Committee D-2 ON PETROLEUM PRODUCTS AND LUBRICANTS

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Reply to: Michael S. Griggs
The Lubrizol Corporation
29400 Lakeland Boulevard
Wickliffe, OH 44092-2298

February 10, 2000

To: Members of the Single Cylinder Oil Test Engine (SCOTE) Surveillance Panel and guest attending the January 12, 2000 meeting.

Enclosed are the minutes of the SCOTE Surveillance panel meeting held in San Antonio, Texas. Please forward any corrections or additions to my attention.

Michael S. Griggs
Secretary, SCOTE Surveillance Panel

MEETING MINUTES

SINGLE CYLINDER DIESEL SURVEILLANCE PANEL

HELD JANUARY 12, 2000
PERKINELMER
SAN ANTONIO, TEXAS

ACTION ITEMS

1. Post SCOTE Surveillance Panel minutes on TMC web site- Mike Griggs, Scott Parke

2. Look up specs for a 2" to 3" expander and recommend dimensions for the 1Q intake air piping drawing- Stacy Bond

3. Obtain specs on the Crane pump described in the 1Q cooling system layout- Stacy Bond

4. Check on the hp of the motor used with the Crane pump- Al Hahn

5. Advise Al Hahn if 1Q top ring side clearances do not agree with his published specification- Test labs

6. Check with Caterpillar to see what parameters are needed to properly identify the 1P/1Q EPROM's- Al Hahn

7. Check on IR O_2 methods- Robert Stockwell

8. Get Crane pump specs and write an equivalent spec around a lower cost pump- Stacy Bond, Robert Stockwell

9. Provide Stacy Bond and Robert Stockwell with Crane pump curves- Al Hahn

10. Reestablish plans to introduce the new 1M-PC liners around the June 2000 timeframe.

1.0 CALL TO ORDER AND MEMBERSHIP CHANGES

Chairman Stacy Bond opened the meeting at 8:30 am. The agenda is attachment 1.

2.0 MEETING MINUTES

2.1 The meeting minutes for the December 13, 1999 meeting were approved.

2.2 The attendance list is attachment 2

2.3 Stacy Bond asked Scott Parke about posting the meeting minutes on the TMC web site. He agreed to do so. The secretary will provide a copy of the minutes to TMC in a pdf file format. The secretary will continue to distribute hardcopies of the minutes until it is shown that the web based minutes can be reliably accessed.

3.0 TEST DEVELOPER'S REPORT ON 1Q

3.1 Al Hahn presented attachment 3 which outlines the 1Q EGR warm-up and operating conditions, required test hardware, installation details and piston/ring measurements.

3.2 The 1Q EGR warm-up and operating conditions (attachment 3, page 1/11) shows the performance data using the new EGR heat exchanger. Al Hahn commented that the cooler was a good match and did not require additional baffles. He also pointed out several corrections to the sheet. The inlet air manifold temperature is 70° C vice 75° C for step 5. Step 2 and step 3 exhaust barrel pressure is 120 Kpaa and 155 kPaa respectively. Al Hahn clarified that the inlet air and exhaust barrel pressures are the same during warm-up (step 1 through 4).

3.3 There was some discussion on the dual requirement to maintain specific air to orifice and inlet manifold temperatures. Al Hahn explained that Caterpillar controlled the air to orifice temperature at 60° C and observed inlet let manifold temperatures around 70° C. The 70° C ± 3° spec actually corresponds to an expected value in the 67° to 73° range. Mark Sutherland commented that cold shell temperatures for the inlet air barrel could be a problem in achieving the expected 70° C inlet manifold temperature. Stacy Bond suggested that labs plan on having air barrel heaters.

3.4 Al Hahn pointed out the CO_2 % at the inlet manifold and exhaust stack needs to be 1.55 and 10.4 %, respectively, to achieve the proper EGR

rates. Caterpillar's EGR control strategy was to fix the exhaust back pressure and control the intake air pressure over a small range to get the proper EGR rate. Al Hahn mentioned that mass air flow at the proper EGR rate was about 325 kg/hr, but was not a reliable means of control. It can, however, be used as a spot check for EGR rates.

3.5 Page 2 of attachment 3 lists the 1Q EGR test hardware. Al Hahn pointed out that the 1Y parts are the same parts as the pre matrix parts except they have tighter specs. He commented that the new ECM 13 degree chip had the coolant temperature limit raised over the current 105° C limit and that more rack was added. The 1Y parts availability is more towards the end of February.

3.6 Al Hahn covered details of the EGR heat exchanger installation (attachment 3, pages 3&4/11). He pointed out that the heat exchanger uses an o-ring at the intake air barrel side to allow for float. The tee assembly (item number 3, 1Y 4007) is made of plain steel. Al Hahn commented that he sees no problems with labs upgrading to stainless steel.

3.7 Page 5 of attachment 3 shows the proposed location of the CO_2 taps. Mike Griggs expressed a concern the exhaust CO_2 tap location after the restrictor valve might be in a negative pressure region. He explained that his lab has a scavenging blower that maintains a slight vacuum in the exhaust line. Al Hahn replied that Caterpillar handles a moderate negative pressure without problems. After some discussion on potential lab to lab variation, Al Hahn agreed that sampling upstream of the exhaust back pressure valve might be better. He agreed to proceed this way unless problems arise later. The panel agreed to use the ASTM specified probe (see page A3:7 of the 1K/1N procedure for a drawing).

3.8 The layout of the intake air piping (page 6 of the attachment) generated quite a bit of discussion. Al Hahn expressed a concern with the discontinuity in pipe diameters resulting from the installation of the Sierra mass air flow meter which has a 2" diameter. The panel agreed that a 20" length of 2" diameter piping should be used upstream of the Sierra meter. Additionally, the 3 tap locations shown downstream of the Sierra meter have been relocated to 10" upstream of the meter. Stacy Bond suggested the use of a 2" to 3" expander immediately after the Sierra meter. He agreed to look up information on the expander and recommend revised dimensions for the piping installation. There was also a brief discussion regarding the need for the Sierra meter. Al Hahn commented that we need to initially ensure lab to lab accuracy in measuring CO_2 before backing off of the Sierra meter requirement. Mike Griggs noted that the Sierra meters need to be calibrated to a tighter standard since the initial calibrations were done to accommodate uncertain operating conditions during Cat 1P

development. Scott Parke acknowledged that he has observed a wide range of flow values in the 1P references.

3.9 Pages 7 and 8 of attachment 3 detail the coolant system modifications. The 6 items listed on page 7 were discussed in detail. Al Hahn commented that item 1, the ¾" hose, should be the same type Aeroquip hose currently used in the cooling system. Robert Stockwell noted that item 6, the flow meter, should have a 50 liter/minute capacity to measure the expected 10 gpm flow. The type of flow meter is not specified, however, it must be able to handle around 10 gpm. Stacy Bond commented that a turbine meter might actually be cheaper that using a Barco venturi meter with the associated instrumentation. Al Hahn commented that the external coolant pump, item 2, has about a 40 gpm capacity with the proper hoses. Following a discussion about the external pump, the panel agreed to consider an equivalent pump that would be readily available with a lower cost. Al Hahn agreed to send Stacy Bond the Crane pump curves along with the motor horsepower. Stacy Bond and Robert Stockwell will work together to write an equivalent pump spec and recommend several low cost pumps.

3.10 The panel engaged in a lengthy discussion regarding various parameters and their required values/tolerances. Al Hahn agreed that in certain instances the procedure probably should have referred to expected values rather than exact values with tight tolerances. He did, however, emphasize that inlet air temperature to the orifice is a critical parameter.

3.11 Al Hahn requested that panel members advise him if they see different values for top ring side clearance than what is shown on page 9 of attachment 3.

3.12 Al Hahn explained that some sludging in the oil filter was observed and that a delta pressure measurement across the oil filter is required. Pressure differentials of 70 kPa and above are a concern. The pressure tap locations shown on page 10 of attachment 3 actually give the pressure drop across the oil cooler and the filter. Al Hahn recommended using a differential pressure transducer.

3.13 Al Hahn commented that that Caterpillar is not seeing a need yet to cool the Paratherm in the oil heating system (see page 11, attachment 3). He did acknowledge that the San Antonio labs may have to add a cooling capability to the oil heat system.

4.0 1Q EGR SCOTE TEST REPORT

4.1 Al Hahn presented attachment 4 which shows the required test report forms. He and various panel members made the following comments on each form:

Form 1- Include TGF and TLHC for now (Al Hahn). Add local start time using 24 hour clock (Scott Parke).

Form 2- Add "CO_2 Inlet Man" parameter under controlled parameters and "Oil Filter ΔP" under non-controlled parameters. Initially in the test development, CO_2 needs to be measured every couple of hours. Another report form may be needed for this (Al Hahn). An O_2 sensor could be used in the exhaust for generating an EGR quality index. (Robert Stockwell).

Form 3- Al Hahn commented that the ECM EPROM part number will change. Stacy Bond advised that the ECM EPROM number on the sheet is meaningless and that the configuration reported by the ET software is what is important. The ET software gives a 7 digit code to identify the EPROM. Al Hahn agreed to check with Caterpillar to see what parameters are needed to properly identify the EPROM's. He mentioned that some labs will receive new EPROMS and others will be emailed a flash file. Stacy Bond also commented that it is necessary to verify that all labs are using the same ET software.

Form 4 & 5A- Additional ratings (TL HYV C, TGF, etc.) are added at the bottom of the form.

Form 4A, 5, 7, 9, 11, 12, 14, 15, & 17- No changes

Form 6- TGA soot % and IR O_2 added. Al Hahn asked the panel if there was an ASTM method for IR O_2. Robert Stockwell agreed to check on this. The panel agreed to delete "Oil filter Delta Press" since it is a part of the normal data acquisition system and can be provided as a plot and summary statistics.

Form 8- Part numbers and specifications changed.

Form 10- Oil filter delta pressure added.

Form 13- Form expanded to accommodate 504 test hours.

Form 16- No changes, however, it was noted that Phillips was chosen as the fuel supplier.

5.0 1Q EGR MEASUREMENT

5.1 Al Hahn explained that Cat uses a model 880A Rosemount gas analyzer for their CO_2 measurements. Their span gases include atmospheric air, 15.1, 3.7 and 0.9 percent CO_2. Cat's actual exhaust stack CO_2 measurements fall in the 10-11% range.

5.2 Stacy Bond commented that gas sample preparation and analyzer calibration needs to be covered during lab visits and that it is important that labs be able to meet the 0.05% CO_2 tolerance spec. He also mentioned that he has the ISO document on taking emissions measurements should any lab desire that reference.

6.0 1Q PROCEDURE

6.1 Stacy Bond informed the panel that Ben Weber will continue to update the procedure. He also mentioned that Mike McMillan has assigned Paul Strigner as facilitator for the 1Q.

6.2 The panel agreed that Ben Weber should start on the procedure after some 1Q tests were run and additional experience is gained.

7.0 DEMONSTRATION MATRIX DESIGN

7.1 Al Hahn explained that the purpose of the demonstration matrix was to ensure we have a test that can discriminate oils. He commented that the first oil should be TMC 1005, but cautioned the panel that Cat was not absolutely sure about 1005 oil based on only one test. Stacy Bond suggested that 1005 oil be used as the baseline. Al Hahn added that the labs must first show they can run 1005. Currently, Cat is running another 1Q-EGR test on an in house oil ("oil A"). Al Hahn was asked about the 1Q test length and explained that it was driven by the desire for extended oil drain intervals.

7.2 Al Hahn asked the panel how many engines would be available at the test labs. The response was as follows:

Lubrizol- 1 initially
PerkinElmer- 2 initially
Ethyl- 1 initially
ALI- 1 initially
SWRI- 1 initially

7.3 Al Hahn mentioned that he would try to expedite EGR hardware to the labs and that actual 1Y parts would be available closer to the precision matrix.

7.4 There was considerable discussion on the selection of oils for the demonstration matrix. Scott Parke suggested that if Cat could show discrimination on their oil A, then other labs could run oil A. Robert Stockwell added that if oil A is dramatically different than 1005, then the matrix plan would be easier. There was general agreement that 1005 oil needs to be run initially. Ethyl, Lubrizol, PerkinElmer and SWRI committed to running 1005 initially.

7.5 Bob Weissman asked the panel about the plan for labs visits. Scott Parke replied that the visits must be done be fore the precision matrix, but could be started after the test has been sufficiently developed. Al Hahn suggested that initial visits be to PerkinElmer and SWRI. Mike Griggs asked if a lab visit checklist would be provided similar to what was done during 1P development. Robert Stockwell suggested that TMC control the checklist. Scott Parke commented that he would need panel input on the contents of the check list.

1Q TIMELINE

8.1 Stacy Bond presented attachment 5 which is the timeline for the 1Q test. The timeline was modified to reflect new start/finish times for each of the 12 tasks listed.

8.2 Stacy Bond commented that at the December HDEOCP meeting he presented the most current 1Q timeline which showed that the development was 6 weeks delayed. He noted that the timeline now is 2 months delayed.

MISCELLANEOUS

Scott Parke informed the panel that he looked into possible lab to lab variations for the oil cooler in temperature (transformed and untransformed data) and found nothing.

NEXT MEETING

The next meeting was not scheduled, however, it is anticipated that the panel will reconvene after labs have some experience with the hardware (at least a month to 6 weeks from this meeting)

Att 1, pg 1/1

Griggs, Michael
From: Bond, Stacy [Stacy_Bond%AR.EGGINC.COM@interlockp.lubrizol.com]
Sent: Monday, December 13, 1999 3:00 PM
To: Al Hahn (E-mail); Brian Lawrence (E-mail); Cooper (E-mail); Mark Sutherland (E-mail); Mike Griggs (E-mail); Parke (E-mail); Stockwell (E-mail); Tietze (E-mail); Carlson (E-mail); Jerry Schaus (E-mail); Stephens (E-mail); Charles Passut (E-mail); John Graham (E-mail); Bruce Hillyer (E-mail); Greg Hillman (E-mail); Ralph Cherrillo (E-mail); Steve Kennedy (E-mail); Bob Cambell (E-mail); Bob Weissman (E-mail); Gil Clark (E-mail); Mark Ferner (E-mail)
Cc: Shoffner, Brent
Subject: SCOTE Surveillance Panel Meeting

SINGLE CYLINDER OIL TEST ENGINE (SCOTE) SURVEILLANCE PANEL MEETING

ANNOUNCEMENT

FROM: **Stacy Bond**
Surveillance Panel Chairman
PLACE: PerkinElmer (Formally EG&G Automotive Research)
5404 Bandera Road
San Antonio, TX 78238
DATE: January 12, 2000
TIME: 8:30 pm to 5:00 pm

1Q DEVELOPMENT

OBJECTIVES FOR THIS MEETING:
Develop a procedure sufficient to run a 1Q EGR test.
Design demonstration oil test matrix.

1. Test Developer's Report
2. 1Q Installation Requirements
   All installation requirements must be complete before this meeting
3. 1Q EGR Measurements
   Be ready to present methods of EGR rate measurement
4. 1Q Procedure Updates
5. Demonstration Matrix Design
   Be prepared to recommend oils for the demonstration matrix

   Be prepared to volunteer resources for the demonstration matrix
6. REVIEW ACTION ITEMS
7. SET NEXT MEETING

SCOTE SURVEILLANCE PANEL
Attendance Roster

*** Please indicate any corrections that should be made to members name, address, etc ***

Member	Status	Indicate Presence with Signature	Alternate
Name: Bond, Stacy Company: PerkinElmer Address: 5404 Bandera Road San Antonio, TX 78238 Phone: 210-523-4604 Fax: 210-523-4607	Member	Stacy Bond	
Name: Carlson, Jon Company: Lubrizol Corporation Address: 4801 N.W. Loop 410, Ste. 430 San Antonio, TX 78229 Phone: 210-520-8013 Fax: 210-520-1983			
Name: Clark, Gil Company: Specified Fuels & Chemicals (Howell) Address: 7 W. Square Lake Road, Ste 106 Bloomfield Hills, MI 48302 Phone: 248-452-5659 Fax: 248-333-7999			
Name: Cooper, Mark Company: Oronite Technology Group Address: Chevron Chemical Company 4502 Centerview Ste. 210 San Antonio, TX 78228 Phone: 210-731-5606 Fax: 210-731-5699			
Name: Foerster, Ed Company: EG&G Automotive Research Address: 5404 Bandera Road San Antonio, TX 78238 Phone: 210-523-4607 Fax: 210-694-0892			
Name: Griggs, Mike Company: The Lubrizol Corporation Address: 29400 Lakeland Blvd. Wickliffe, OH 44092 Phone: 440-943-1200 Ext. 2905 Fax: 440-943-9013	V	Griggs	

Att 2, pg 1/5

SCOTE SURVEILLANCE PANEL
Attendance Roster

*** Please indicate any corrections that should be made to members name, address, etc ***

Member		Status	Indicate Presence with Signature	Alternate
Name: Company: Address: Phone: Fax:	Hillman, Gregory E. AutoResearch Lab Inc. 6735 S. Old Harlem Ave. Chicago, IL 60638 (708) 963-4262 (708) 563-0087	V	Greg Hillman HILLMAN.ALI@PRODIGY.NET	
Name: Company: Address: Phone: Fax:	Hillyer, Bruce Mobil Technology Co. 600 Billingsport Road Paulsboro, NJ 08066 609-224-2414 609-224-3628			
Name: Company: Address: Phone: Fax:	Lewis, John Shell Research Limited P.O. Box 1 Poole Lane INCE (Nr. Chester) Chester CH1 3 SH United Kingdom 011-44-151-373-5888			
Name: Company: Address: Phone: Fax:	Knight, John Test Engineering, Inc. 12718 Cimarron Path San Antonio, TX 78249-3417 210-690-1958 210-690-1959 jknight@testeng.com			
Name: Company: Address: Phone: Fax:	Lawrence, Brian Infineum 4335 West Piedras Dr., Suite 101 San Antonio, TX 78228 (210) 732-8123 (210) 732-8480	V	Lawrence	
Name: Company: Address: Phone: Fax:	Nycz, David S. Caterpillar, Inc. Box 610 Mossville, IL 61552-0610 309-578-3003 309-578-6457			

Att 2, pg 2/5

SCOTE SURVEILLANCE PANEL
Attendance Roster

*** Please indicate any corrections that should be made to members name, address, etc ***

Member	Status	Indicate Presence with Signature	Alternate
Name: Steinke, Richard E. Company: R.E. Steinke Association Address: P.O. Box 2103 Sausalito, CA 94966 Phone: 415-331-2930 Fax: 415-332-7757			
Name: Stephen, Carl Company: Ashland, Inc. Address: 22nd Front Street Ashland, KY 41101 Phone: 606-329-5198 Fax: 606-329-3009			
Name: Sutherland, Mark Company: Ethyl Petroleum Additives, Inc. Address: 9901 IH 10 West Suite 800 San Antonio, TX 78230 Phone: 210-558-2818 Fax: 210-694-0892	NV		
Name: Strigner, Paul Company: 31 Sequin Street Address: Ottawa, Ontario K1J6P2 CANADA Phone: Fax: MAIL			
Name: Stockwell, Robert Company: Southwest Research Institute Address: 6220 Culebra Road San Antonio, TX 78228 Phone: 210-522-5913 Fax: 210-523-6919	M		
Name: Weissman, Bob Company: Ethyl Petroleum Additives, Inc. Address: 500 Spring Street P.O. Box 2158 Richmond, VA 23219 Phone: 804-788-5340	M		

Att 2, pg 3/5

SCOTE SURVEILLANCE PANEL
Attendance Roster

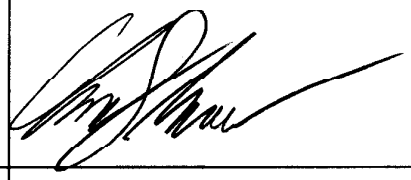
(Visitors Page)

Member	Status	Indicate Presence with Signature	Alternate
Name: John Hacgelin Company: PerKin Elmer Address: LA Phone: 310 523 4623 Fax:			
Name: James N Chapman Company: PerkinElmer Address: S.A. Phone: (210) 523-4649 Fax:			
Name: Company: Address: Phone: Fax:			
Name: Company: Address: Phone: Fax:			
Name: Company: Address: Phone: Fax:			
Name: Company: Address: Phone: Fax:			
Name:			

Att 2, pg 4/5

SCOTE SURVEILLANCE PANEL
Attendance Roster

(Visitors Page)

Member	Status	Indicate Presence with Signature	Alternate
Name: Chris Schmid Company: Lubrizol Address: 29400 Lakeland Blvd Wickliffe OH 44092 Phone: 440 943 1200 x1305 Fax: 440 943 2360			
Name: AL HANK Company: Address: See Other Sheet Phone: Fax:			
Name: Company: SCOTT PARKE Address: ASTM TMC Phone: Fax:			
Name: Company: Address: Phone: Fax:			
Name: Company: Address: Phone: Fax:			
Name: Company: Address: Phone: Fax:			
Name:			

Att 2, pg 5/5

1Q/ EGR SCOTE Warm- Up And Operating Conditions

PARAMETER	UNITS	TOL	STEP 1 5 Min	STEP 2 5 Min	STEP 3 5 Min	STEP 4 10 Min	STEP 5 60 Min
Speed	RPM	+/- 3	1000	1000	1400	1800	1800
Power	kW		Idle	10	28	51	65
Torque	Nm	(a) +/- 5	-	100	175	270	340
Fuel Rate	g/ min	(b) +/- 1	-	45	95	192	240
B.S.F.C.	g/ kW-hr		-	-	220	220	215
Fuel Timing	BTC		13	13	13	13	13
Fuel Rack Pos.	mm		2.6	3.8	6	8.6	10.3
Humidity	g/kg	+/- 1.7		-	-	-	17.8
TEMPERATURES	DEG C						
Fuel Into Head		+/- 3	~31	~32	~33	~36	42
Coolant Into Jug				~55	101	101	101
Coolant From Head		+/- 3		57	105	105	105
Oil To Cooler				-	93	102	124
Oil Manifold		+/- 3		-	92	101	120
Oil Fr Extern. Heater				-	97	104	~110
Air To Orifice		+/- 3		55	60	60	60
Inlet Air Manifold		+/- 3		40	45	68	~~78~~ 70 °C
Exhaust Manifold			~120	300	430	590	~600
EGR H/E - Exh To				48	249	390	~480
- Exh From		+/- 5		45	80	135	135
- Coolant In				57	98	99	~99
- Coolant Out				57	101	102	~102
PRESSURES	kPa						
Fuel From Head		+/- 20	275	275	275	275	275
Coolant Into Jug		(c)	~44	~44	90	100	~100
Oil Manifold		+/- 20	415	415	415	415	415
Air To Orifice (abs)				120	155	250	295
Inlet Air Barrel (abs)		+/- 1	120	120	155	250	292
Exhaust Barrel (abs)		+/- 1	-	~~100~~/20	~~145~~ /55	250	298
EGR H/E - Exh From (abs)							297
- Water Out						150	150
Oil Filter Delta Pressure					30	36	44
Crankcase							~.2
FLOWS							
% EGR Flow							
Coolant	L/ min	+/- 2	~40	40	~55	~75	~75
Blowby	L/ min					~30	~30
Air	kg/ hr				165	230	325
EGR H/E Coolant Flow	GPM				10.1	10.7	10.7
Oil Scale Cart Reading	Grams						
EMISSONS							
CO2 % Inlet Manif	%	+/- .05		-	-	-	1.55
CO2 % Exh Stack							10.4

Note:

(a) Engine controlled to Torque Spec for Steps #2, #3, #4 and 5 minutes of Step #5

(b) Engine controlled to Fuel Rate for last 55 minutes of Step #5

(c) Air Pressure at coolant tower controlled to 35 kPa

Ramp Up Conditions Between Warm- Up Steps

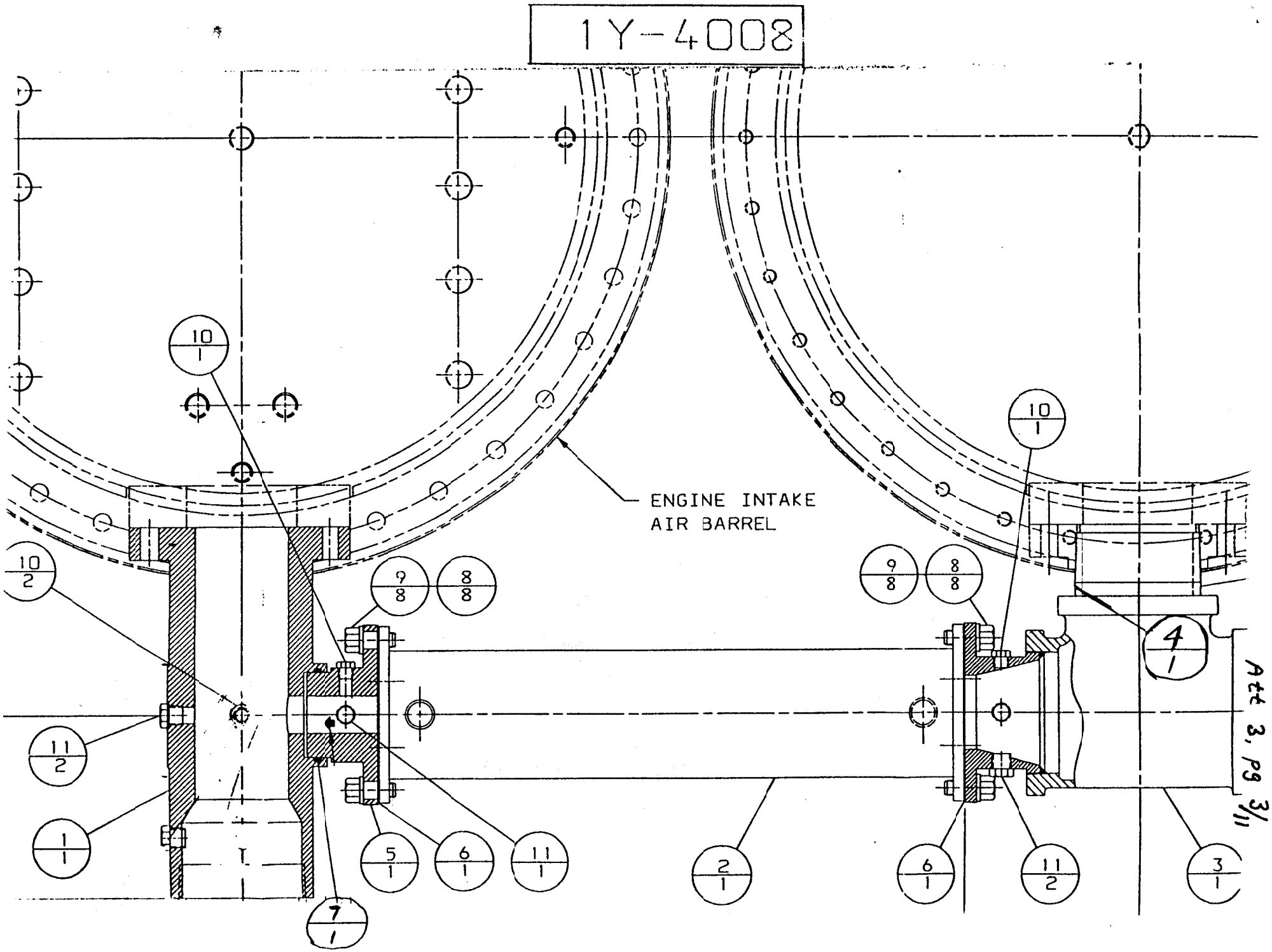
Torque	At 5 minutes (beginning at step #2)	20 Nm/ min
Speed	At 10 minutes (beginning at step #3)	100 rpm/ min
Inlet Air Press	At 10 minutes (beginning at step #3)	12 kPa/ min
Exhaust Press	At 10 minutes (beginning at step #3)	12 kPa/ min
Inlet Air Temp	At 0 minutes (at start of test)	5 deg C/ min

1Q - EGR Test Hardware

MAR

	Pre Matrix (Dec)	Ind Matrix (~~Feb~~)
Piston Crown	145-6744	1Y4016
Piston Skirt	132-6663	1Y4015
Top Ring	132-6662	1Y4014
2nd Ring	139-9126	1Y4013
Oil Ring	7E2990	1Y4012
Cooling Jet	145-6860	1Y4011
(use 1P jet aim fixture)	1Y3980	1Y3980
New ECM 13 deg Chip	154-8353	154-8353

Att 3, pg 2/11


1Y-4008
ENGINE INTAKE
AIR BARREL
10/1
10/2
9/8
8/8
11/2
1/1
5/1
6/1
11/1
7/1
2/1
4/1
3/1
Att 3, pg 3/11

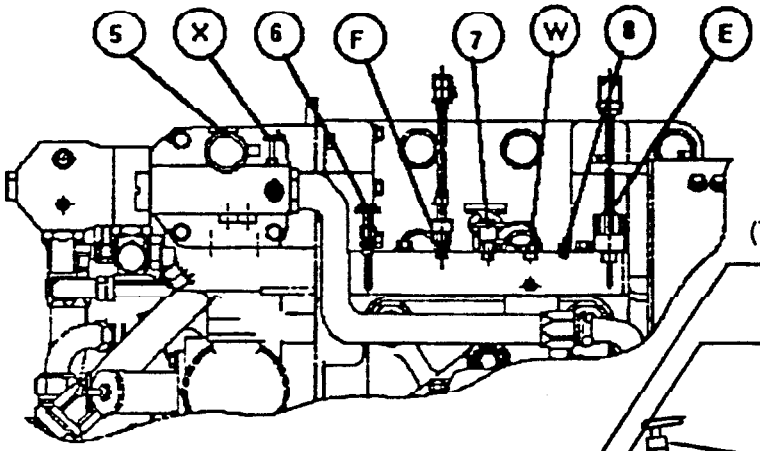
Att 3, pg 4/11

1Y-4008

NOTE	ITEM	QTY	MEAS UNIT	PART NO.	NAME
			PARTS LIST		
	1	1		1Y-4005	HOUSING
	2	1		1Y-4017	COOLER
	3	1		1Y-4007	TEE AS.
	4	1		140-5978	NIPPLE
	5	1		1Y-4002	ADAPTER
	6	2		1Y-4003	GASKET
	7	1		8F-6711	SEAL
	8	16		0S-1594	BOLT
	9	16		5M-2894	WASHER
	10	4		8T-6764	PLUG
	11	5		8T-6765	PLUG

Att 3, pg 5/11

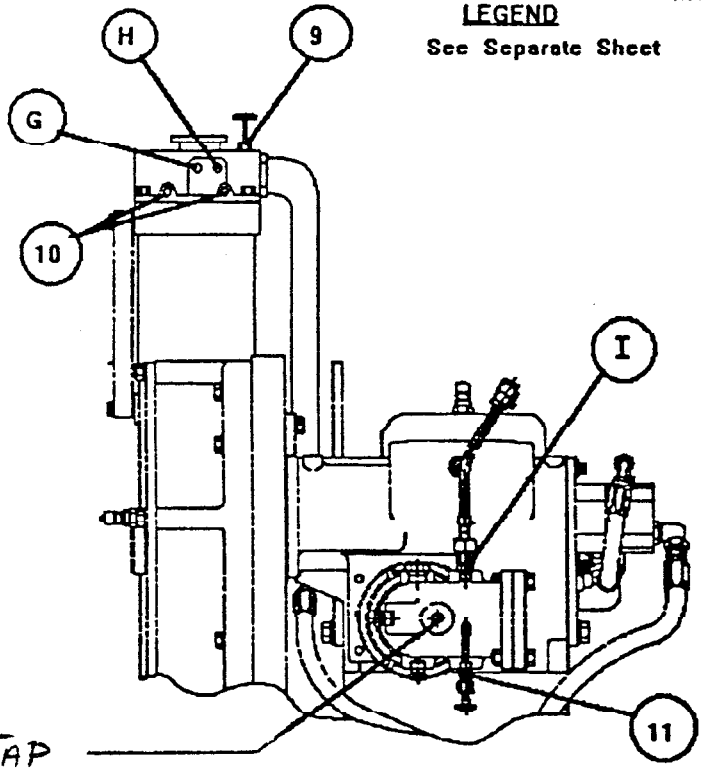
1Q - EGR SCOTE TEST PROCEDURE



TOP VIEW

(7) Equivalent Oil Sample Valve
7/16 -20 Male
SAE x 1/8 FNPT Swagelok
1/4 x 1/8 Bushing
(Fill Bushing Solder Or Equiv
and Drill .038 " (#61) Bit For Orifice)
2M-Valq-SSP 1/8 NPT S.S.
CPI Toggle Valve (Parker)
Pipe Elbow

LEGEND
See Separate Sheet



CO_2 TAP
AIR INLET MAN

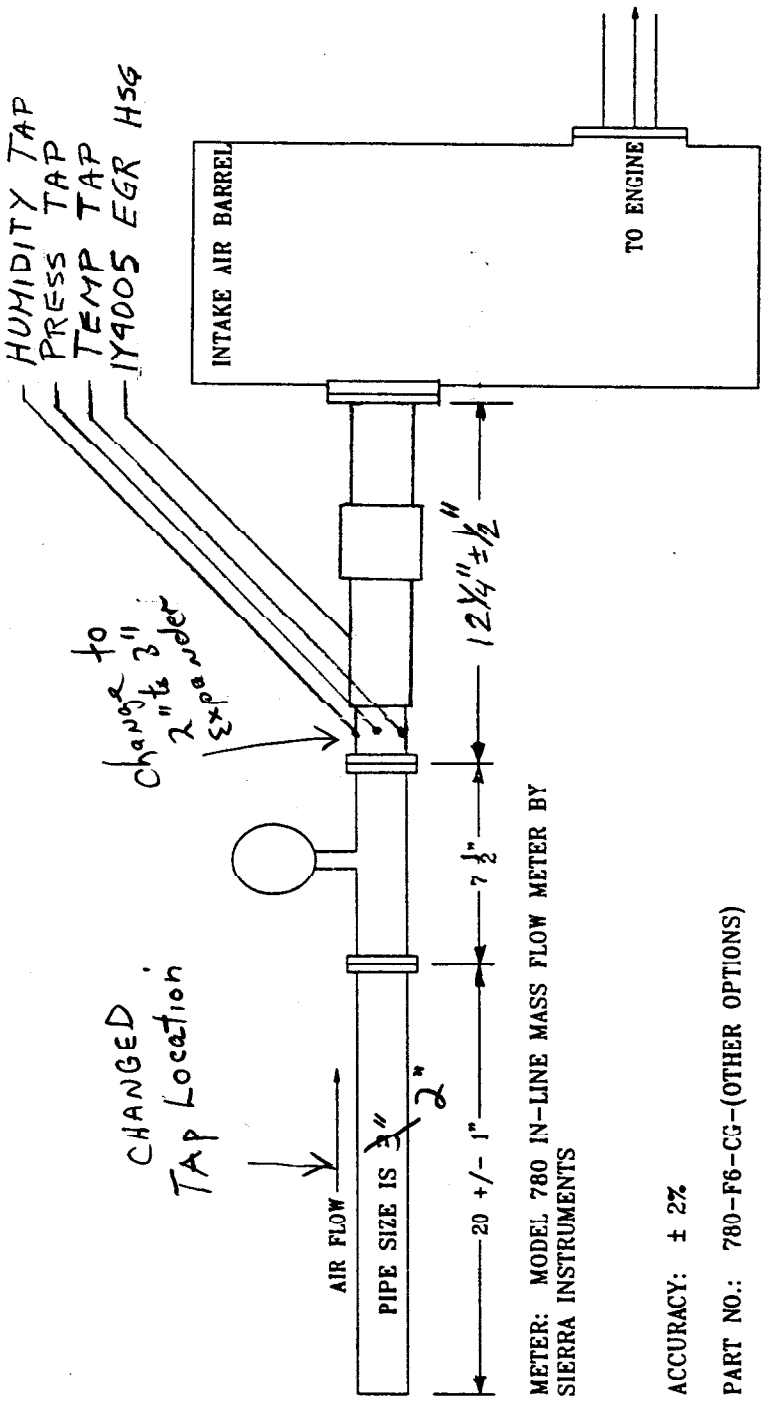
LEFT SIDE VIEW

Note: CO2 Exh. Stack Tap Location After Exhaust Restrictor Valve

$$\% \text{ EGR} = \frac{\% \text{ CO2 Inlet Man} - \% \text{ CO2 Air To Orifice}}{\% \text{ CO2 Exh. Stack} - \% \text{ CO2 Air To Orifice}}$$

1Q - EGR SCOTE TEST PROCEDURE

A4. INTAKE AIR PIPING



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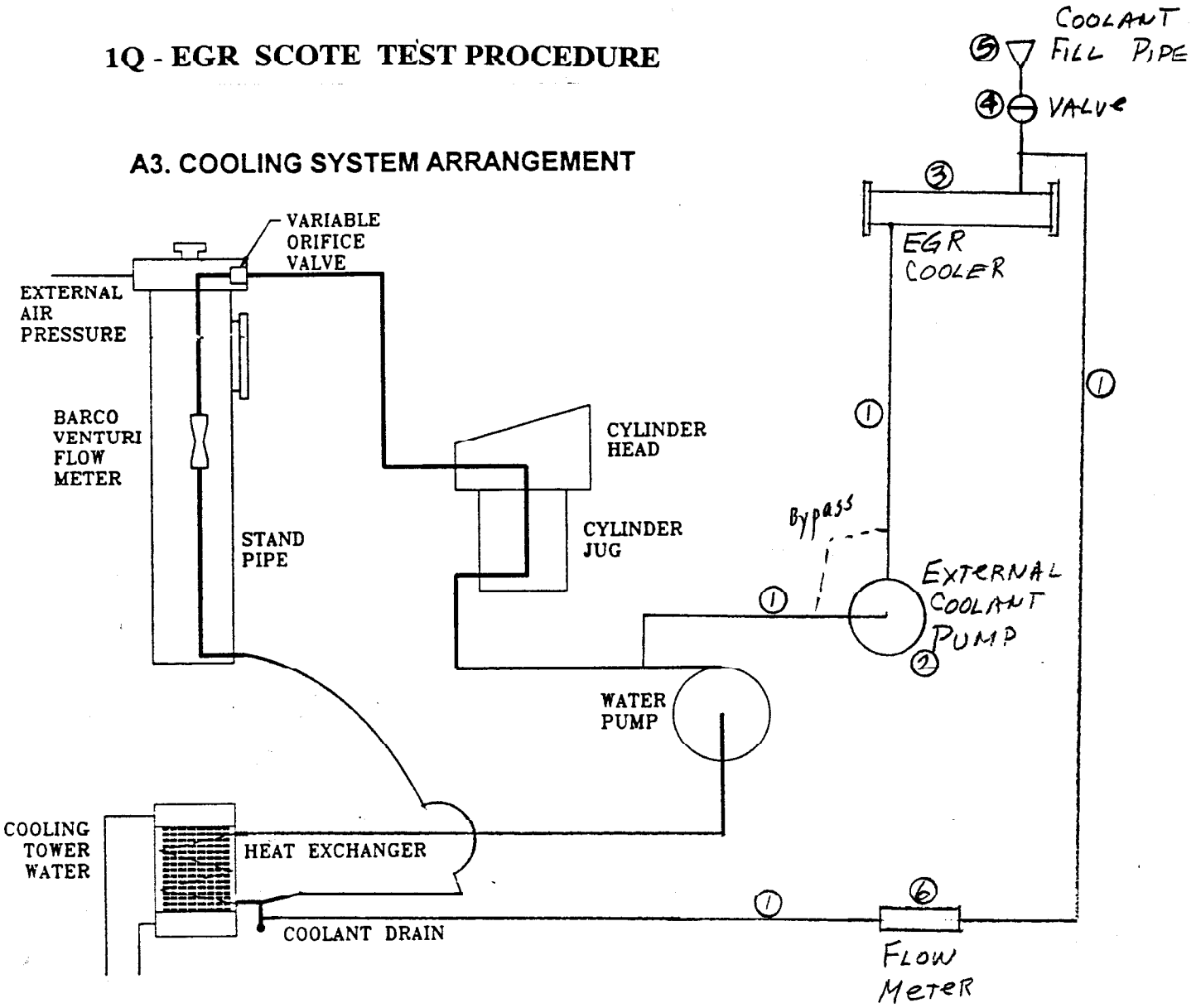
1Q - EGR SCOTE TEST PROCEDURE

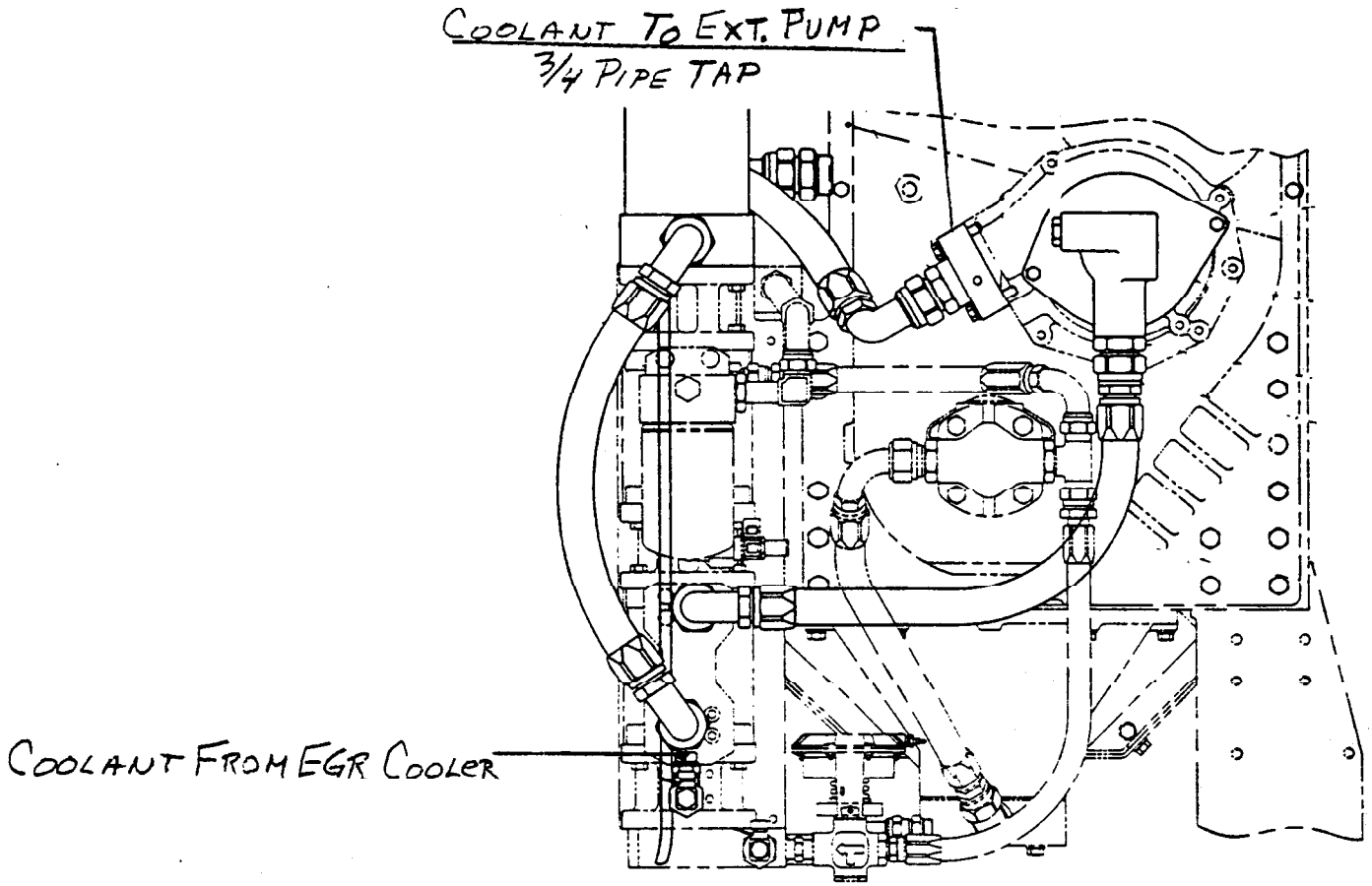
A3. COOLING SYSTEM ARRANGEMENT

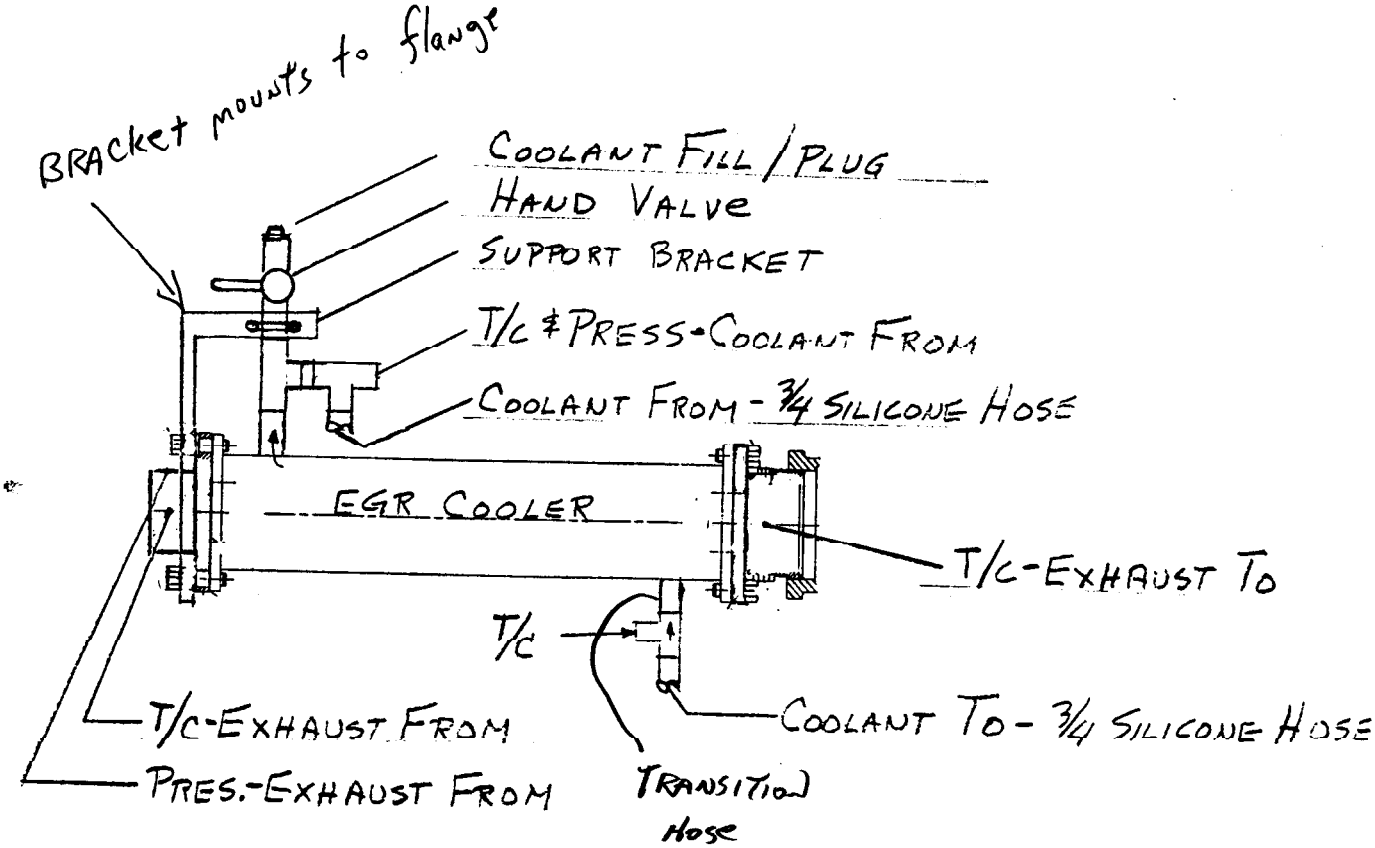


Aeroquip hose

(1) 3/4 dia ~~silicone~~ hose
(2) External coolant pump
Crane Deming Salem, Ohio
Model 3062 1 1/2 X 6 1750 rpm Type D-1
(3) EGR Cooler Arrange 1Y4008
(4) Hand Valve
(5) Fill Pipe
(6) Flow Meter (large meter with 20 lpm min capacity)

1Q - EGR SCOTE TEST PROCEDURE





1Q - EGR SCOTE TEST PROCEDURE

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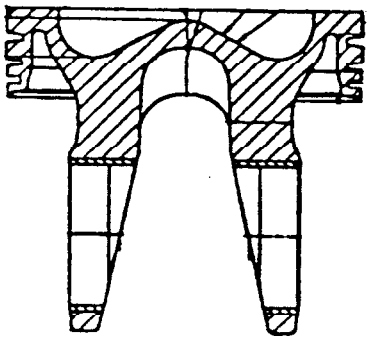
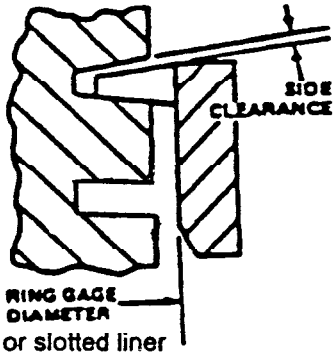
PISTON AND RING SPECIFICATIONS

Piston: Skirt p/n 1Y4015 , Crown p/n 1Y4016
Rings: Top p/n 1Y4014 , Intermediate p/n 1Y4013 Oil p/n 1Y4012





	TOP RING*	INTERMEDIATE RING*	OIL CONTROL RING*
Width of groove in piston for piston ring (new)		3.07 ± 0.01mm	4.03 ± 0.01mm
Thickness of piston ring (new)		2.985 ± .015mm	3.975 ± 0.015 mm
Side Clearance between groove and piston ring (new)	0.090-.127mm	0.060-0.110 mm	0.030-0.080 mm
End gap clearance between end of ring (new) installed in 137.160mm diameter gage	0.350-0.550 mm	0.754-0.906 mm	0.400-0.750 mm

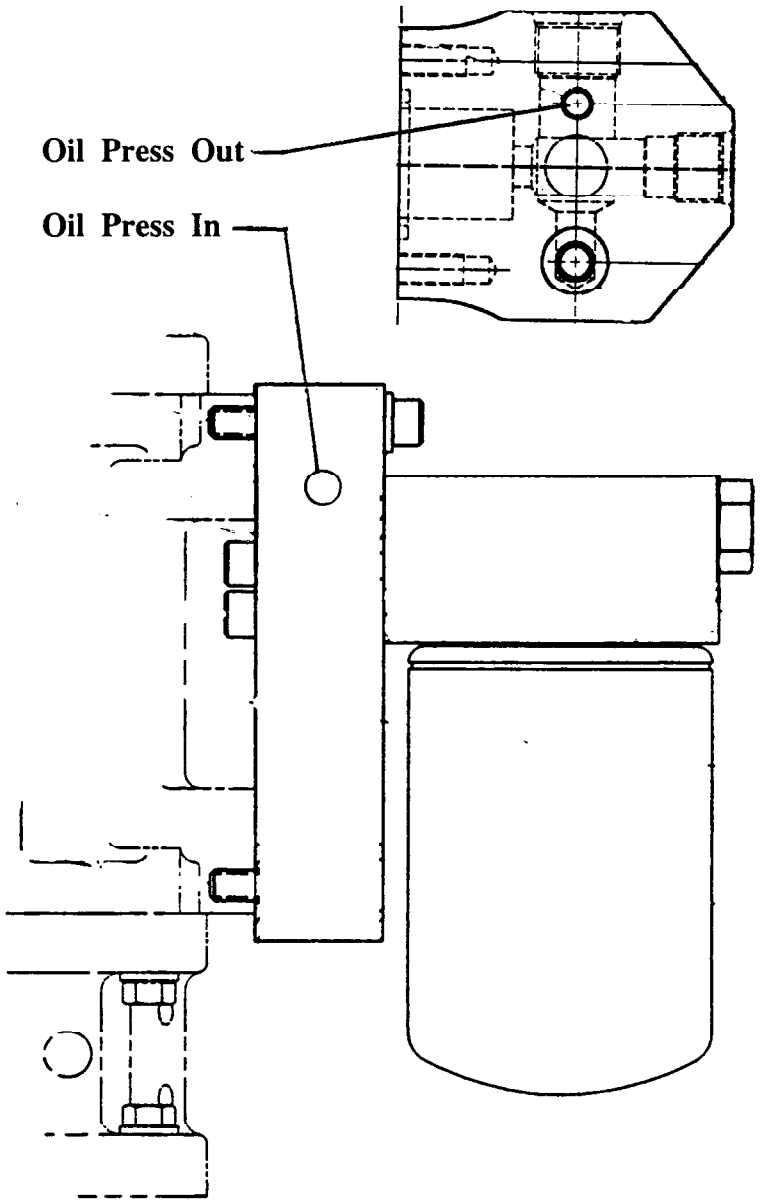
*NOTE: This engine uses keystone style piston rings and grooves in the piston. The piston ring lands are also elliptically ground; therefore, measure ring side clearance as follows:

a. Assemble piston ring on the piston with "UP" side toward the top of the piston.
b. Install piston and ring in a 137.60mm diameter ring gage or modified 'slotted' liner.
c. Push piston and ring until ring to be measured is at the top of the gage. Keep the piston in the center of the gage.
d. Measure the side clearance with a feeler gage at both major (90° from the centerline of the pin bore) and minor diameters. Each measurement should be within specification shown.

Install the oil control ring with gap in the spring 180° away from the gap in the ring.

1Q - EGR SCOTE TEST PROCEDURE

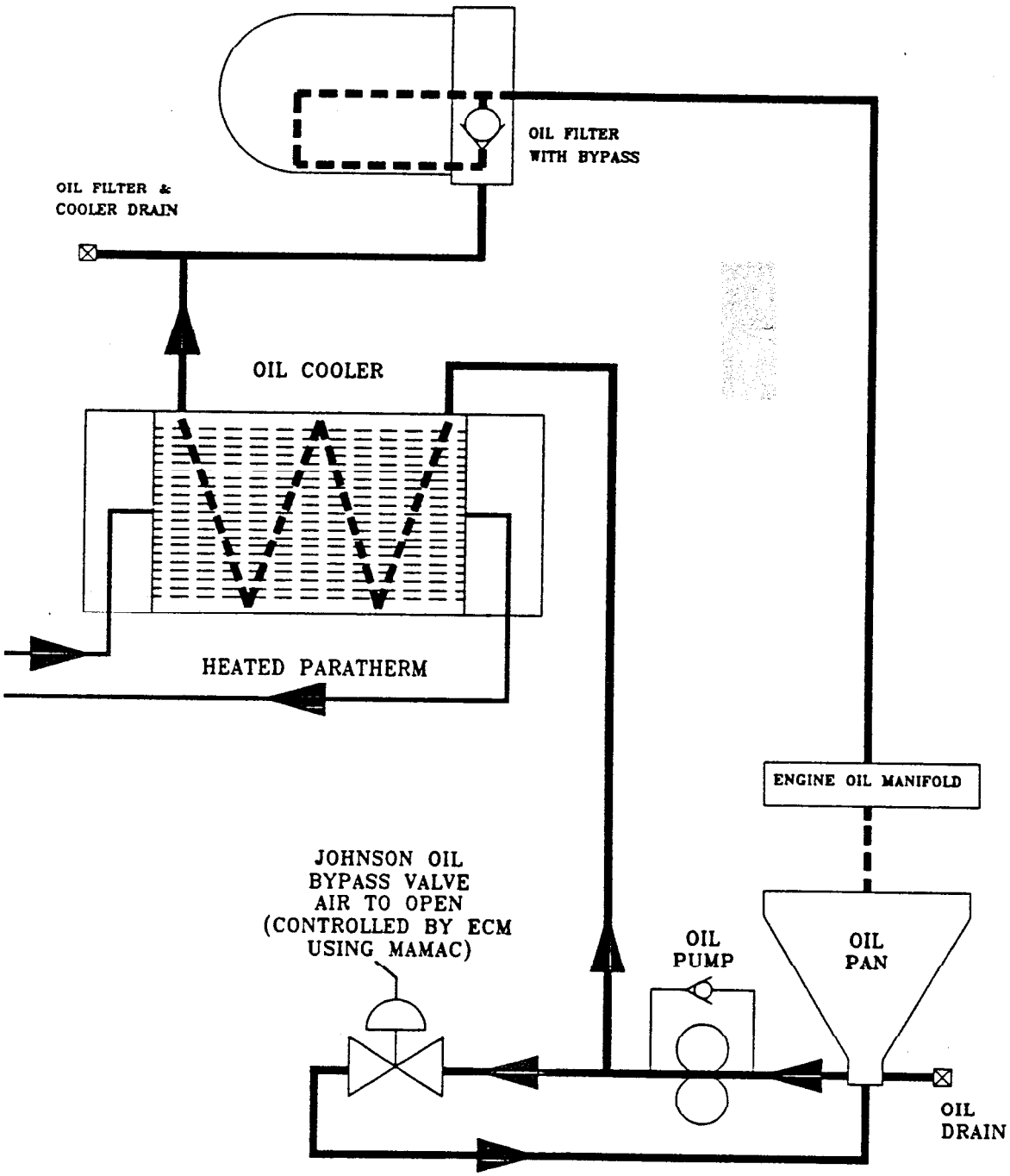
Oil Filter Delta Pressure Locations



RIGHT SIDE VIEW

1Y3681 FILTER GP - ENGINE OIL

A6. OIL SYSTEM



1Q - EGR SCOTE TEST PROCEDURE Att 4, pg 1/19

FORM 1
TEST REPORT SUMMARY

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE (or CMIR): *OILCODE/CMIR*			

START DATE: *DTSTRT*	TOTAL TEST LENGTH: *TESTLEN*	TMC OIL TYPE: [A] *IND*
LAB INTERNAL OIL CODE: *LABOCODE*		ENGINE SERIAL NUMBER: *ENGSN*

	CORRECTION EFFECTIVE DATE	WDP	TGC / TGF	TLC / TLHC	OIL CONSUMPTION g/h	TRANSFORMED OIL CONSUMPTION	EOTOC g/h	TRANSFORMED EOTOC
UNADJUSTED LAB RATING		*WD*	*TGC*	*TLC*	*OC*	*OCT*	*EOTOC*	*ETOCT*
INDUSTRY CORRECTION (IF ANY)	*DATECF*	*WDCF*	*TGCCF*	*TLCCF*		*OCTCF*		*ETOCTCF*
SUBTOTAL		*WDCOR*	*TGCCOR*	*TLCCOR*		*OCTCOR*		*ETOCTCOR*
LAB SEVERITY ADJUSTMENT [B] (IF ANY)	*DATESA*	*WDSA*	*TGCSA*	*TLCSA*		*OCTSA*		*ETOCTSA*
TOTAL		*WDFNL*	*TGCFNL*	*TLCFNL*	*OCFNL*	*OCTFNL*	*EOTOCFNL*	*ETOCTFNL*

	EFFECTIVE DATE	WDP	TGC	TLC	OIL CONSUMPTION g/h	TRANSFORMED OIL CONSUMPTION	EOTOC g/h	TRANSFORMED EOTOC
TEST TARGET MEAN [A]	*EFFDATE*	*WDM*	*TGCM*	*TLCM*		*OCTM*		*EOTOCTM*
TEST TARGET STD [A]	*EFFDATE*	*WDS*	*TGCS*	*TLCS*		*OCTS*		*EOTOCTS*
API *CATEGORY* PASS LIMIT [B]	*DTCEFF*	*WDPL*	*TGCPL*	*TLCPL*	*OCPL*		*EOTOCPL*	

	REFEREE LAB	WDP	TGC	TLC
REFEREE RATINGS [A]	*RRLAB*	*RRWD*	*RRTGC*	*RRTLC*

	TOP	INT. 1	OIL	PISTON CROWN	PISTON SKIRT	LINER
RING LOSS OF SIDE CLEARANCE (mm)	*LSCTOP*	*LSCINT1*	*LSCOIL*			
RING END GAP INCREASE (mm)	*RINGGTI*	*RINGGI11*	*RINGGOI*			
IS THE RING STUCK?	*STUCKTOP*	*STUCKIN1*	*STUCKOIL*			
SCUFFED AREA %	*SCUFFTOP*	*SCUFFIN1*	*SCUFFOIL*	*SCUFCRON*	*SCUFSKRT*	*SCUFFLIN*
AVERAGE WEAR STEP (mm)						*AWEARST*
% BORE POLISH						*BOREPOL*

Notes:
[A] Reference oil tests or as requested by test sponsor
[B] Non-reference oil tests only

1Q - EGR SCOTE TEST PROCEDURE Att 4, pg 2/19

FORM 2
OPERATIONAL SUMMARY

LAB: LAB	EOT DATE: DTCOMP	END TIME: EOTTIME	METHOD: METHOD
STAND: STAND	RUN NUMBER: ENRUN		
FORMULATION/STAND CODE: FORM			
OILCODE (or CMIR): OILCODE/CMIR			

CONTROLLED PARAMETERS

OPERATING PARAMETER	QUALITY INDEX THRESHOLD	EOT QUALITY INDEX	PROCESS UNITS	PROCESS TARGET	PROCESS AVERAGE	TOTAL DATA POINTS SAMPLES [A]	BQD [B]	OVER/UNDER [C] RANGE
ENGINE SPEED	0.00	QRPM	r/min	1800	ARPM	NRPM	BRPM	ORPM
FUEL FLOW	0.00	QFFLO	g/min	240	AFFLO	NFFLO	BFFLO	OFFLO
HUMIDITY	0.00	QHUMID	g/kg	17.8	AHUMID	NHUMID	BHUMID	OHUMID
COOLANT FLOW	0.00	QCOLFLO	L/min	75	ACOLFLO	NCOLFLO	BCOLFLO	OCOLFLO
TEMPERATURE								
COOLANT OUT	0.00	QCOLOUT	°C	105	ACOLOUT	NCOLOUT	BCOLOUT	OCOLOUT
OIL TO MANIFOLD	0.00	QOMANTMP	°C	120	AOMANTMP	NOMANTMP	BOMANTMP	OOMANTMP
INLET AIR MANIFOLD	0.00	QINAIRT	°C	75 70	AINAIRT	NINAIRT	BINAIRT	OINAIRT
FUEL INTO HEAD	0.00	QFUELTMP	°C	42	AFUELTMP	NFUELTMP	BFUELTMP	OFUELTMP
PRESSURES								
OIL TO MANIFOLD	0.00	QOMANPR	kPa	415	AOMANPR	NOMANPR	BOMANPR	OOMANPR
INLET AIR (ABSOLUTE)	0.00	QINAIRP	kPa	290 2	AINAIRP	NINAIRP	BINAIRP	OINAIRP
EXHAUST (ABSOLUTE)	0.00	QEBP	kPa	298	AEBP	NEBP	BEBP	OEBP
FUEL FROM HEAD	0.00	QFUELPR	kPa	275	AFUELPR	NFUELPR	BFUELPR	OFUELPR
CO2 % INLET MAN				1.55				

NON-CONTROLLED PARAMETERS

OPERATING PARAMETER	PROCESS UNITS	PROCESS TYPICAL RANGE [D]	PROCESS AVERAGE	TOTAL DATA POINTS SAMPLES [A]	BQD [B]	OVER/UNDER [C] RANGE
INTAKE AIR FLOW(reference test only)	kg/h	312-378	AAIRFLO			
POWER	kW	65-70	APWR	NPWR	BPWR	OPWR
TORQUE	Nm	330-350	ATORQUE	NTORQUE	BTORQUE	OTORQUE
BLOWBY	L/min	20-56	ABLOBY	NBLOBY	BBLOBY	OBLOBY
TEMPERATURE						
COOLANT IN	°C	100-102	ACOLIN	NCOLIN	BCOLIN	OCOLIN
COOLANT DELTA T	°C	2-6	ACOLDT	NCOLDT	BCOLDT	OCOLDT
OIL COOLER IN	°C	120-124	AOCOOLIN	NOCOOLIN	BOCOOLIN	OOCOOLIN
HEATING OIL	°C	166 maximum	AHEATOIL	NHEATOIL	BHEATOIL	OHEATOIL
EXHAUST	°C	590 - 620	AEXHTMP	NEXHTMP	BEXHTMP	OEXHTMP
PRESSURES						
CRANKCASE	kPa	0.09-0.33	ACCV	NCCV	BCCV	OCCV
COOLANT TO JUG	kPa	64-92	ACOLPR	NCOLPR	BCOLPR	OCOLPR

A - Total number of data points taken as determined from test length and procedural specified sampling rate

B - Number of Bad Quality Data points not used in the calculation of the statistical measures

C - Number of points clipped by over/under range limits of the statistical measures

D - Gathered from 1P Matrix Test data

OIL FILTER ΔP

1Q - EGR SCOTE TEST PROCEDURE Att 4, pg 3/19

FORM 3
ASSEMBLY MEASUREMENTS AND PARTS RECORD

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE: *OILCODE/CMIR*			

ASSEMBLY MEASUREMENTS AND PARTS RECORD	
INJECTOR SETTING (GO / NO-GO)	*INJSET*
WAS TIMING INITIALIZED? (YES/NO)	*TINIT*
PISTON/HEAD CLEARANCE mm	*PISTONCL*
CAM GEAR BACKLASH mm	*CAMLASH*
DESIRED FUEL TIMING °BTC	*FUELTIM*
INTAKE VALVE OPEN °ATC	*INVALOPN*
INJECTOR PLUNGER LIFT mm @ 72°	*PLUNLIFT*
INTAKE VALVE LIFT mm @ 456°	*INLIFT*
EXHAUST VALVE LIFT mm @ 247°	*EXLIFT*

	PART NUMBER		SERIAL NUMBER		DATE CODE		INSPECTION CODE	
LINER	*LINERPN*	A	*LINERSN*	A	*LINERDC*	B		
TOP RING	*TOPPN*	C	*TOPSN*	E				
INTERMEDIATE RING	*INTPN*	C	*INTSN*	E				
OIL RING	*OILPN*	C	*OILSN*	E				
PISTON CROWN	*CROWNPN*	D	*CROWNSN*	D	*CROWNDC*	F	*CROWNIC*	G
PISTON SKIRT	*SKIRTPN*	H	*SKIRTSN*	I				
FUEL INJECTOR	*NOZZLEPN*	J	*NOZZLESN*	K				
ECM EPROM	*ECMPN*				*ECMDC*			
PISTON COOLING JET	*PTUBEPN*		*PTUBESN*					

A On liner O.D.
B On liner O.D. (NNAN)
C On box label
D On top of piston
E On paper envelope containing the ring
F Number below "E" located on piston top
G Number above "E" located on piston top
H On bottom surface of skirt rim
I On bottom surface under pin bore
J On top surface of plunger
K On top surface of plunger -6 digits

1Q - EGR SCOTE TEST PROCEDURE

FORM 4

PISTON RATING SUMMARY

TEST IDENTIFICATION	LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	STAND: *STAND*	RUN #: *ENRUN*	METHOD: *METHOD*
FORMULATION/STAND CODE: *FORM*			OILCODE/CMIR: *OILCODE/CMIR*			
TEST FUEL: *TESTFUEL*	FUEL BATCH: *FUELBTID*	DATE RATED: *DTRATE*	RATER INITIALS: *RINIT*	VERIFIED BY: *VRINIT*		
LAST STAND REFERENCE INFORMATION	DATE COMPLETED: *LRDTCOMP*	STAND #: *STAND*	RUN #: *LRENRUN*	TMC OIL CODE: *LIND*		

	WDP	TGC	TLC	OIL CONSUMPTION g/h	TRANSFOMED OIL CONSUMPTION	EOTOC g/h	TRANSFORMED EOTOC
LAST REF. THIS STAND	*LRWD*	*LRTGC*	*LRTLC*	*LROC*	*LROCT*	*LREOTOC*	*LRETOCT*
INDUSTRY AVERAGE	*LRAWD*	*LRATGC*	*LRATLC*		*LRAOCT*		*LRAETOCT*
INDUSTRY STD	*LRSWD*	*LRSTGC*	*LRSTLC*		*LRSOCT*		*LRSETOCT*

TOTAL PISTON RATINGS SUMMARY

		GROOVES				LANDS					GROOVE	LANDS				OIL COOLING GALLERY		UNDER CROWN	
	DEP. FACTOR	NO. 1		NO. 2		NO. 1		NO. 2		DEP. FACTOR	NO. 3	NO. 3		NO. 4					
		A.%	DEM.	A.%	DEM.	A.%	DEM.	A.%	DEM.		A.%	DEM.	A.%	DEM.	A.%	DEM.	A.%	DEM.	A.%	DEM.
CARBON	HC - 1.0	G1HCA	G1HCD	G2HCA	G2HCD	L1HCA	L1HCD	L2HCA	L2HCD		G3HCA	G3HCD	L3HCA	L3HCD	L4HCA	L4HCD				
	MC - 0.5	G1MCA	G1MCD								G3MCA	G3MCD								
	LC - .25	G1LCA	G1LCD	G2LCA	G2LCD	L1LCA	L1LCD	L2LCA	L2LCD		G3LCA	G3LCD	L3LCA	L3LCD	L4LCA	L4LCD	OGLCA	OGLCD	UCLCA	UCLCD
	TOTAL	G1ACTOT	G1DCTOT	G2ACTOT	G2DCTOT	L1ACTOT	L1DCTOT	L2ACTOT	L2DCTOT		G3ACTOT	G3DCTOT	L3ACTOT	L3DCTOT	L4ACTOT	L4DCTOT	OGACTOT	OGDCTOT	UCACTOT	UCDCTOT
VARNISH	8 - 9	G1V9A	G1V9D	G2V9A	G2V9D	L1V9A	L1V9D	L2V9A	L2V9D											
	7 - 7.9	G1V8A	G1V8D	G2V8A	G2V8D	L1V8A	L1V8D	L2V8A	L2V8D	7.5	G3V76A	G3V76D	L3V76A	L3V76D	L4V76A	L4V76D	OGV76A	OGV76D	UCV76A	UCV76D
	6 - 6.9	G1V7A	G1V7D	G2V7A	G2V7D	L1V7A	L1V7D	L2V7A	L2V7D											
	5 - 5.9	G1V6A	G1V6D	G2V6A	G2V6D	L1V6A	L1V6D	L2V6A	L2V6D											
	4 - 4.9	G1V5A	G1V5D	G2V5A	G2V5D	L1V5A	L1V5D	L2V5A	L2V5D	4.5	G3V45A	G3V45D	L3V45A	L3V45D	L4V45A	L4V45D	OGV45A	OGV45D	UCV45A	UCV45D
	3 - 3.9	G1V4A	G1V4D	G2V4A	G2V4D	L1V4A	L1V4D	L2V4A	L2V4D											
	2 - 2.9	G1V3A	G1V3D	G2V3A	G2V3D	L1V3A	L1V3D	L2V3A	L2V3D											
	1 - 1.9	G1V2A	G1V2D	G2V2A	G2V2D	L1V2A	L1V2D	L2V2A	L2V2D	1.5	G3V15A	G3V15D	L3V15A	L3V15D	L4V15A	L4V15D	OGV15A	OGV15D	UCV15A	UCV15D
	>0 - 0.9	G1V1A	G1V1D	G2V1A	G2V1D	L1V1A	L1V1D	L2V1A	L2V1D											
	CLEAN	G1VCLNA	0	G2VCLNA	0	L1VCLNA	0	L2VCLNA	0	CLEAN	G3VCLNA	0	L3VCLNA	0	L4VCLNA	0	OGVCLNA	0	UCVCLNA	0
	TOTAL	G1AVTOT	G1DVTOT	G2AVTOT	G2DVTOT	L1AVTOT	L1DVTOT	L2AVTOT	L2DVTOT		G3AVTOT	G3DVTOT	L3AVTOT	L3DVTOT	L4AVTOT	L4DVTOT	OGAVTOT	OGDVTOT	UCAVTOT	UCDVTOT
RATING		G1UWD		G2UWD		L1UWD		L2UWD			G3UWD		L3UWD		L4UWD		OGUWD		UCUWD	
LOCATION FACTOR		2		3		1		3			20		20		60		0.5		1	
IND RATING		G1WD		G2WD		L1WD		L2WD			G3WD		L3WD		L4WD		OGWD		UCWD	

WDP	TL HYV C	TGF	2GF	TL FLAKED C
UNWEIGHT	TLC	TGC	2GC	UN CROWN C

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1Q - EGR SCOTE TEST PROCEDURE

Form 4A

PISTON RATING WORKSHEET

Att 4, pg 5/19

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

RATEWSIM

Refer to Appendix A14 for an example of Piston Rating Worksheet.

1Q - EGR SCOTE TEST PROCEDURE

FORM 5
SUPPLEMENTAL PISTON DEPOSITS (GROOVE SIDES AND RINGS)

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

DEPOSIT TYPE			CARBON			VARNISH									
			HC	MC	LC	8 - 9	7 - 7.9	6 - 6.9	5 - 5.9	4 - 4.9	3 - 3.9	2 - 2.9	1 - 1.9	>0 - 0.9	CLEAN
GROOVE TOP AND BOTTOM	1	T	G1THCA	G1TMCA	G1TLCA	G1T9A	G1T8A	G1T7A	G1T6A	G1T5A	G1T4A	G1T3A	G1T2A	G1T1A	G1TCLNA
		B	G1BHCA	G1BMCA	G1BLCA	G1B9A	G1B8A	G1B7A	G1B6A	G1B5A	G1B4A	G1B3A	G1B2A	G1B1A	G1BCLNA
	2	T	G2THCA	G2TMCA	G2TLCA	G2T9A	G2T8A	G2T7A	G2T6A	G2T5A	G2T4A	G2T3A	G2T2A	G2T1A	G2TCLNA
		B	G2BHCA	G2BMCA	G2BLCA	G2B9A	G2B8A	G2B7A	G2B6A	G2B5A	G2B4A	G2B3A	G2B2A	G2B1A	G2BCLNA
	3	T	G3THCA	G3TMCA	G3TLCA	G3T9A	G3T8A	G3T7A	G3T6A	G3T5A	G3T4A	G3T3A	G3T2A	G3T1A	G3TCLNA
		B	G3BHCA	G3BMCA	G3BLCA	G3B9A	G3B8A	G3B7A	G3B6A	G3B5A	G3B4A	G3B3A	G3B2A	G3B1A	G3BCLNA
TOP BOTTOM AND BACK OF RINGS	1	T	R1THCA	R1TMCA	R1TLCA	R1T9A	R1T8A	R1T7A	R1T6A	R1T5A	R1T4A	R1T3A	R1T2A	R1T1A	R1TCLNA
		B	R1BHCA	R1BMCA	R1BLCA	R1B9A	R1B8A	R1B7A	R1B6A	R1B5A	R1B4A	R1B3A	R1B2A	R1B1A	R1BCLNA
		BK	R1BKHCA	R1BKMCA	R1BKLCA	R1BK9A	R1BK8A	R1BK7A	R1BK6A	R1BK5A	R1BK4A	R1BK3A	R1BK2A	R1BK1A	R1BKCLNA
	2	T	R2THCA	R2TMCA	R2TLCA	R2T9A	R2T8A	R2T7A	R2T6A	R2T5A	R2T4A	R2T3A	R2T2A	R2T1A	R2TCLNA
		B	R2BHCA	R2BMCA	R2BLCA	R2B9A	R2B8A	R2B7A	R2B6A	R2B5A	R2B4A	R2B3A	R2B2A	R2B1A	R2BCLNA
		BK	R2BKHCA	R2BKMCA	R2BKLCA	R2BK9A	R2BK8A	R2BK7A	R2BK6A	R2BK5A	R2BK4A	R2BK3A	R2BK2A	R2BK1A	R2BKCLNA
	3	T	R3THCA	R3TMCA	R3TLCA	R3T9A	R3T8A	R3T7A	R3T6A	R3T5A	R3T4A	R3T3A	R3T2A	R3T1A	R3TCLNA
		B	R3BHCA	R3BMCA	R3BLCA	R3B9A	R3B8A	R3B7A	R3B6A	R3B5A	R3B4A	R3B3A	R3B2A	R3B1A	R3BCLNA
		BK	R3BKHCA	R3BKMCA	R3BKLCA	R3BK9A	R3BK8A	R3BK7A	R3BK6A	R3BK5A	R3BK4A	R3BK3A	R3BK2A	R3BK1A	R3BKCLNA

ADDITIONAL DEPOSIT & CONDITION RATINGS	
PISTON CROWN	*CROWNAD*
PISTON SKIRT	*SKIRTAD*
RINGS	*RINGSAD*
LINER	*LINERAD*

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1Q - EGR SCOTE TEST PROCEDURE

FORM 5A
REFEREE RATING

TEST IDENTIFICATION							
LAB:	*LAB*	EOT DATE:	*DTCOMP*	END TIME:	*EOTTIME*	METHOD:	*METHOD*
STAND:	*STAND*	RUN #:	*ENRUN*				
FORMULATION/STAND CODE:	*FORM*						
OILCODE/CMIR:	*OILCODE/CMIR*						
REFEREE RATING INFORMATION							
COMPANY:	*RRLAB*	RATING NUMBER:	*RRNO*	DATE RATED:	*RRDATE*	RATER:	*RRINIT*

TOTAL PISTON RATINGS SUMMARY

		GROOVES NO. 1		GROOVES NO. 2		LANDS NO. 1		LANDS NO. 2		DEP. FACTOR	GROOVES NO. 3		LANDS NO. 3		LANDS NO. 4		OIL COOLING GALLERY		UNDER CROWN	
	DEP. FACTOR	A,%	DEM.	A,%	DEM.	A,%	DEM.	A,%	DEM.		A,%	DEM.	A,%	DEM.	A,%	DEM.	A,%	DEM.	A,%	DEM.
CARBON	HC-1.0	RRG1HCA	RRG1HCD	RRG2HCA	RRG2HCD	RRL1HCA	RRL1HCD	RRL2HCA	RRL2HCD		RRG3HCA	RRG3HCD	RRL3HCA	RRL3HCD	RRL4HCA	RRL4HCD				
	MC-0.5	RRG1MCA	RRG1MCD								RRG3MCA	RRG3MCD								
	LC-.25	RRG1LCA	RRG1LCD	RRG2LCA	RRG2LCD	RRL1LCA	RRL1LCD	RRL2LCA	RRL2LCD		RRG3LCA	RRG3LCD	RRL3LCA	RRL3LCD	RRL4LCA	RRL4LCD	RROGLCA	RROGLCD	RRUCLCA	RRUCLCD
	TOTAL	RG1ACTOT	RG1DCTOT	RG2ACTOT	RG2DCTOT	RL1ACTOT	RL1DCTOT	RL2ACTOT	RL2DCTOT		RG3ACTOT	RG3DCTOT	RL3ACTOT	RL3DCTOT	RL4ACTOT	RL4DCTOT	ROGACTOT	ROGDCTOT	RUCACTOT	RUCDCTOT
VARNISH	8 - 9	RRG1V9A	RRG1V9D	RRG2V9A	RRG2V9D	RRL1V9A	RRL1V9D	RRL2V9A	RRL2V9D											
	7 - 7.9	RRG1V8A	RRG1V8D	RRG2V8A	RRG2V8D	RRL1V8A	RRL1V8D	RRL2V8A	RRL2V8D	7.5	RRG3V75A	RRG3V75D	RRL3V75A	RRL3V75D	RRL4V75A	RRL4V75D	RROGV75A	RROGV75D	RRUCV75A	RRUCV75D
	6 - 6.9	RRG1V7A	RRG1V7D	RRG2V7A	RRG2V7D	RRL1V7A	RRL1V7D	RRL2V7A	RRL2V7D											
	5 - 5.9	RRG1V6A	RRG1V6D	RRG2V6A	RRG2V6D	RRL1V6A	RRL1V6D	RRL2V6A	RRL2V6D											
	4 - 4.9	RRG1V6A	RRG1V6D	RRG2V6A	RRG2V6D	RRL1V6A	RRL1V6D	RRL2V6A	RRL2V6D	4.5	RRG3V45A	RRG3V45D	RRL3V45A	RRL3V45D	RRL4V45A	RRL4V45D	RROGV45A	RROGV45D	RRUCV45A	RRUCV45D
	3 - 3.9	RRG1V4A	RRG1V4D	RRG2V4A	RRG2V4D	RRL1V4A	RRL1V4D	RRL2V4A	RRL2V4D											
	2 - 2.9	RRG1V3A	RRG1V3D	RRG2V3A	RRG2V3D	RRL1V3A	RRL1V3D	RRL2V3A	RRL2V3D											
	1 - 1.9	RRG1V2A	RRG1V2D	RRG2V2A	RRG2V2D	RRL1V2A	RRL1V2D	RRL2V2A	RRL2V2D	1.5	RRG3V15A	RRG3V15D	RRL3V15A	RRL3V15D	RRL4V15A	RRL4V15D	RROGV15A	RROGV15D	RRUCV15A	RRUCV15D
	>0 - 0.9	RRG1V1A	RRG1V1D	RRG2V1A	RRG2V1D	RRL1V1A	RRL1V1D	RRL2V1A	RRL2V1D											
	CLEAN	RRG1VCLA	0	RRG2VCLA	0	RRL1VCLA	0	RRL2VCLA	0		RRG3VCLA	0	RRL3VCLA	0	RRL4VCLA	0	RROGVCLA	0	RRUCVCLA	0
	TOTAL	RG1AVTOT	RG1DVTOT	RG2AVTOT	RG2DVTOT	RL1AVTOT	RL1DVTOT	RL2AVTOT	RL2DVTOT		RG3AVTOT	RG3DVTOT	RL3AVTOT	RL3DVTOT	RL4AVTOT	RL4DVTOT	ROGAVTOT	ROGDVTOT	RUCAVTOT	RUCDVTOT
RATING		RRG1UWD		RRG2UWD		RRL1UWD		RRL2UWD			RRG3UWD		RRL3UWD		RRL4UWD		RROGUWD		RRUCUWD	
LOCATION FACTOR		2		3		1		3			20		20		60		0.5		1	
IND RATING		RRG1WD		RRG2WD		RRL1WD		RRL2WD			RRG3WD		RRL3WD		RRL4WD		RROGWD		RRUCWD	

WDP	TL HYV C	TGF	2GF	TL FLAKED C
UNWEIGHT	TLC	TGC	2GC	UN CROWN C

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1Q - EGR SCOTE TEST PROCEDURE

Form 6

Engine Endurance Data

Test Identification			
Lab	LOT Date	End Time	Method
Stand	Run Number		
Formulation/ Stand Code			
Oil Code/ CMIR			
Test Fuel		Fuel Batch	

Oil Analysis	New	36	72	108	144	180	216	252	288	324	360	396	432	468	504
Visc @ 100 C	X	X			X			X			X		X		X
Visc @ 40 C	X	X			X			X			X		X		X
TBN D4739	X	X			X			X			X		X		X
TAN D664	X	X			X			X			X		X		X
Fuel Dilution %		X									X				X
TGA Soot %		X			X			X			X		X		X
Wear Metals (ppm)															
Fe	X	X			X			X			X		X		X
Al	X	X			X			X			X		X		X
Si	X	X			X			X			X		X		X
Cu	X	X			X			X			X		X		X
Cr	X	X			X			X			X		X		X
Pb	X	X			X			X			X		X		X
IR O2	X	X			X			X			X		X		X
Blowby (L/min)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oil Cons (g/hr)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oil Cons r2		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fuel Position(mm)		X						X			X				X
~~Oil Filter Delta Press~~		X	X	X	X	X	X	X	X	X	X	X	X	X	X

Delete

NOTE:

(1) Total Oil In System 5800 +/-50 grams

(2)Refill oil scale cart to full level every 36 hours. Take oil samples, as shown, before adding oil.

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1Q - EGR SCOTE TEST PROCEDURE

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FORM 7

DOWNTIME SUMMARY

LAB: LAB	EOT DATE. DTCOMP	END TIME: EOTTIME	METHOD: METHOD
STAND: STAND	RUN NUMBER: ENRUN		
FORMULATION/STAND CODE: : FORM			
OILCODE/CMIR: OILCODE/CMIR			

Number of Downtime Occurrences	DWNOCR	

TEST HOURS	DATE	DOWNTIME	REASONS
DOWNH001	DDATH001	DTIMH001	DREAH001
	TOTLDOWN		TOTAL DOWNTIME (125 HR. MAX)

Comments		
Number of Comment Lines	TOTCOM	

OCOMH001

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1Q - EGR SCOTE TEST PROCEDURE

FORM 8

RING MEASUREMENTS

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

ALL RING MEASUREMENTS ARE MADE USING METRIC FEELER GAGES

RING GAPS (mm)	1Y4014 TOP	1Y4013 INTERMEDIATE	1Y4012 OIL
SPECIFICATIONS	0.350-.550 mm	0.754-.906 mm	0.400-.750mm
PRE-TEST	*RINGGTE*	*RINGGI1E*	*RINGGOE*
POST-TEST	*RINGGTO*	*RINGGI1O*	*RINGGOO*
INCREASE	*RINGGTI*	*RINGGI1I*	*RINGGOI*

RING SIDE CLEARANCE*		A	B	C	D	AVG.	MIN.	SPECIFICATION
TOP	PRE-TEST	*SIDETPE1*	*SIDETPE2*	*SIDETPE3*	*SIDETPE4*	*ASIDETPE*	*ISIDETPE*	0.090-.127mm
	POST-TEST	*SIDETPO1*	*SIDETPO2*	*SIDETPO3*	*SIDETPO4*	*ASIDETPO*	*ISIDETPO*	
	LSC	*LSCT1*	*LSCT2*	*LSCT3*	*LSCT4*	*LSCTOP*	*ILSCT*	
INT.	PRE-TEST	*SIDE1PE1*	*SIDE1PE2*	*SIDE1PE3*	*SIDE1PE4*	*ASIDE1PE*	*ISIDE1PE*	0.060-.110mm
	POST-TEST	*SIDE1PO1*	*SIDE1PO2*	*SIDE1PO3*	*SIDE1PO4*	*ASIDE1PO*	*ISIDE1PO*	
	LSC	*LSCI1*	*LSCI2*	*LSCI3*	*LSCI4*	*LSCINT1*	*ILSCINT*	
OIL	PRE-TEST	*SIDEOPE1*	*SIDEOPE2*	*SIDEOPE3*	*SIDEOPE4*	*ASIDEOPE*	*ISIDEOPE*	0.030-.080mm
	POST-TEST	*SIDEOPO1*	*SIDEOPO2*	*SIDEOPO3*	*SIDEOPO4*	*ASIDEOPO*	*ISIDEOPO*	
	LSC	*LSCO1*	*LSCO2*	*LSCO3*	*LSCO4*	*LSCOIL*	*ILSCO*	

* NOTES:

1. WRITE "STUCK" IN PLACE OF DIMENSION WHEN APPLICABLE

2. WRITE "<0.03 mm" FOR CLEARANCE WHEN APPLICABLE.

3. WRITE ">" BEFORE CALCULATED DECREASE OR AVERAGE DECREASE VALUES THAT INCORPORATE A "<0.03 mm" IN CALCULATION.

4 LSC = LOSS OF SIDE CLEARANCE

5. MIN: OIL RING MINIMUM SIDE CLEARANCE IS MEASURED 360°AROUND PISTON.

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1Q - EGR SCOTE TEST PROCEDURE

FORM 9
LINER MEASUREMENTS

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

LINER SURFACE FINISH (MICROMETER)			
DISTANCE FROM TOP	TRANSVERSE	LONGITUDINAL	AVERAGE
130 mm	*BBLFINT1*	*BBLFINL1*	*BBLFINA1*
50 mm	*BBLFINT2*	*BBLFINL2*	*BBLFINA2*
25 mm	*BBLFINT3*	*BBLFINL3*	*BBLFINA3*
		TOTAL AVERAGE (Spec: 0.4-0.8 µm)	*BBLFIN*

%LINER BORE POLISH - GRID (ADD T/AT VALUES FROM GRID)	
THRUST	*BOREPT*
ANTI-THRUST	*BOREPAT*
TOTAL	*BOREPOL*

LINER BORE MEASUREMENT (137.154mm minimum)			
BEFORE TEST - DIAMETER (DIAL BORE GAGE)			
BORE HEIGHT	LONGITUDINAL	TRANSVERSE	OUT OF ROUND (0.038 mm max)
250 mm	*BBLONG1*	*BBTRAN1*	*OOR1*
210 mm	*BBLONG2*	*BBTRAN2*	*OOR2*
170 mm	*BBLONG3*	*BBTRAN3*	*OOR3*
130 mm	*BBLONG4*	*BBTRAN4*	*OOR4*
50 mm	*BBLONG5*	*BBTRAN5*	*OOR5*
25 mm	*BBLONG6*	*BBTRAN6*	*OOR6*
15 mm	*BBLONG7*	*BBTRAN7*	*OOR7*
TAPER (0.050 max)	*TAPRLONG*	*TAPRTRAN*	

AFTER TEST - (SURFACE PROFILE)				
	LONGITUDINAL		TRANSVERSE	
	FRONT	REAR	T	AT
WEAR STEP @ 13 mm	*AWEARLF*	*AWEARLR*	*AWEARTT*	*AWEARTAT*

1Q - EGR SCOTE TEST PROCEDURE

FORM 10

CHARACTERISTICS OF THE DATA ACQUISITION SYSTEM

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

PARAMETER (1)	SENSING DEVICE (2)	CALIBRATION FREQUENCY (3)	RECORD DEVICE (4)	OBSERVATION FREQUENCY (5)	RECORD FREQUENCY (6)	LOG FREQUENCY (7)	SYSTEM RESPONSE (8)
OPERATION CONDITIONS							
ENGINE SPEED (R\min)	RPMSENS	RPMCALF	RPMRECD	RPMOBSF	RPMRECF	RPMLOGF	RPMSYSR
ENGINE POWER (kW)	PWRSENS	PWRCALF	PWRRECD	PWROBSF	PWRRECF	PWRLOGF	PWRSYSR
FUEL FLOW (g/min)	FFLOSENS	FFLOCALF	FFLORECD	FFLOOBSF	FFLORECF	FFLOLOGF	FFLOSYSR
HUMIDITY (g/kg)	HUMSENS	HUMCALF	HUMRECD	HUMOBSF	HUMRECF	HUMLOGF	HUMSYSR
TEMPERATURES (°C)							
COOLANT OUT	COTSENS	COTCALF	COTRECD	COTOBSF	COTRECF	COTLOGF	COTSYSR
COOLANT IN	CONSENS	CONCALF	CONRECD	CONOBSF	CONRECF	CONLOGF	CONSYSR
OIL TO MANIFOLD	OBRGSENS	OBRGCALF	OBRGRECD	OBRGOBSF	OBRGRECF	OBRGLOGF	OBRGSYSR
OIL COOLER IN	OCOLSENS	OCOLCALF	OCOLRECD	OCOLOBSF	OCOLRECF	OCOLLOGF	OCOLSYSR
INLET AIR	AIRTSENS	AIRTCALF	AIRTRECD	AIRTOBSF	AIRTRECF	AIRTLOGF	AIRTSYSR
EXHAUST	EXTSENS	EXTCALF	EXTRECD	EXTOBSF	EXTRECF	EXTLOGF	EXTSYSR
FUEL TO HEAD	FUELSENS	FUELCALF	FUELRECD	FUELOBSF	FUELRECF	FUELLOGF	FUELSYSR
PRESSURES (kPa)							
OIL TO MANIFOLD	OBRPSENS	OBRPCALF	OBRPRECD	OBRPOBSF	OBRPRECF	OBRPLOGF	OBRPSYSR
INLET AIR	AIRPSENS	AIRPCALF	AIRPRECD	AIRPOBSF	AIRPRECF	AIRPLOGF	AIRPSYSR
EXHAUST	EXPSENS	EXPCALF	EXPRECD	EXPOBSF	EXPRECF	EXPLOGF	EXPSYSR
FUEL FROM HEAD	FFILSENS	FFILCALF	FFILRECD	FFILOBSF	FFILRECF	FFILLOGF	FFILSYSR
CRANKCASE	CCVSENS	CCVCALF	CCVRECD	CCVOBSF	CCVRECF	CCVLOGF	CCVSYSR
FLOWS (L/min)							
BLOWBY	BLBYSENS	BLBYCALF	BLBYRECD	BLBYOBSF	BLBYRECF	BLBYLOGF	BLBYSYSR
COOLANT FLOW	CFLWSENS	CFLWCALF	CFLWRECD	CFLWOBSF	CFLWRECF	CFLWLOGF	CFLWSYSR

LEGEND: Add Oil FILTER ΔP

(1) OPERATING PARAMETER
(2) THE TYPE OF DEVICE USED TO MEASURE TEMPERATURE, PRESSURE OR FLOW
(3) FREQUENCY AT WHICH THE MEASUREMENT SYSTEM IS CALIBRATED
(4) THE TYPE OF DEVICE WHERE DATA IS RECORDED
  LG - HANDLOG SHEET
  DL - AUTOMATIC DATA LOGGER
  SC - STRIP CHART RECORDER
  C/M - COMPUTER, USING MANUAL DATA ENTRY
  C/D - COMPUTER, USING DIRECT I/O ENTRY

(5) DATA AREA OBSERVED BUT ONLY RECORDED IF OFF SPEC.
(6) DATA ARE RECORDED BUT ARE NOT RETAINED AT EOT
(7) DATA ARE LOGGED AS PERMANENT RECORD, NOTE SPECIFY IF:
  SS - SNAPSHOT TAKEN AT SPECIFIED FREQUENCY
  AQ/X AVERAGE OF X DATA POINTS AT SPECIFIED FREQUENCY
(8) TIME FOR THE OUTPUT TO REACH 63.2% OF FINAL VALUE FOR STEP CHANGE AT INPUT

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1Q - EGR SCOTE TEST PROCEDURE

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FORM 11

ENGINE OPERATIONAL DATA PLOTS

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

1Q - EGR SCOTE TEST PROCEDURE

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FORM 12

TORQUE AND EXHAUST TEMPERATURE HISTORY

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

Data From Last 10 Tests

Test No.	1	2	3	4	5	6	7	8	9	10
Avg. Exh Temp.°C	*AEXHH001*	*AEXHH002*	*AEXHH003*	*AEXHH004*	*AEXHH005*	*AEXHH006*	*AEXHH007*	*AEXHH008*	*AEXHH009*	*AEXHH010*
Avg.Eng.Torque Nm	*ATORH001*	*ATORH002*	*ATORH003*	*ATORH004*	*ATORH005*	*ATORH006*	*ATORH007*	*ATORH008*	*ATORH009*	*ATORH010*

1Q - EGR SCOTE TEST PROCEDURE

FORM 13

OIL CONSUMPTION PLOT

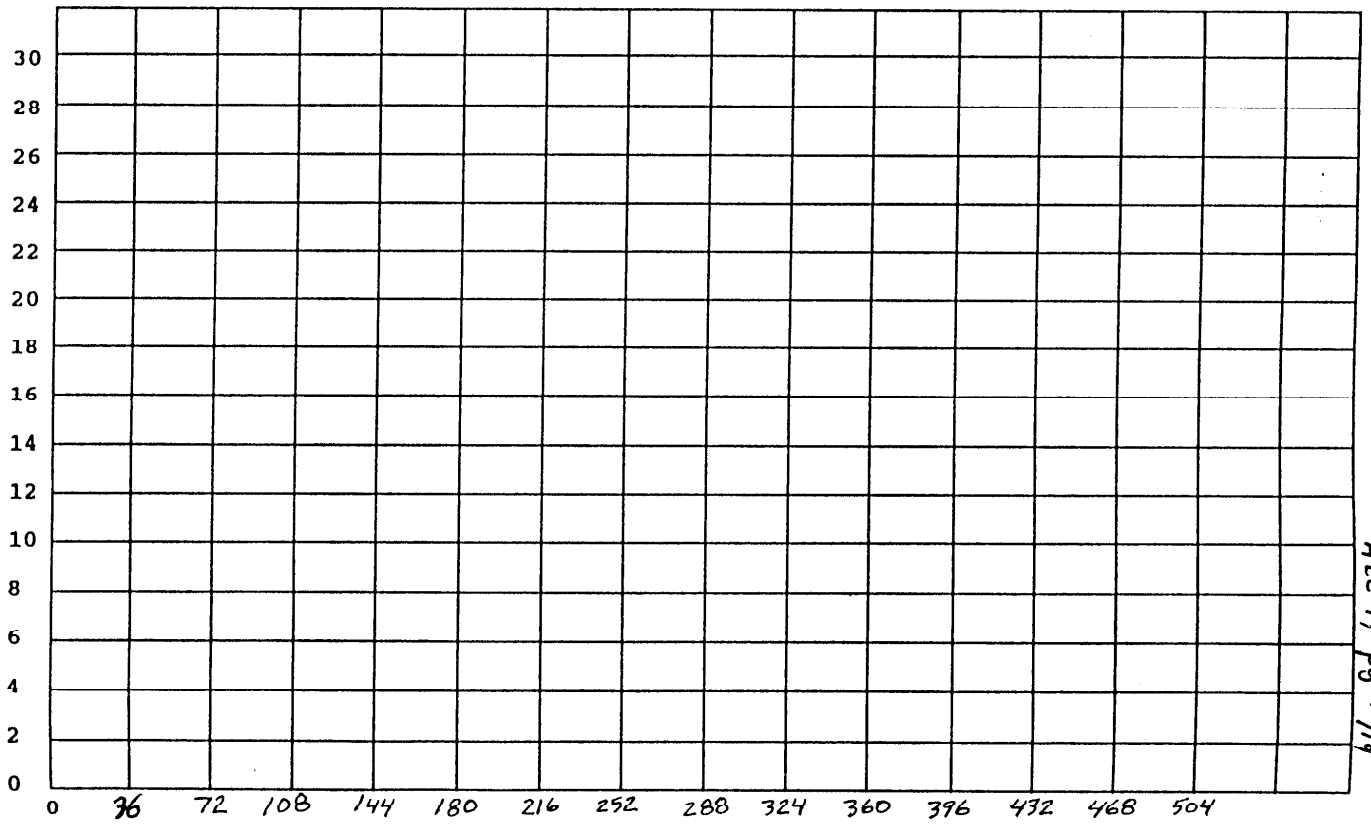
LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

Oil Consumption g/h

Beginning of Test Oil Consumption *BOTOC*

End of Test Oil Consumption *EOTOC*

Overall Oil Consumption *OC*



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OCPM

1Q - EGR SCOTE TEST PROCEDURE

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Form 14

PISTON, RING AND LINER PHOTOGRAPHS

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

PRUM

Refer to Appendix A14 for example of Photo Layout.

1Q - EGR SCOTE TEST PROCEDURE

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FORM 15
SEVERITY ADJUSTMENT HISTORY

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

USAGE DATES		WDP		TGC		TLC		TRANSFORMED OC		TRANSFORMED EOTOC	
START	TIME	Zi	S.A.	Zi	S.A.	Zi	S.A.	Zi	S.A.	Zi	S.A.
DTSTR001	*DTTMR001*	*WDZIR001*	*WDSAR001*	*TGZIR001*	*TGSAR001*	*TLZIR001*	*TLSAR001*	*OCZIR001*	*OCSAR001*	*ETZIR001*	*ETSAR001*

1Q - EGR SCOTE TEST PROCEDURE

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Form 16

FUEL BATCH ANALYSIS

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

FUELIM

Refer to Appendix A14 for examples of appropriate Fuel Batch Analysis pages.

1Q - EGR SCOTE TEST PROCEDURE

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Form 17

TMC CONTROL CHART ANALYSIS

(Reference Oil Tests Only)

LAB: *LAB*	EOT DATE: *DTCOMP*	END TIME: *EOTTIME*	METHOD: *METHOD*
STAND: *STAND*	RUN NUMBER: *ENRUN*		
FORMULATION/STAND CODE: *FORM*			
OILCODE/CMIR: *OILCODE/CMIR*			

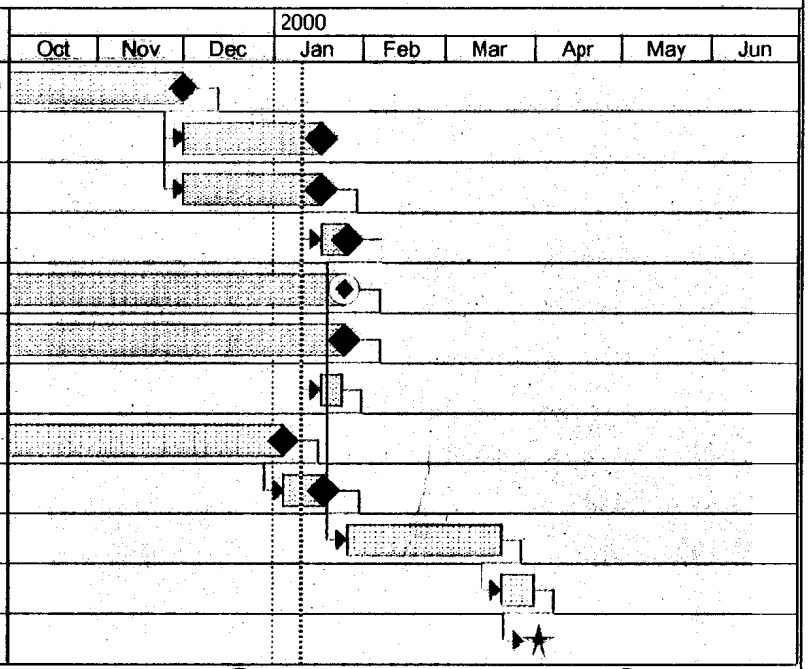
CCMIM

Refer to Appendix A14 for example of Control Chart Analysis page.

Time Line for the 1Q Test

Brent Shoffner - 12/3/99

ID	Task Name	Start	Finish
1	Design EGR Hardware	03/01/99	11/30/99
2	Produce and ship test kits to labs	12/01/99	2/1/00
3	Specify Installation / Prelim Procedure	12/01/99	01/17/00
4	Install test kit	01/18/00	01/26/00
5	Write procedure (Draft Complete)	03/01/99	01/25/00
6	Develop EGR rate measurement	03/01/99	01/25/00
7	Lab Visits	01/18/00	01/24/00
8	Discrimination Matrix Design Complete	03/01/99	01/04/00
9	Discr. Oils Available at the labs	01/05/00	01/18/00
10	Run Discrimination Tests	01/27/00	03/20/00
11	Data Analysis	03/21/00	03/31/00
12	HDEOCP Approves Proof of Concept*	04/03/00	04/03/00



1 Done

2. Finish 2/1

3. Done

4. Start 2/1
Finish 3/1

5. Finish 4/1

6. Done

7. Start 5/1
Finish 6/1

8 Finish 4/1

9. Start 2/15
Finish 3/15

10: Start 3/1
Finish 5/1

Add: ~~Preliminary Procedure~~
~~Finish~~:

11. Start 5/1
Finish 5/15

12. Finish 6/1

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* Contingent on HDEOCP Meeting Date