST – PAGE 2**

4. COOLANT SYSTEM – See procedure for details
  - a. THERMOCOUPLES – locations, insertion depths, diameters, and lengths
  - b. COOLANT FLOW RATE – Provide documentation of calculation used to obtain lpm
  - c. COOLANT MIXTURE
  
5. ENGINE OIL SYSTEM – See procedure for details
  - a. THERMOCOUPLES – locations, insertion depths, diameters, lengths
  - b. CRANKCASE PRESSURE AND OIL PRESSURE TAP LOCATIONS
  - c. OIL SCALE LINE LENGTHS
  - d. OIL SCALE PICK-UP LOCATION AND CONFIGURATION
  
6. CRANKCASE ASPIRATION SYSTEM
  - a. PIPING – schematic, diameters and length
  - b. CONDENSATE BUCKET LOCATION
  - c. BLOWBY MEASUREMENT DEVICE
  
7. ENGINE
  - a. ECM SOFTWARE
  - b. ENGINE NUMBER – part numbers for base engine components
  - c. PERFORMANCE DATA – Team will review performance data
  - d. GENERAL CONFIGURATION
  - e. ENGINE MAINTENANCE HISTORY
  
- E. STAND OPERATION – We will record warm-up, cooldown, and at least two hours of steady state operation. If a lab is unable to record this data, a data logger will be provided.
  1. WARM-UP
  2. COOLDOWN
  3. STEADY STATE
  
- F. BUILD, TEARDOWN, AND CLEANING PROCESSES
  1. PARTS FOR RATING
  2. PARTS FOR MEASURING – rings, liners, rod bearings
  3. ENGINE CLEANING METHOD
  
- G. CALIBRATION – Provide current calibration records for the test cell and standards used.
  1. TEMPERATURES
  2. PRESSURES
  3. FLOWS
  4. HUMIDITY - A spot check of humidity will be performed with a standard provided by the visitation team.
  
- H. SUPPLEMENTAL ROUND ROBINS – Some informal round robins will be performed during the lab visitation
  1. RING WEIGHT LOSS
  2. LINER WEAR STEP
  3. OIL ANALYTICALS

# Attachment 6

## T-10 BASIC ENGINE-COMPONENT PART NUMBER LIST SHEET 1

ITEM	PART NUMBER	QTY. PER BUILD
Auxiliary Shaft Assembly	453GC431M3	1
Auxiliary Shaft Bushing Kit	57GC2128	1
Bearings, Connecting Rod	62GC310 Lower, 62GB318 Upper	6 Each
Bearings, Connecting Rod Pair	62GB2396A	6
Bearings, Mains Kit	57GC387	1
Camshaft	454GCX165	1
Camshaft Key	43AX9	1
Camshaft Bushing Kit	57GC2180	1
Connecting Rod Bushings	187GB29	6
Connecting Rod Assembly	367GC4267M	6
Crankshaft	456GC5140M	1
Crankshaft Oil Seal, Front	446GC316	1
Crankshaft Oil Seal, Rear	446GC311A	1
Crank Seal With Wear Sleeve	57GC186B	1
Crankshaft Thrust Washer Kit	57GC2144	1
Cylinder Head, Bare	732GB5341M	2
Cylinder Head Assembly With Guides & Inserts	732GB5349M	2
Cylinder Head Assy. With Valves, Springs, Etc.	732GB3485M	2
Cylinder Sleeves	509GC466	6
Cylinder Rebuild Kit	215SB219A	6
Filter Kit (Oil, Fuel, Water)	57GC2184	1
Injection Pump	313GC5227M	6
Injection Nozzles	736GB49M3	6
Oil Pan	240GB5240M	1
Oil Pan Gasket	579GB422	1
Oil Pump Assembly	315GC465BM2	1
Piston Cooling Nozzle	115GC316	6
Piston Crowns	240GC598AM	6
Piston Skirts	240GC590BM	6
Piston Assembly	240GC2250AM	6
Piston Pin Retainers	97AX127	12
Piston Pins	182GC2223	6
Piston Ring Set	353GC2137	6
Push Rods	369GC417	12
Rocker Shaft	466GC485	2
Rocker Arms	44GB473M Exhaust, 44GB474M Inlet	6 Each
Rocker Arm Shaft & Bracket Assembly	466GC486M	2
Valve Guides	714GB3103	24
Valve Keepers	54GC25	48
Valve Lifters	72GC366B	12
Valve Lifter Guide	718GB35	12

**T-10 BASIC ENGINE-COMPONENT  
PART NUMBER LIST**

**SHEET 2**

ITEM	PART NUMBER	QTY. PER BUILD
Valve Rotators	722GC314	24
Valve Springs	575GC35	24
Valve Stem Seals	446GC328	24
Valve Yokes	891GC215M	12
Valves, Exhaust	688GC344	12
Valves, Intake	690GC410	12
Valve Seat Insert, Inlet	13GC38	12
Valve Seat Insert, Exhaust	13GC2290	12
Water Pump Assembly	316GC551M2	1
Cylinder Head Gasket	553GB51	2
Cylinder Head Gasket Fire Ring	553GB224	6
Cylinder Head Gasket Kit	57GC2176	2
Cylinder Head Cover	337GB537	2
Cylinder Head Cover Gasket	554GB213	2
Fuel Filter Primary	483GB470M	1
Fuel Filter Secondary	483GB471M	1
Cylinder Block	239GB5536M	1
Cylinder Block Assembly	239GB5537M	1
Unit Pump O-Ring Kit	935-DGK132	1
Valve Grinding Gasket Kit	57GC2178A	1
Engine Lower Gasket Kit	57GC2179	1
ECU Cooling Plate	312GB567M	1
Crankcase Breather Assembly	191GC434	1
Engine Wiring Harness	41MR5397CM	1
Fuel/Coolant Temperature Sensors	64MT2103	2
Oil Pressure Sensor	64MT2114	1
Boost Temperature Sensor	64MT2102	1
RPM/TDC Sensors - Timing Gear Cover - Flywheel Housing	64MT348M	2
Fuel Supply Pump	322GC42	1
Fuel Filter Adapter Assembly	32GB454M5	1
Coolant Conditioner	25MF435B	1

**PART NUMBER LISTING FOR  
LEFT SIDE PLATE STYLE  
OIL COOLER/OIL FILTER ARRANGEMENT**

ITEM	PART NUMBER	QTY.
Oil Cooler, Plate Type	312GB569M	1
90° Fitting, 1/8" NPT x 1/4" OD Barb	63AX3900	2
1/2" Clamp	83AX1004	2
Hose, 1/4" ID x 1/2" OD x 16"	160AX567-P16	1
O'Ring, Viton, Coolant Tube	446GC2140	1
O'Rings, Viton, Oil Cooler to Bracket	56AX596	2
Capscrews, Oil Cooler to Bracket	66AM53	4
Water Pump Inlet Tube, Mid-Mount	670GC523	1
Capscrews, Water Pump to Tube Flange, 40 Lbs.Ft.	66AM12	2
Gasket, Water Pump to Tube Flange	56AX392	1
Centri-Max Bracket Sub-Assembly	142GB3159M	1
Gasket, Bracket to Block	590GB345	1
Capscrews, Bracket to Block	41AM9	4
M12 Hardened Washer	271AM15	4
Centrifugal Filter Assembly	485GB4357M	1
Full Flow Oil Filters	485GB3191C	2
Centrifugal Rotor	236GB245M	1
Centri-Max Drain Plate	332GB232	1
Silastic for Drain Plate	629KB155	1
Screws, Drain Plate	66AM2	2
Turbo Oil Feed Hose	744GB315-P3	1
Protective Conduit for Turbo Oil Feed Hose	796AX11-P24	1
Fitting, 1/4" NPT x 5/8-18, 90°, Turbo Oil Feed	63AX3667	1

## B.O.M. for EGR COMPONENTS on T-10 ENGINES

PART DESCRIPTION	PART DETAILS	QTY PER ENGINE	"X" PART NO.	"HL" PART NO.
Front inlet manifold	A level hardware	1	105GCX4232	HL91 - 56
Rear inlet manifold	A level hardware	1	105GCX5212	HL91 - 57
Tube 90° with Y	Venturi / bypass Y pipe	1	680GCX466	HL91 - 58
Tube 45°	Bypass valve to Y pipe	1	680GCX350	HL91 - 59
Air inlet	Inlet/outlet tubes for bypass valv	2	690GCX351	HL91 - 60
Actuator	Bypass valve	1	9MS42	
Actuator Support - top	Actuator support - top	1		HL15 - 101
Actuator Supp. front	Actuator support - front	1	158GBX4753	HL15 - 98
Actuator Supp. rear	Actuator support - rear	1	158GBX3554	HL15 - 99
Venturi support top	Venturi support - top	2	158GBX3555	HL15 - 100
Stud 3/8 - 16 x 3.00		2	616gcx258	
Gasket		2	590GB343	
Spacer 0.156 thick		2	37AX495	
Screw M10 x 70		2	11AM5021	
Screw M10 x 20		3	66AM6	
Nut, lock 3/8 -16		6	23AX467	
Screw 3/8 - 16 x 5.00		4	4AX147	
Screw M8 x 16		2	66AM44	
Screw 3/8 - 16 x 0.75		2	6AX1591X	
Screw M10 x 16		2	66AM2	
Red Cell Hose		1	Dia 3.5 x 3.0 length	
Clamp - dia 3.50		4	83AX870	
Hose - dia 3.00		1	744GB310	
Clamp - dia 3.00		4	83AX868	
Washer, 3/8 x .12 thick		2	37AX138	
Red Cell Hose		1	Dia 3.5 x 4.0 length	
Green Cell Hose		1	Dia 3.0 x 4.5 length	
Venturi housing assembly	See breakout below		762GBX433-P3	
	Venturi housing (contains the parts listed below)	1		HL89 - 1
	housing	1	762GBX432	
	retainer	1	362GCX310	
	cover	1	332GBX351	
	tube	1	680GCX348	
	retainer	1	326GCX221	
	flange	1	507GBX251	
	seal	2	446GCX2136	
	seal	1	446GCX2137	
	seal	1	446GCX2135	
	screw	8	6AX871	
	screw	12	6AX1446	
	Venturi nozzle	1	115GCX262	HL89A - 2
	Venturi throat	1	295GBX44	HL89B - 2
	Venturi Divergent tube	1	682GCX41	HL89C - 1
Cooler	76mm x 490mm	2	19GBX52	HL80A - 4__ & 4__
Tube (complete)			670GBX350	
Exhaust Manifold, End	Mfld end sections	2	104GCX4452	HL52 - 185

## B.O.M. for EGR COMPONENTS on T-10 ENGINES

PART DESCRIPTION	PART DETAILS	QTY PER ENGINE	"X" PART NO.	"HL" PART NO.
Bracket (EGR elbow)	EGR elbow, mflid to valve (short)	1	253GCX454	HL52E - 1
Bracket (EGR elbow)	EGR elbow, mflid to valve (tall)	1	253GCX455	HL52E - 2
Bracket (EGR elbow)	EGR elbow, valve to cooler	2	253GCX458-P2	HL52E - 3
EGR Valve	Valve - On/Off, hot side	2	691GCX46	HL57 - 1A thru ...
Cover		2	332GBX262	
Spacer	Mflid to valve mounting brkt	2	537GCX275	
Screw		4	6AX1292	
Washer		4	35AX1360	
Gasket		4	590GBX2176	
Screw		8	6AX1281	
Gasket		2	590GBX2177	
Screw		4	66AM10	
Gasket		2	590GBX2178	
Gasket		2	590GBX2181	
Screw		24	6AX1646	
Gasket		4	590GBX2182	
Gasket		1	590GBX2180	
Screw		4	41AM3	
Nut, Lock		4	21AX829	
Stud		4	999GB2554	
Clamp	For crossover tube	4	83AX452	
Red Cell Hose	For crossover tube	2	Dia 1.5 x 3.0 length	
Fuel Lines		3		HL69 - 151
Fuel Lines		3		HL69 - 152
Turbo	2nd stage comp. - Schwitzer	1	631GC5145M3	
Turbo	1st stage comp. - Holset	1	631GCX	
Fitting, exh to exh.		1	453GBX439M	
Tube, comp to comp		1	670GCX531	
Clamp	comp to comp tube	4	83AX870	
Tube, turbo drain	for Holset	1	744GB230A	
Clamp, turbo drain	for Holset	2	83AX756	
Fitting, turbo drain	for Holset at A/C drive cover	1	63AX3604	
Screw	at A/C drive cover	2	421GC268M	
Screw	turbo drain	4	1AM13	
Washer		4	36AX22X	
Tube, turbo drain	for Holset	1	681GCX490	
Bracket, turbo	for Holset	1	133GBX57	
Stud		6	616GC228M2	
Nut		14	171AM10	
Washer		14	271AM5009	
Stud		8	616GC228M	
Tube, tubo drain	for Schwitzer	1	681GC485	
Washer		1	37AX83	
Screw		1	11AM15	
Hose, turbo compressor		2	744GB37-P3	

## B.O.M. for EGR COMPONENTS on T-10 ENGINES

PART DESCRIPTION	PART DETAILS	QTY PER ENGINE	"X" PART NO.	"HL" PART NO.
Gasket, turbo drain		2	590GB2150	
Gasket, exh manifold		2	590GB1189A	
Gasket, exh fitting		1	590GBX347	
Seal		1	446GC2126	
Tube, tubo drain	for Schwitzer	1	681GCX491	
Cover, A/C drive		1	331GBX34	
Heat sheild		1	492GCX4	
Seal	o-ring - Holset comp out	1	446GCX2139	
Cover, cylinder head	with top mount oil fill	1	337GB4112	



## Attachment 7

1. EGR coolant return to water pump inlet elbow

2. Temp / Pressure measurement before Venturi.

