Issued: May 30, 2012
Reply to: Dan Worcester
Southwest Research Institute
6220 Culebra Rd.
San Antonio, TX 78238
Phone: 210.522.2405
Fax: 210.684.7523
Email: dworcester@swri.org

These are the unapproved minutes of the 05.22.2012 Sequence VI Task Force meeting.

The meeting was called to order at 10:00 AM Central Time by Chairman Dave Glaenzer.

Agenda

The Agenda is the included as Attachment 1.

1.0 Roll Call

The Attendance list Attachment 2.

2.0. Approval of minutes

2.1. Approval of the minutes of the 04.26.2012 Conference Call.
The minutes were approved without changes.

3.0. Action Item Review

3.1. Afton to run VIA type break-in on MY2012 GM engine.
The modified break in is included as Attachment 3. Afton then ran reference oil 542 with an FEI1 of 3.62 [17 sigma mild] and FEI2 of 1.27 [3.4 sigma mild]. The group will recommend to the Surveillance Panel to continue to use the existing break in for VIE engines.
IAR has purchased a 2012 engine from a dealer and run reference oils in the current sequence. For RO 542, they achieved FEI1 of 2.30 and FEI2 of 1.07. For RO 541 they had FEI1 of 1.27 and FEI2 of 0.91.

3.2. SwRI to run BLB1 & BLB2 as normal, then re-run with 90 minute stabilization times.
This was an issue as some labs appear to have problems controlling to the VID temperatures. This change would improve stabilization during stages.

Motion – Recommend to the Surveillance Panel to move to 90 minute stabilization for the VIE test.

Charlie Leverett/ Dan Worcester / Unanimous.

3.3. TMC to evaluate data for oil pressure trends.
The TMC Oil Pressure Presentation is Attachment 4. There was no stage correlation FEI1, but a slight positive correlation for FEI2 in stages 1, 2, and 5.

3.4. TMC to conduct engine coolant flow calibration round robin with meter supplied by Afton. Ed Altman will write a procedure for calibration using the 50-50 mixture. It was recommended that the same fluid used for testing be used for calibration.

3.5. Oberg filter line size to be evaluated along with remainder of external oil line plumbing. Labs are to fill out a survey on oil line sizes, fittings and lengths.

3.6. Lubrizol to run flush effectiveness study to evaluate Ca carryover.
Performing dual BL flushes does bring the calcium level down to the level in BL. IAR will run using the Lubrizol format for comparison.
Here are the results for the flush study on 258:

CALCIUM %	0.3758	FLUSH #1	3hr
CALCIUM %	0.2471	FLUSH #2	4hr
CALCIUM %	0.2111	FLUSH #3	5hr
CALCIUM %	0.1999	FLUSH #4	6hr
CALCIUM %	0.2018	FLUSH #5	6.5hr
CALCIUM %	0.1979	DRAIN #6	7hr
CALCIUM %	0.2038	BLA START	7.5hr
CALCIUM %	0.1998	BLA END	16.5hr

3.7. ExxonMobil to generate list of ECM data that would be desirable to monitor and record. This action is still open.

4.0) Old Business

4.1. None

5.) New Business

5.1. The Afton results on RO 542 are covered above.

5.2. Oil lines will be covered in the survey responses.

5.3. Dan Worcester sent an email with some recommendations for test improvements.
The procedure review is Attachment 6. The oil pressure and BSFC for the current break in is Attachment 5. The SwRI Recommendations is Attachment 7. SwRI has recommended the concept of selecting a Golden Stand and other labs duplicate to improve lab to lab results. SwRI also recommends the BLB Delta be reviewed, especially for new engines, and that the engine hour correction be adjusted, although that will not resolve the mild first result on 2012 engines. Those targets for RO 542 will need to be changed at a minimum.

6.) Next Meeting

The next call will be 06.19.2012.

7.) Meeting Adjourned

The meeting adjourned at 11:10 AM Central Time.

Sequence VI Test Quality TF Teleconference

May 22, 2012

11:00 EDT

Call-in Number: 866-817-9787

Participant Passcode: 2158089

Non-Toll Free: 203-320-3489

Agenda

1) Attendance

2) Approval of minutes

2.1) Approve the minutes from April 26, 2012

3) Action Item Review from 03/27/2012 & 04/26/2012

1. Afton to run VIA type break-in on MY2012 GM engine. Done Review
2. SwRI to run BLB1 & BLB2 as normal, then re-run with 90 minute stabilization times. Done Review
3. TMC to evaluate data for oil pressure trends. Grundza report
4. TMC to conduct engine coolant flow calibration round robin with meter supplied by Afton. Altman/Grundza report
5. Oberg filter line size to be evaluated along with remainder of external oil line plumbing. Open, Survey sent to labs
6. Lubrizol to run flush effectiveness study to evaluate Ca carryover. Brys Done Review
7. ExxonMobil to generate list of ECM data that would be desirable to monitor and record. Mosher report

4) New or Additional Areas of Concern

1. Afton results RO 542, engine GM5.
2. Survey of test stand oil line componentry on suction side of engine driven oil pump as well as lines to and from engine oil filter.
3. Dan Worcester email

6) Next Meeting

Teleconference on XX/XX/2012

7) Meeting Adjourned

ASTM SEQUENCE VI T.F 05/22/2012 TELE CONFERENCE

Name	Address	Phone/Fax/Email	Attendance
Jason Bowden Voting Member	OH Technologies, Inc. P.O. Box 5039 Mentor, OH 44061-5039	Phone: 440-354-7007 Fax: 440-354-7080 jhbowden@ohtech.com	✓
Timothy Caudill Voting Member	Ashland, Inc. 21st and Front Streets Ashland, KY 41101	Phone: 606-329-5708 Fax: 606-329-3009 Tlcaudill@ashland.com	✓
David Glaenzer Voting Member	Afton Research Center 500 Spring Street Richmond, VA 23218	Phone: 804-788-5214 Fax: 804-788-6358 Dave.Glaenzer@aftonchemical.com	✓
Rich Grundza Voting Member	ASTM TMC 6555 Penn Ave. Pittsburgh, PA 15206-4489	Phone: 412-365-1034 Fax: 412-365-1047 reg@astmtmc.cmu.edu	✓
Charlie Leverett Voting Member	Intertek Automotive Research 5404 Bandera Road San Antonio, TX 78238	Phone: 210-647-9422 Fax: 210-523-4607 charlie.leverett@intertek.com	✓
Jim Linden Voting Member	Toyota	lindenjim@hotmail.com	
Bruce Matthews Voting Member	GM Powertrain Engine Oil Group Mail Code: 483-730-472 823 Joslyn Rd	Pontiac, MI 48340 Phone: 248-830-9197 bruce.matthews@gm.com	✓
Timothy Miranda Voting Member	BP Castrol Lubricants USA 1500 Valley Road Wayne, NJ 07470	Phone: 973-305-3334 Timothy.Miranda@bp.com	
Nathaniel Moles Voting Member	Lubrizol 29400 Lakeland Blvd. Wickliffe, OH 44092	Phone: (440) 347-4472 Nathaniel.Moles@Lubrizol.com	
Mark Mosher Voting Member	ExxonMobil 600 Billingsport Road Paulsboro, NJ 08066	Phone: 856-224-2132 Fax: 856-224-3628 mark_r_mosher@exxonmobil.com	
Andy Ritchie Voting Member	Infineum 1900 East Linden Ave. Linden, NJ 07036-0735	Phone: 908-474-2097 Fax: 908-474-3637 Andrew.Ritchie@infineum.com	

ASTM SEQUENCE VI

Name	Address	Phone/Fax/Email	Attendance
Ron Romano Voting Member	Ford Motor Company 21500 Oakwood Blvd POEE Bldg Rm DR 167 MD 44 Dearborn, MI 48121-2053	Phone: 313-845-4068 rromano@ford.com	
Mark Sutherland Voting Member	Chevron Oronite Company LLC 4502 Centerview Ste. 210 San Antonio, TX 78228	Phone: 210.731.5605 Fax: 210.731.5621 msut@chevrontexaco.com	
Haiying Tang Voting Member	Chrysler	HT146@Chrysler.com Tel: 248-512-0593	
Dan Worcester Voting Member	Southwest Research Institute (SwRI) 6220 Culebra Road San Antonio, TX 78228	Phone: 210.522.2405 dan.worcester@swri.org	✓

Guests

Ed Altman	ed.altman@aftonchemical.com	Afton	✓
Bob Campbell	Bob.Campbell@aftonchemical.com	Afton	
Todd Dvorak	todd.dvorak@aftonchemical.com	Afton	✓
Christian Porter	Christian.porter@aftonchemical.com	Afton	✓
Jo Martinez	jogm@chevron.com	Chevron	
Kurt Knapp	knappka@cpchem.com	CP	
Jim Carter	jecarter@jhaltermann.com	Haltermann	
Doyle Boese	Doyle.boese@infineum.com	Infineum	
Jerry Brys	Jerome.brys@lubrizol.com	Lubrizol	✓
Jeff Kettman	Jeff.kettman@gm.com	GM	

ASTM SEQUENCE VI

Name	Address	Phone/Fax/Email	Attendance
Don Smolenski	donald.j.smolenski@gm.com	GM	
Robert Stockwell	Robert.Stockwell@GM.com Phone: 210.563.0785	GM	✓
Angela Willis	angela.p.willis@gm.com	GM	
Matthew Snider	matthew.j.snider@gm.com	GM	✓
Scott Stap	Scott.stap@tgdirect.com	TG Direct	
Dwight Bowden	dhbowden@ohtech.com	OHT	✓
Matt Bowden	mjbowden@ohtech.com	OHT	✓
Clayton Knight	cknight@tei-net.com	TEI	
Jeff Clark	jac@astmtmc.cmu.edu	TMC	
Guy Stubbs	Guy.Stubbs@swri.org	SwRI	
William Buscher	wbuscher@swri.edu	SwRI	✓

Terry Hoffman ✓ Afton

Modified Break-In of Sequence VIE Engine GM5

Potential adaptation of Sequence VIA style new engine break-in for Sequence VIE use.

Experiment completed on normally calibrated, Sequence VID stand with Instrumentation calibrated 02/08/2012.

David L. Glaenzer

May, 2012

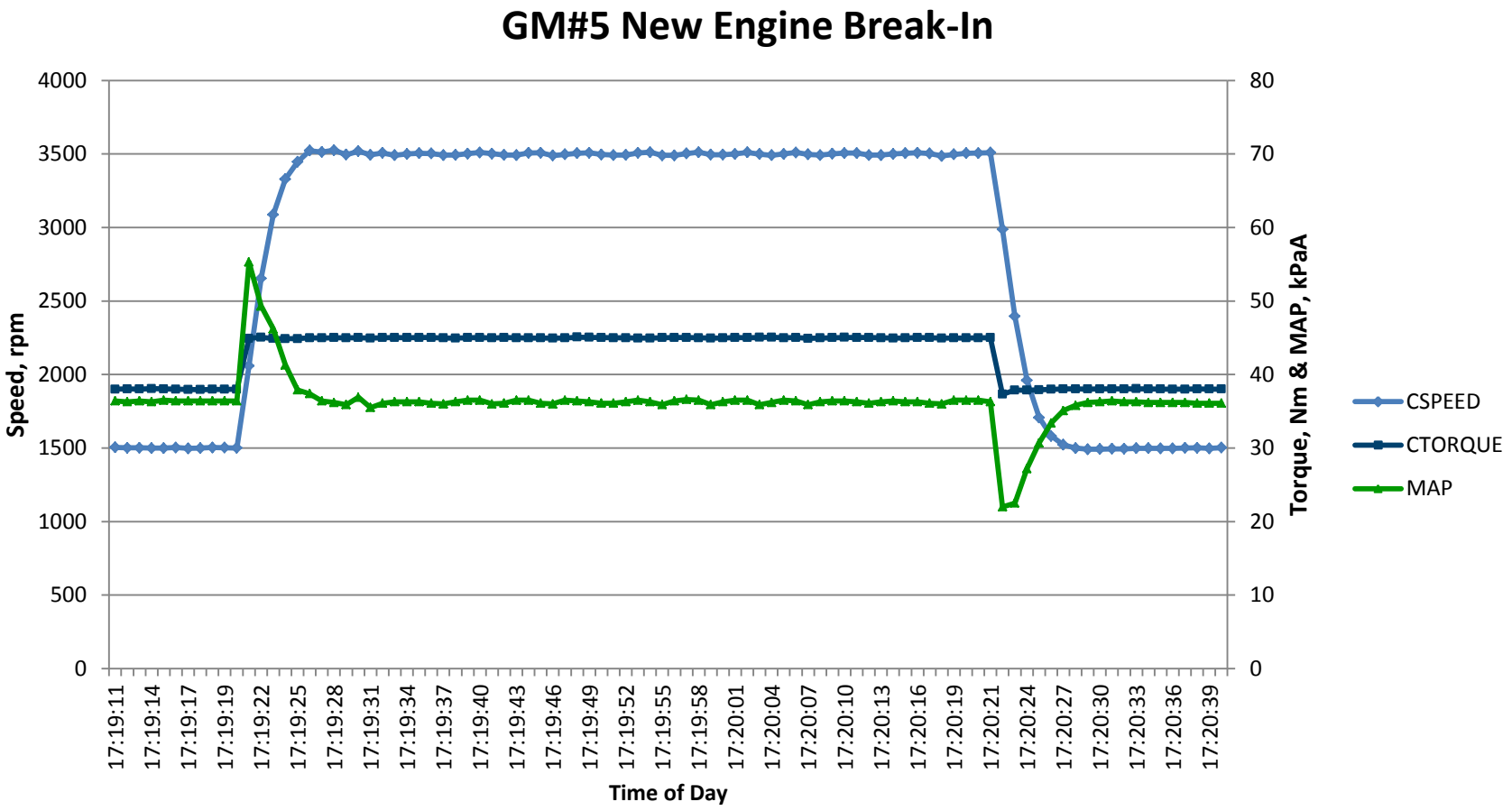
Protocol

- Engine GM5 installed, initial start-up completed and oil pan level set using BL3.
- Cyclical operation as described in D7589 with modified Oil Gallery temperature of 105°C and Coolant Inlet temperature of 95°C.
- New oil adds completed when 400ml below full.
- 28 micron oil filter screen.
- Run cycles A & B for 110 hours.
- Stabilize at Sequence VID Stage 3 for 60 minutes; data logging was inadvertently omitted.
- Complete BSFC measurement at Stage 3 conditions as described in D7589 with six steps completed over 30 minutes logging data every one second.

Protocol (continued)

- **Resume cyclical operation for 10 hours.**
- **Repeat 60 minute Stage 3 stabilization.**
- **Repeat 30 minute BSFC routine.**
- **Continue to 160 hours of cyclical operation. Calculate maximum delta (high minus low) of BSFC averages gathered at hours 110, 120, 130, 140, 150 & 160.**
- **If delta is <1.0%, consider break-in complete.**
- **If delta is >1.0%, continue 10 hour cyclical operation followed by stabilization and BSFC measurement until four consecutive BSFC averages have a maximum delta of <1.0%.**
- **No appreciable change after 140 hours.**

Cycle A/B transition times targeted to midline



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BSFC Data

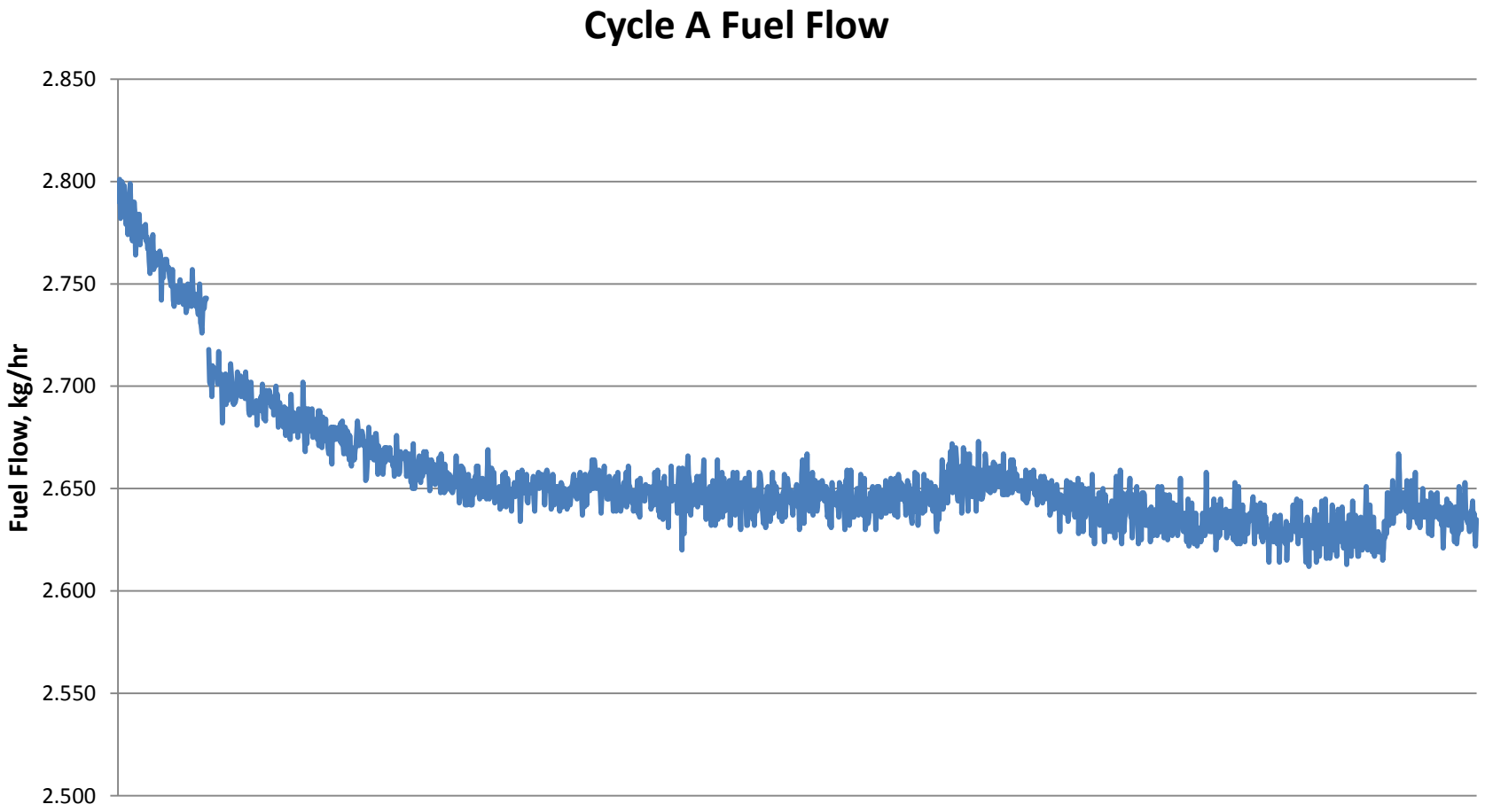
	Hour 110	Hour 120	Hour 130	Hour 140	Hour 150	Hour 160
Step 1	0.2892	0.2887	0.2878	0.2883	0.2877	0.2885
Step 2	0.2891	0.2879	0.2880	0.2879	0.2876	0.2889
Step 3	0.2891	0.2883	0.2878	0.2884	0.2878	0.2884
Step 4	0.2893	0.2882	0.2883	0.2882	0.2884	0.2885
Step 5	0.2891	0.2886	0.2878	0.2880	0.2879	0.2883
Step 6	0.2888	0.2879	0.2877	0.2881	0.2880	0.2885
Average	0.28910	0.28827	0.28790	0.28815	0.28790	0.28852
Std. Dev.	0.0002	0.0003	0.0002	0.0002	0.0003	0.0002
C.V.	0.06	0.12	0.08	0.06	0.10	0.07
MAX vs.		0.29%	0.42%	0.33%	0.42%	0.20%

Fresh Oil Adds

- **Followed D7589 and added fresh BL3 when 400ml low.**

	Hour 0	Full	
	Hour 73	Add 400 ml	
	Hour 132	Add 400 ml	
	Hour 160	200 ml Low	
	Total	1000 ml	

Fuel Flow Rate Measured at End of Cycle A



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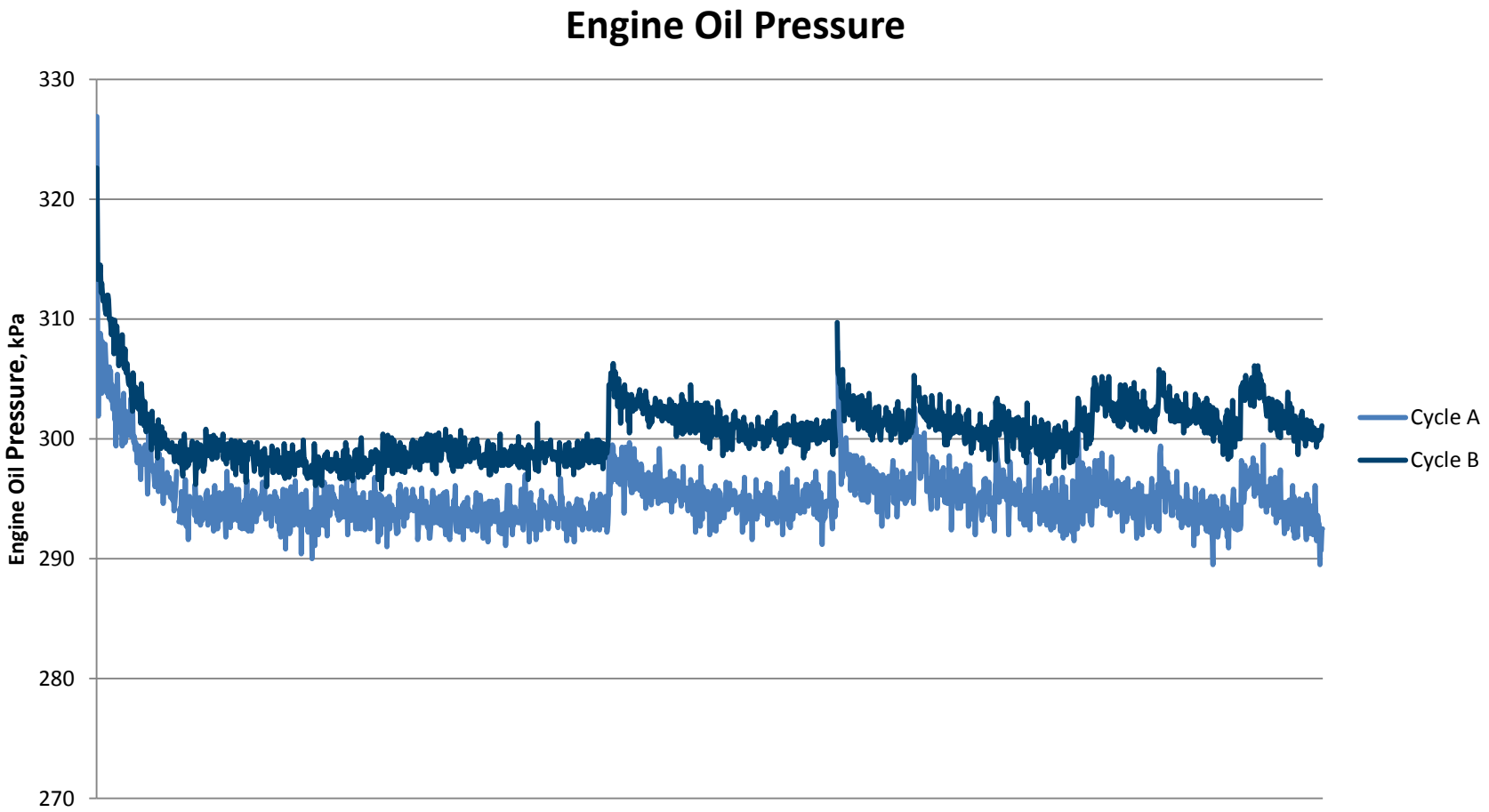
Engine Oil Pressure Measured at End of Cycle



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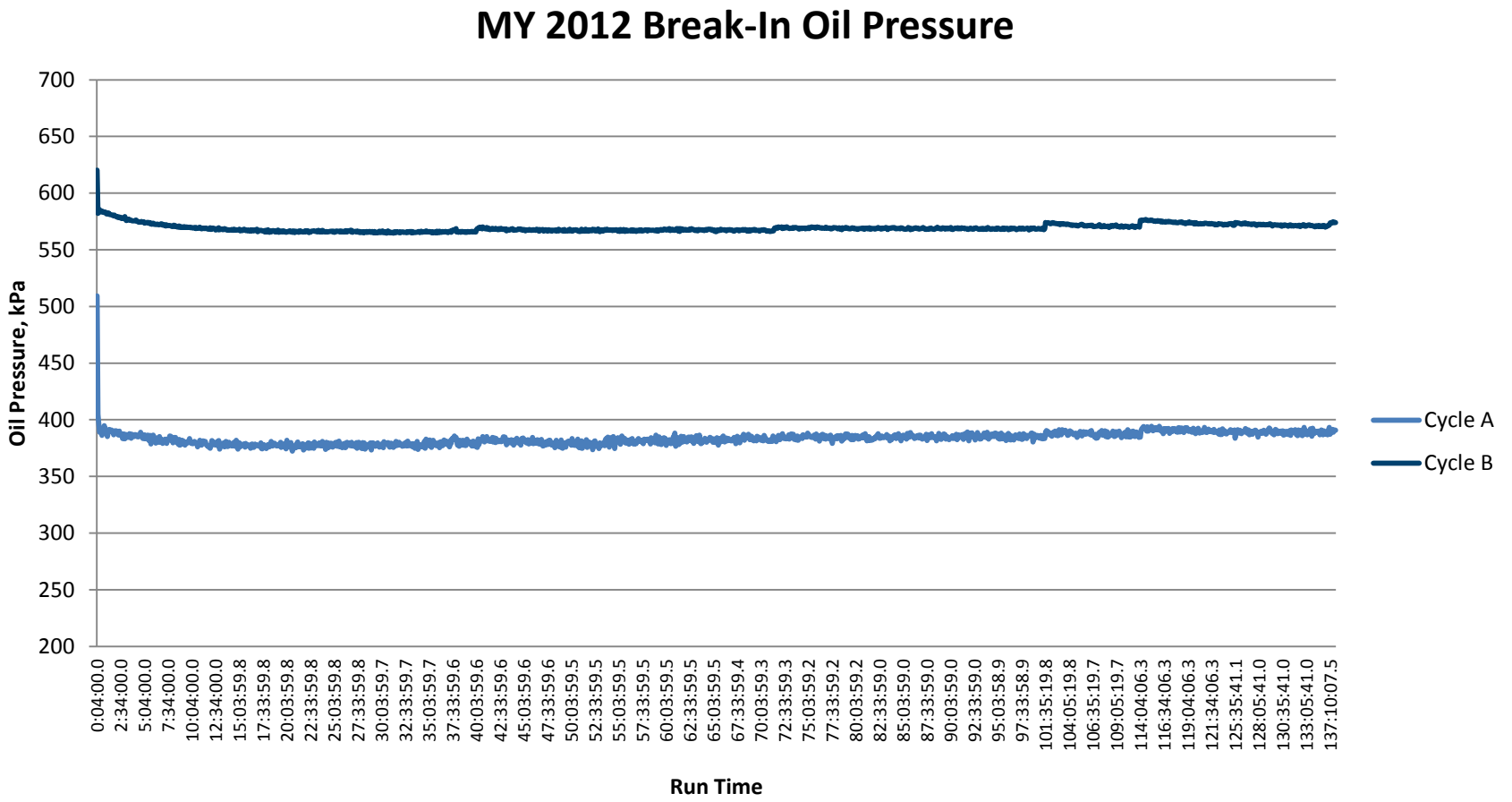
Supplemental Information

- **MY 2012 dealer engine run in proprietary research stand at Afton Chemical following same protocol exhibited similar stability (0.45% at 130 hours) with Midwest 175 hp dynamometer.**
- **Afton research engine uses OEM oil pickup from oil pan. Oil pressure controlled by engine oil pump relief valve with significant pressure difference noted between Step A and B.**
- **No appreciable change in engine oil pressure when cycling from Step A to B with GM5 engine**
- **Graph of Afton research stand oil pressure follows.**

Afton Research Stand Engine Oil Pressure



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Summary

- **Modified Break-In conditions appear to produce stability after 150 hours of cyclical operation.**
- **Oil consumption with MY 2012 engine using Sequence VID protocol is low compared to MY 2009 experience.**
- **Acceleration and Deceleration times may have impact results, but would require additional runs to quantify.**
- **Based of differences observed at Afton, oil pressure for engine GM5 is apparently being controlled by the external oil system and not the oil pump pressure relief valve.**
- **Run RO 542 next to see if results differ from engines using D7589 (Sequence VID) break-in procedure.**

Oil Pressure Study

Sequence VID Task Force

May 22, 2012

Summary of Results

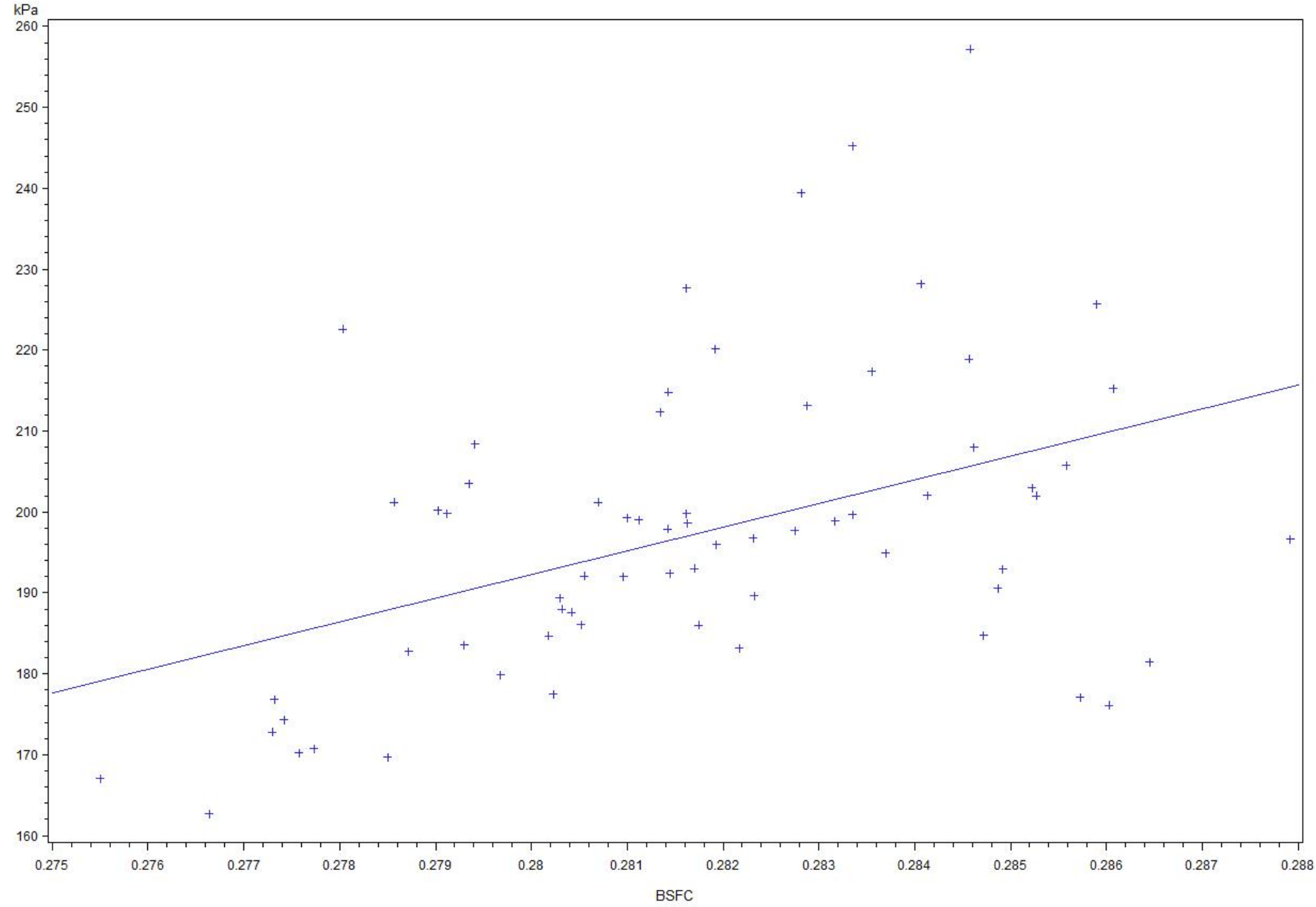
- 10 engines studied from six labs
- How does increase oil pressure affect fuel consumption?
- 5 of 6 stages (1, 2, 3, 5 & 6) all tested significant using regression analysis. However, only limited amounts of variability can be explained by model.
- Also studied effects of oil pressure and fuel consumption on FEI.

Summary of Results

- Fuel Consumption was negatively correlated with engine hours for stages 1, 3, and 6.
- No stages correlated with FEI1
- Positive correlation with FEI2 stages 1, 2 and 5
- Engine oil pressure also correlated with FEI2Yi for stages 1, 2, and 5

Sequence VID

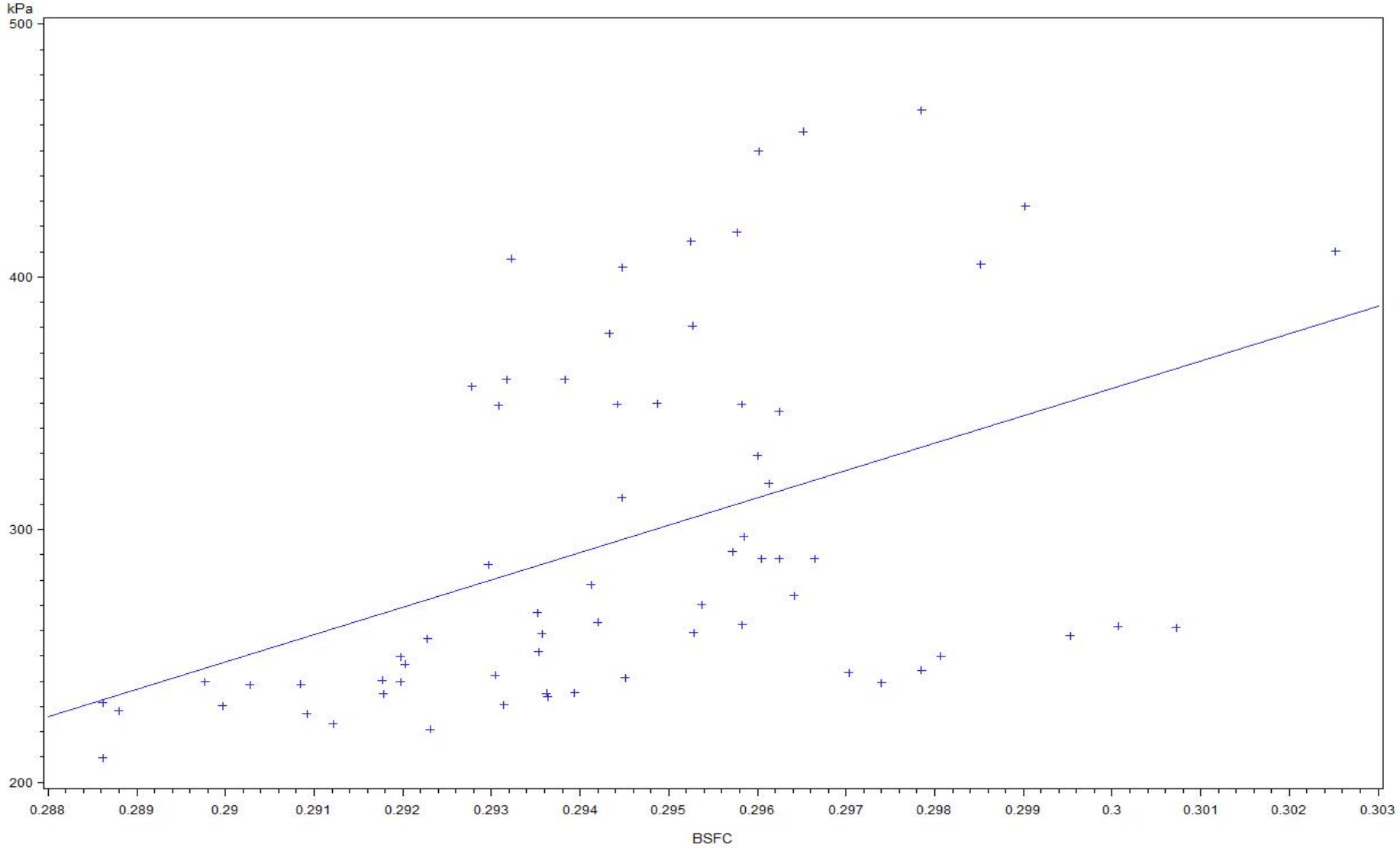
Plot of Oil Pressure versus BSFC
BLB2, Stage 1



r-square 0.185

Sequence VID

Plot of Oil Pressure versus BSFC
BLB2, Stage 2



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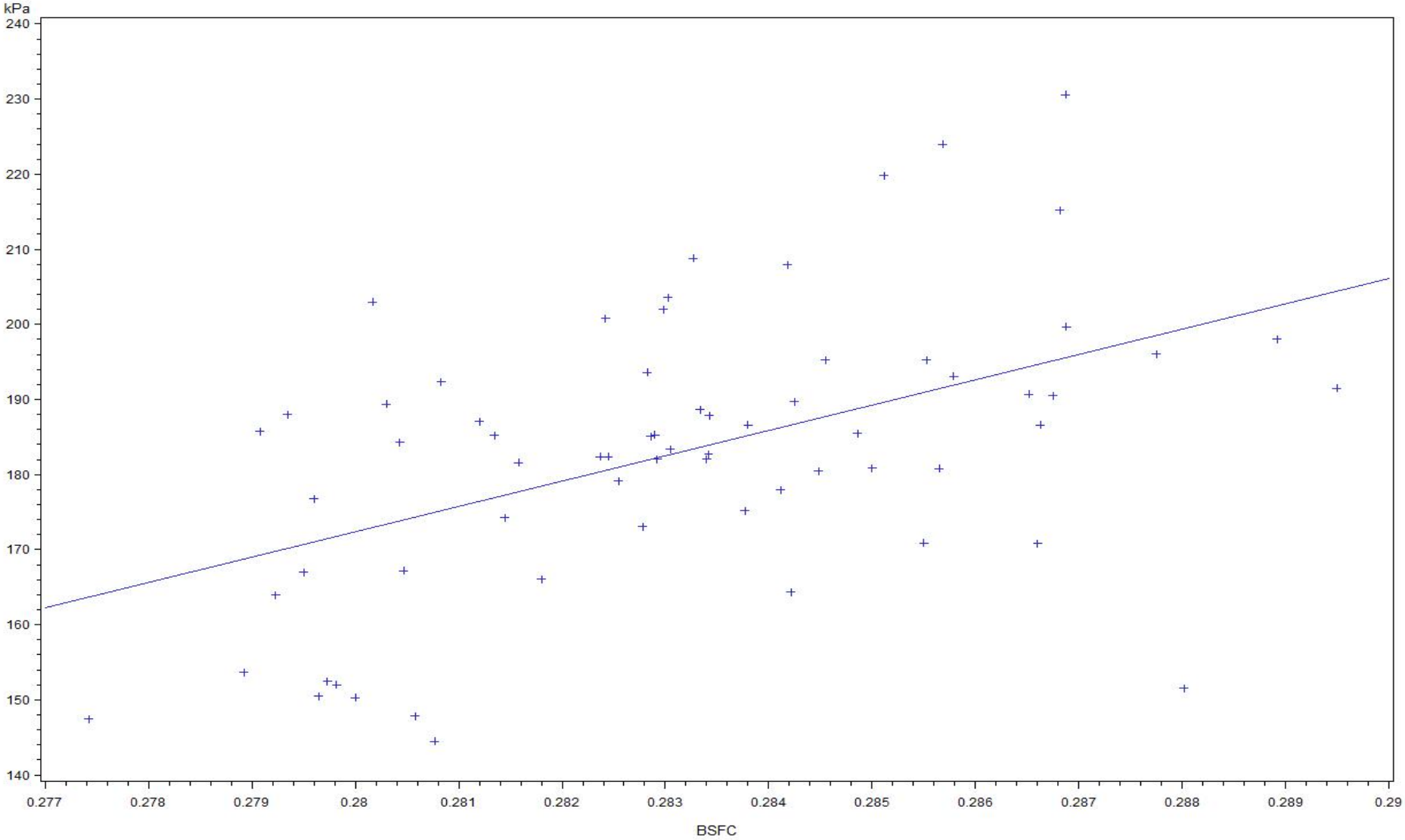
Sequence VID

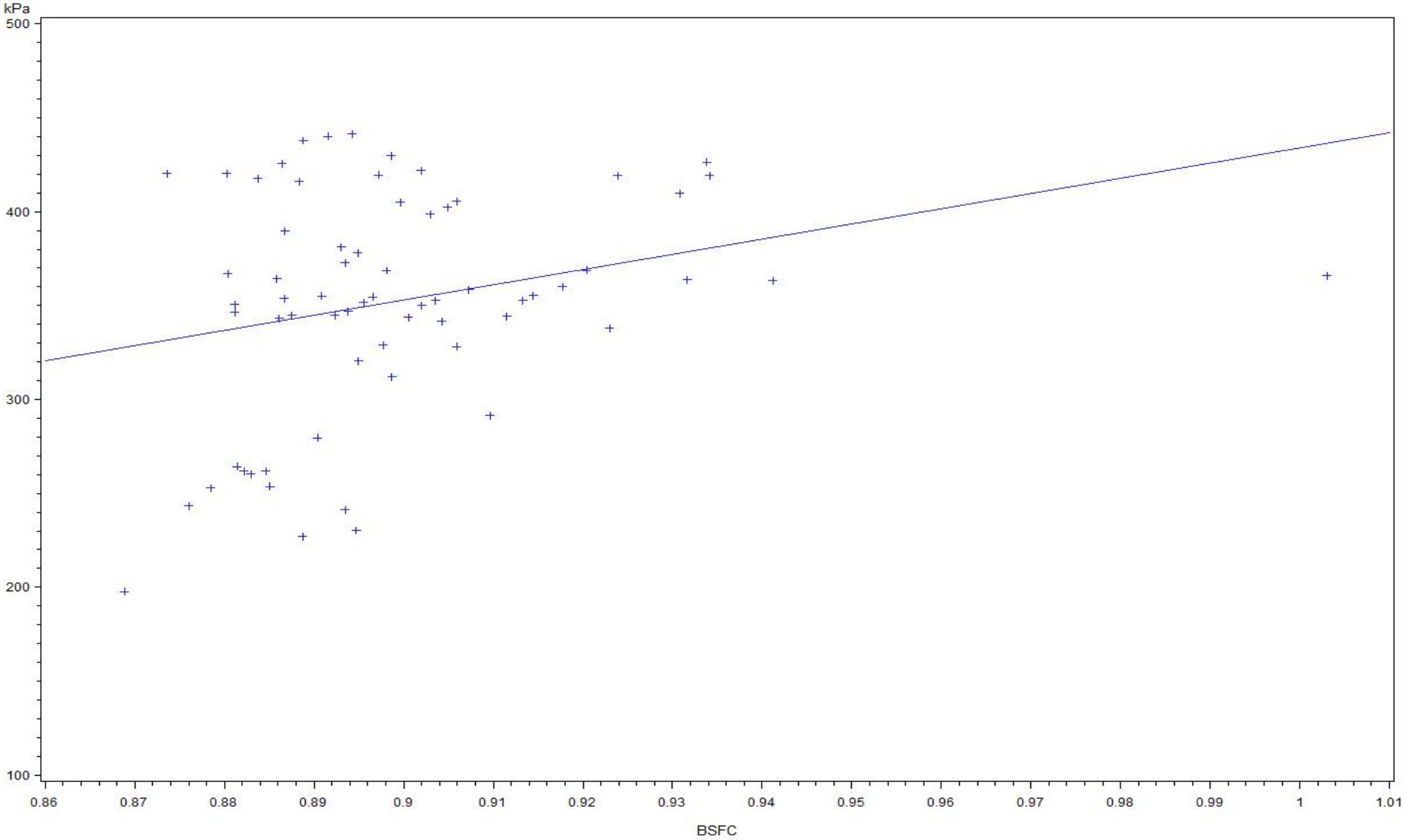
Plot of Oil Pressure versus BSFC
BLB2, Stage 3



r-square 0.246

Sequence VID

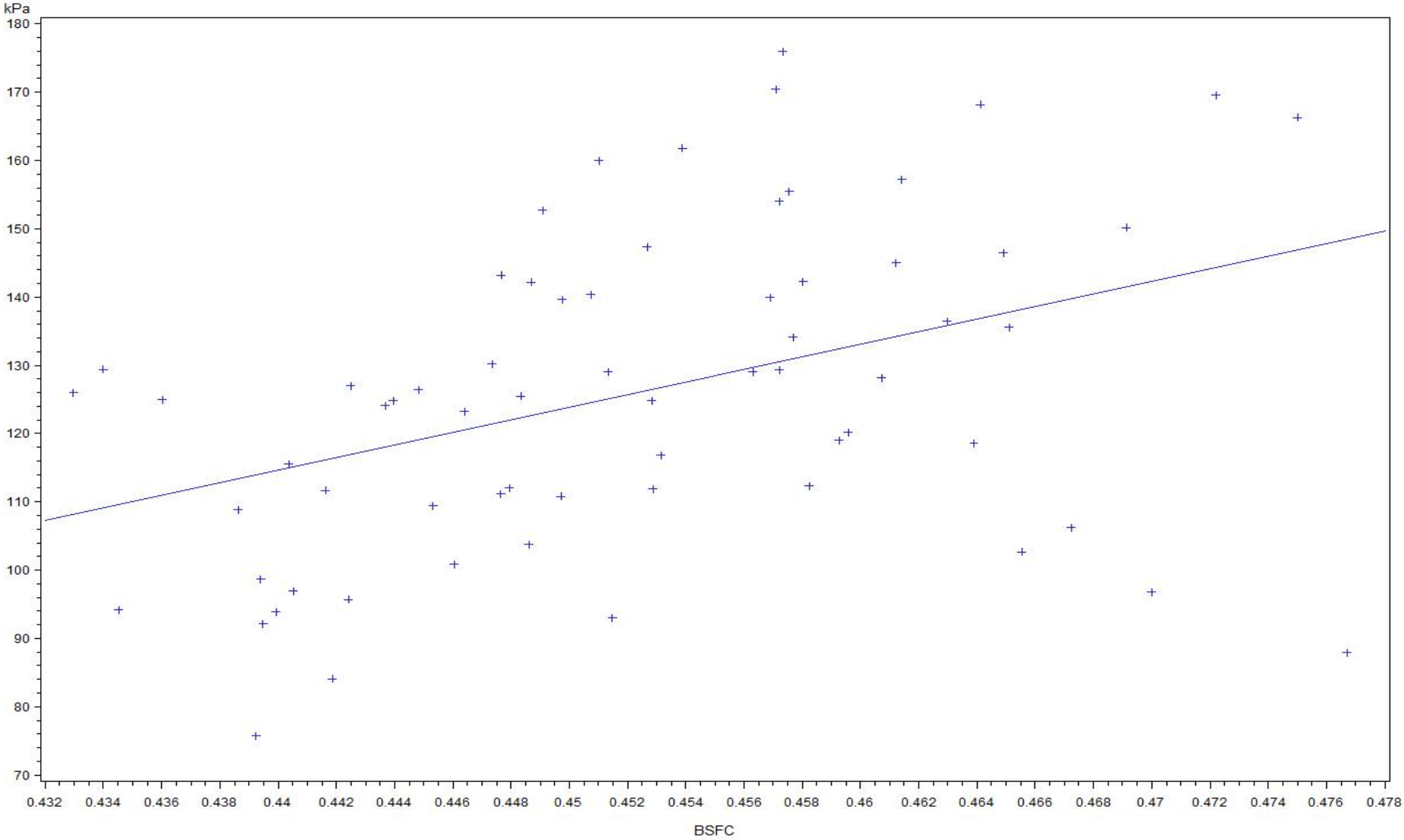
Plot of Oil Pressure versus BSFC
BLB2, Stage 5



r-square 0.075

Sequence VID

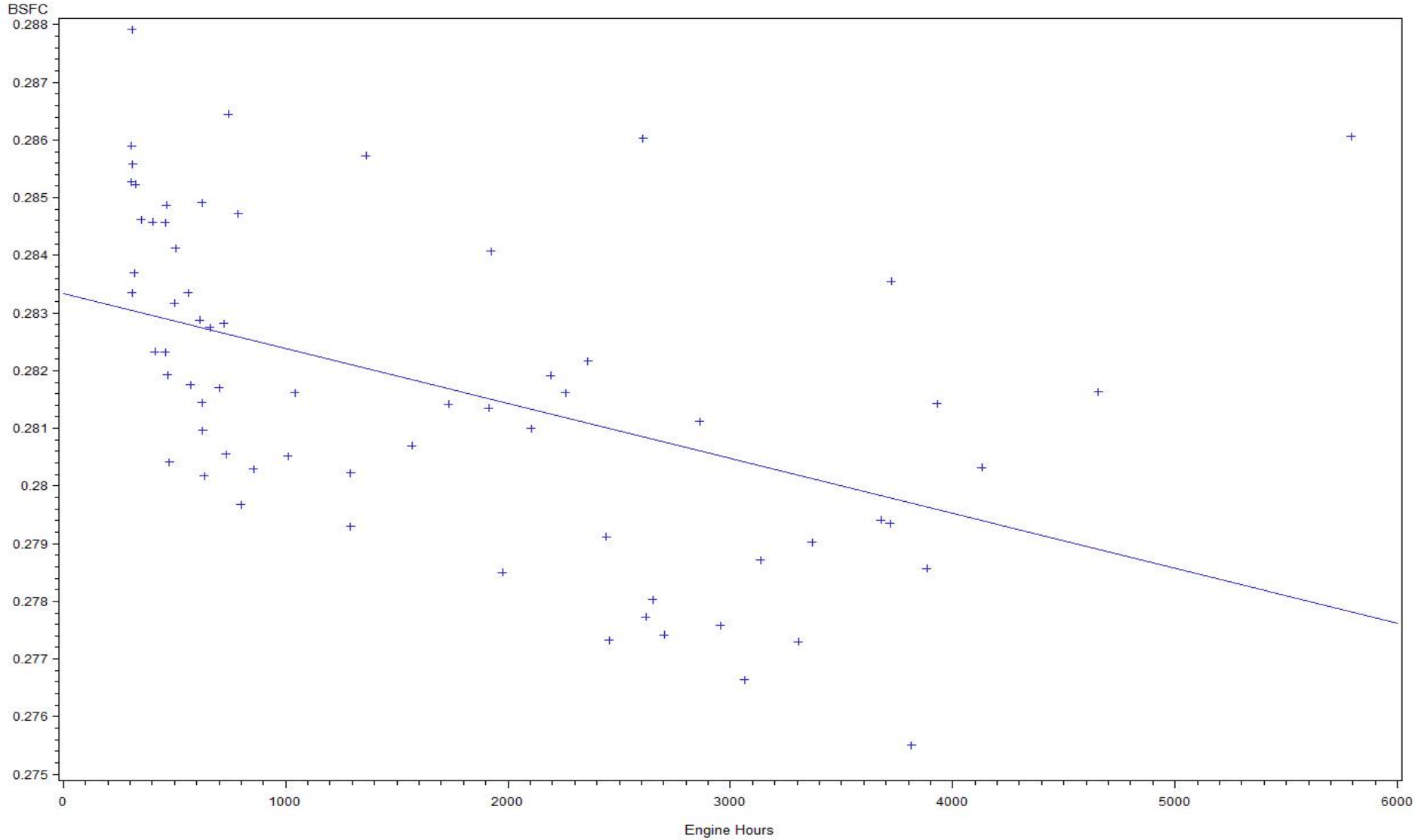
Plot of Oil Pressure versus BSFC
BLB2, Stage 6



r-square 0.165

Sequence VID

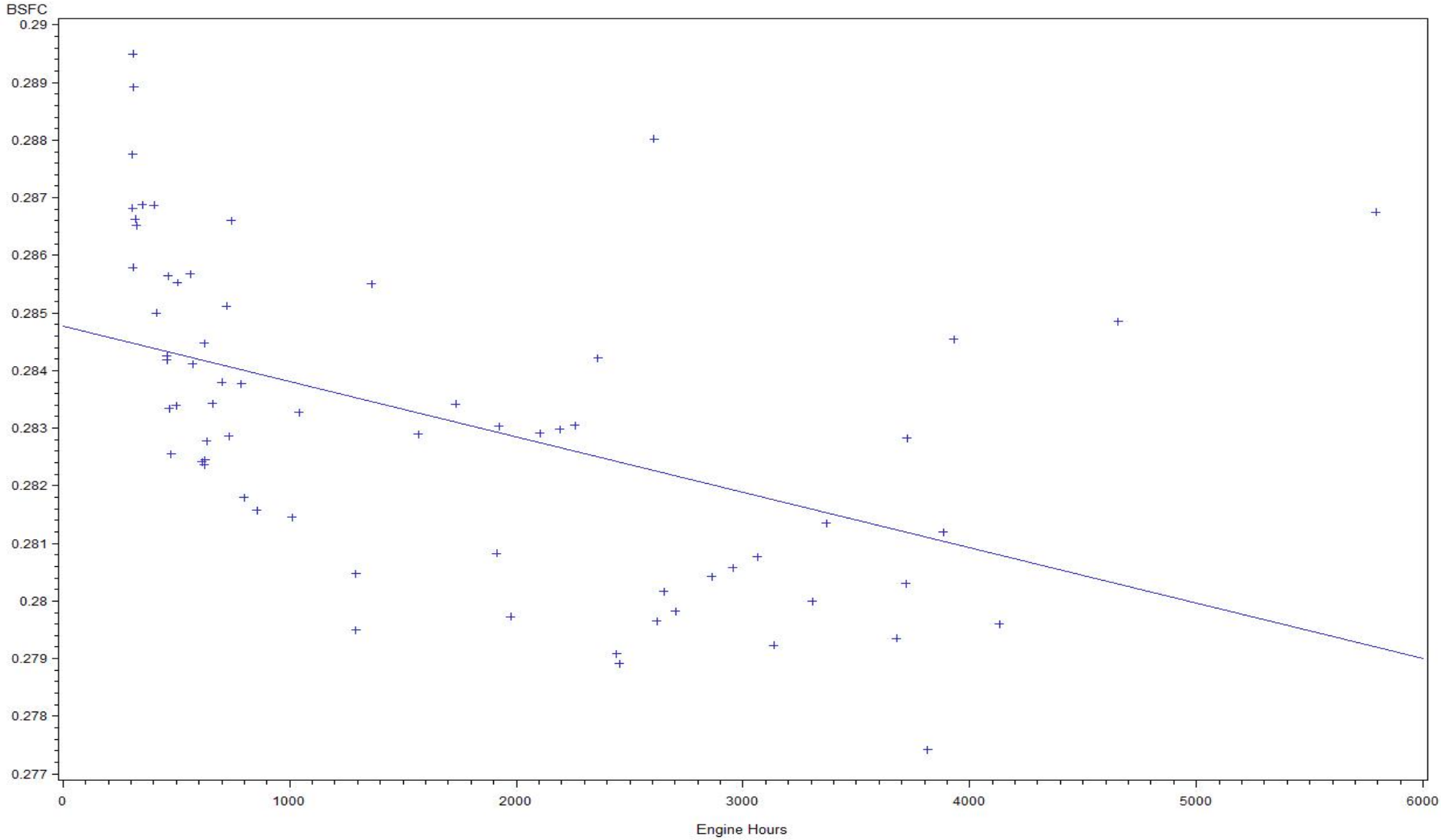
Plot of BSFC versus Engine Hours
BLB2, Stage 1



r-square 0.22

Sequence VID

Plot of BSFC versus Engine Hours
BLB2, Stage 3



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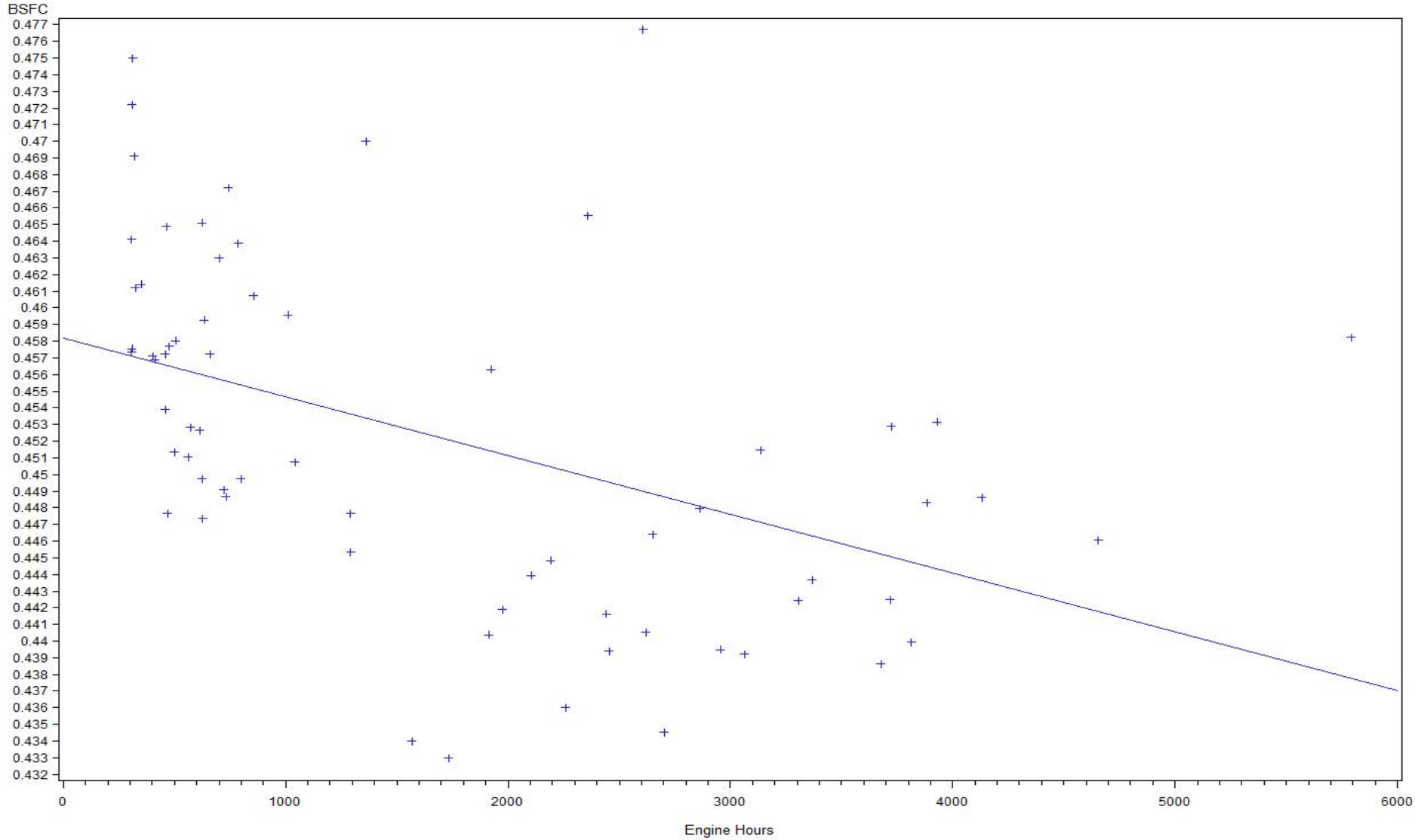
Sequence VID

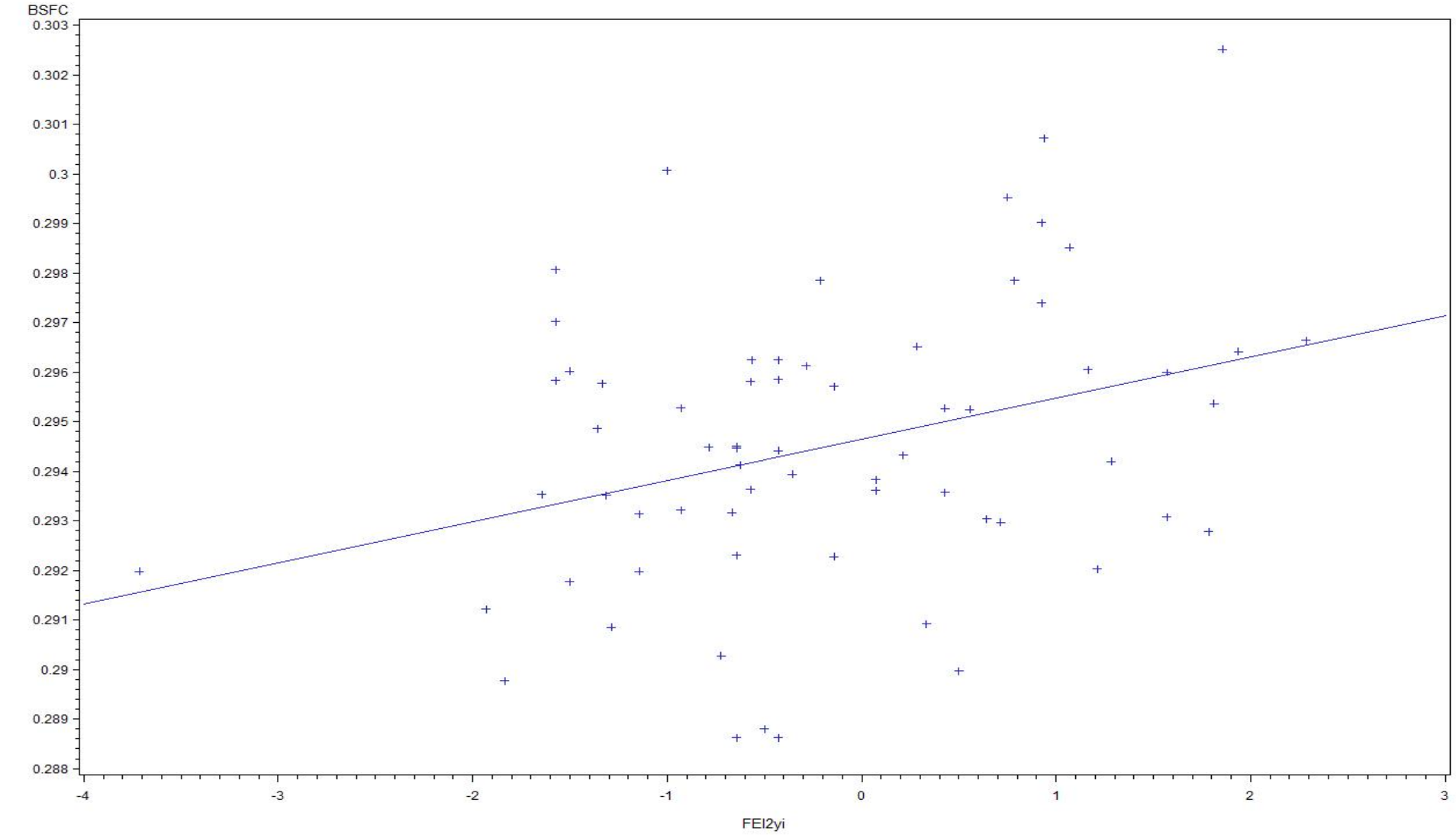
Plot of BSFC versus Engine Hours
BLB2, Stage 6



r-square 0.212

Sequence VID

Plot of BSFC versus FEI2YI
BLB2, Stage 2



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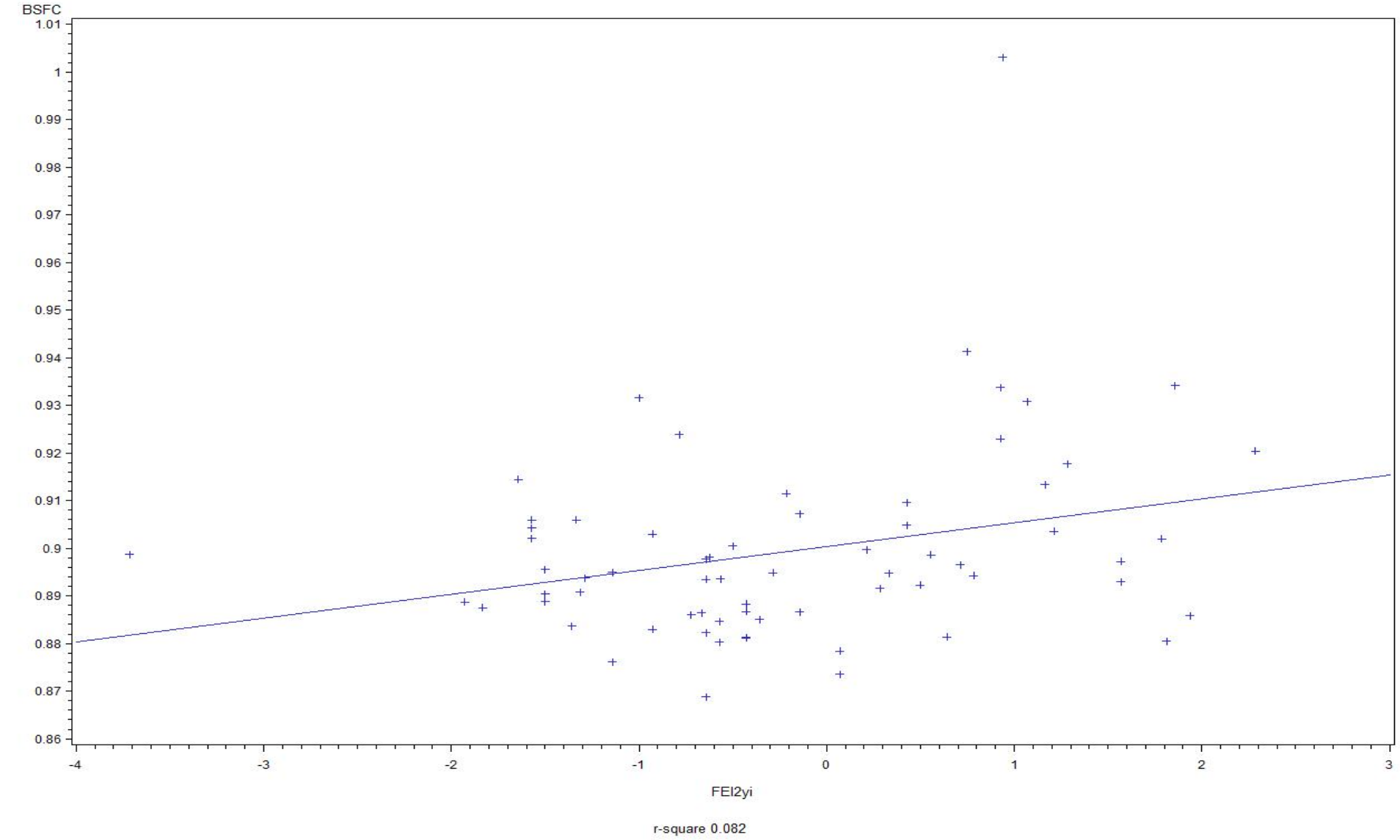
Sequence VID

Plot of BSFC versus FEI2YI
BLB2, Stage 5



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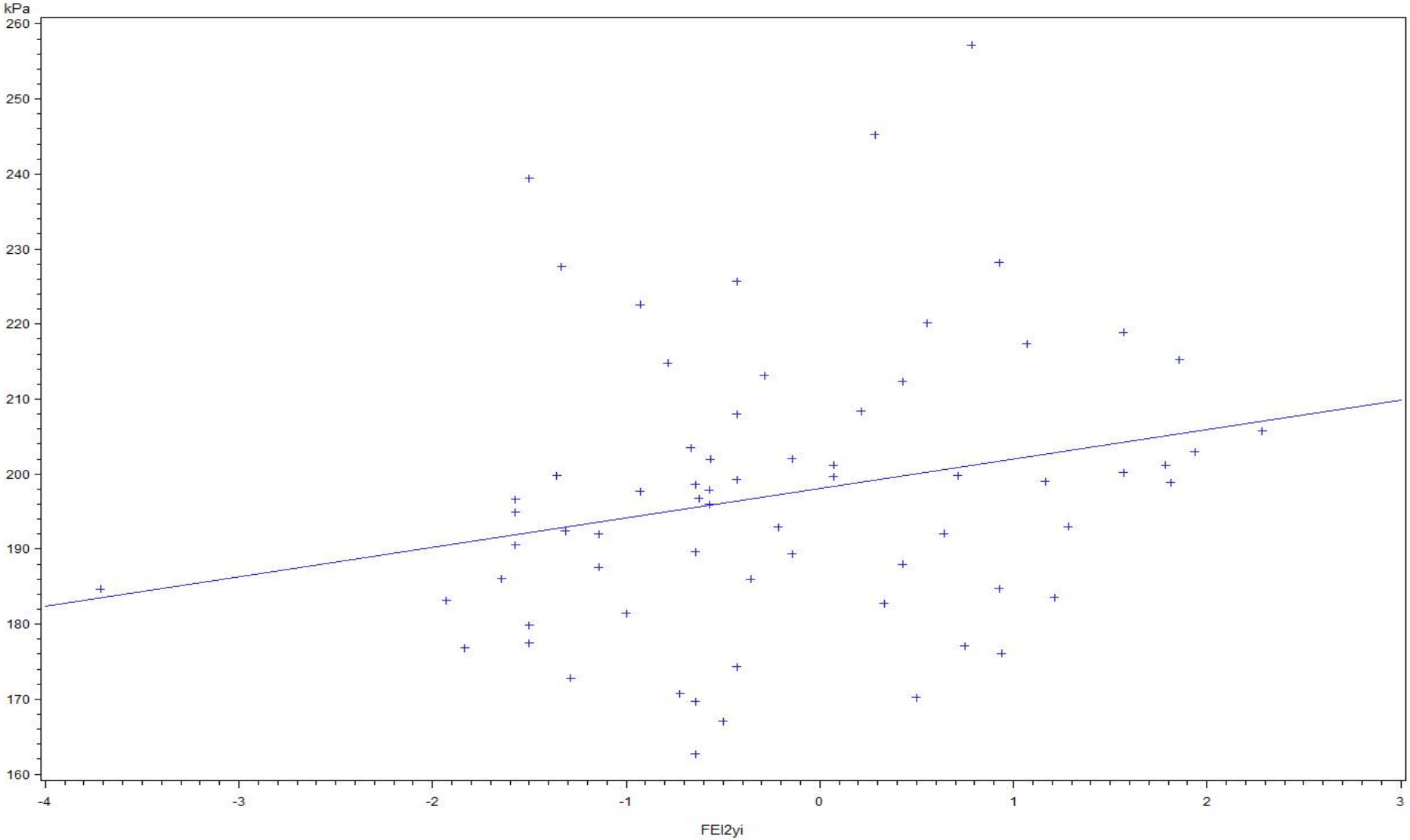
Sequence VID

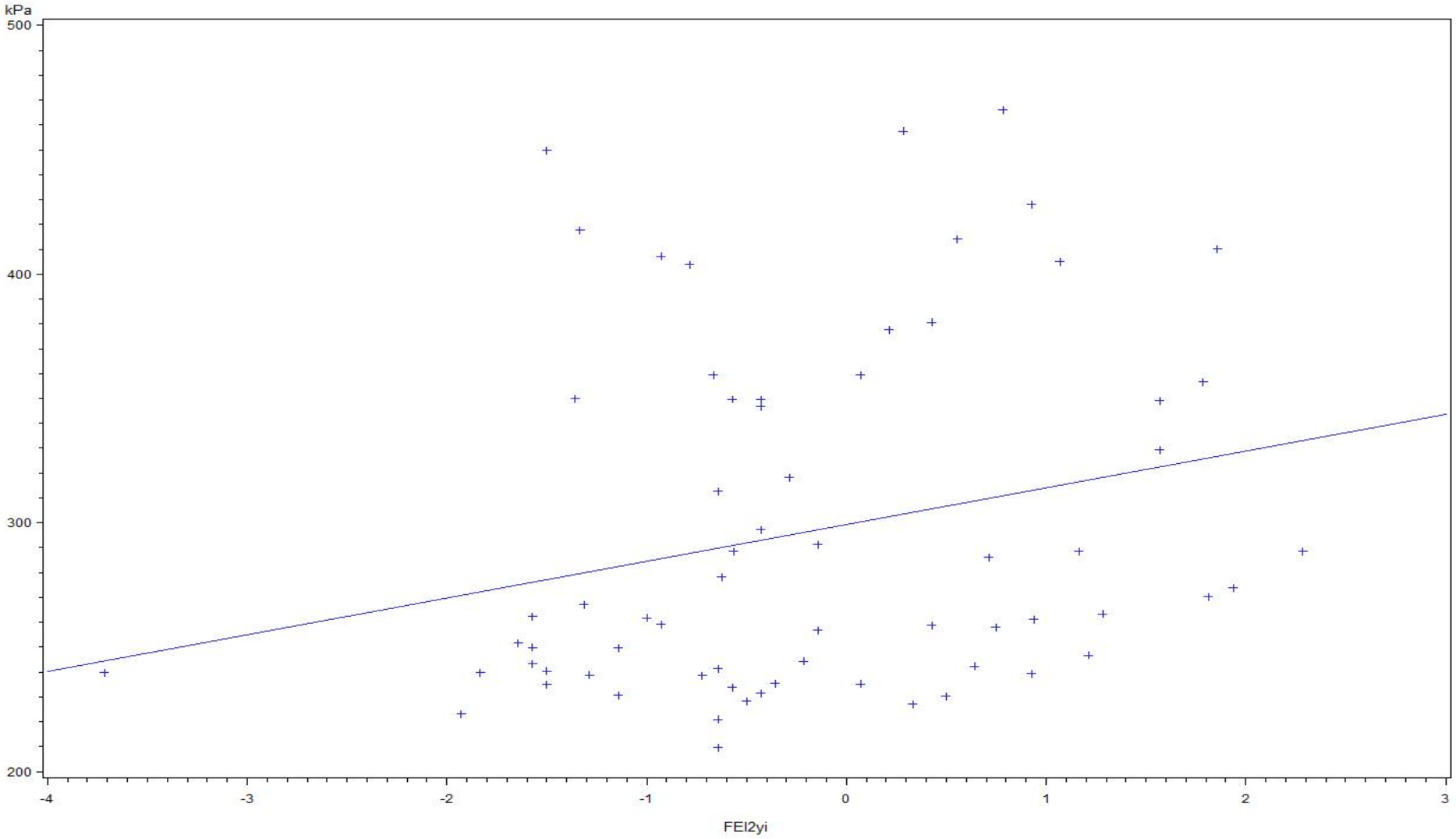
Plot of Oil Pressure versus FEI2YI
BLB2, Stage 1



r square 0.06

Sequence VID

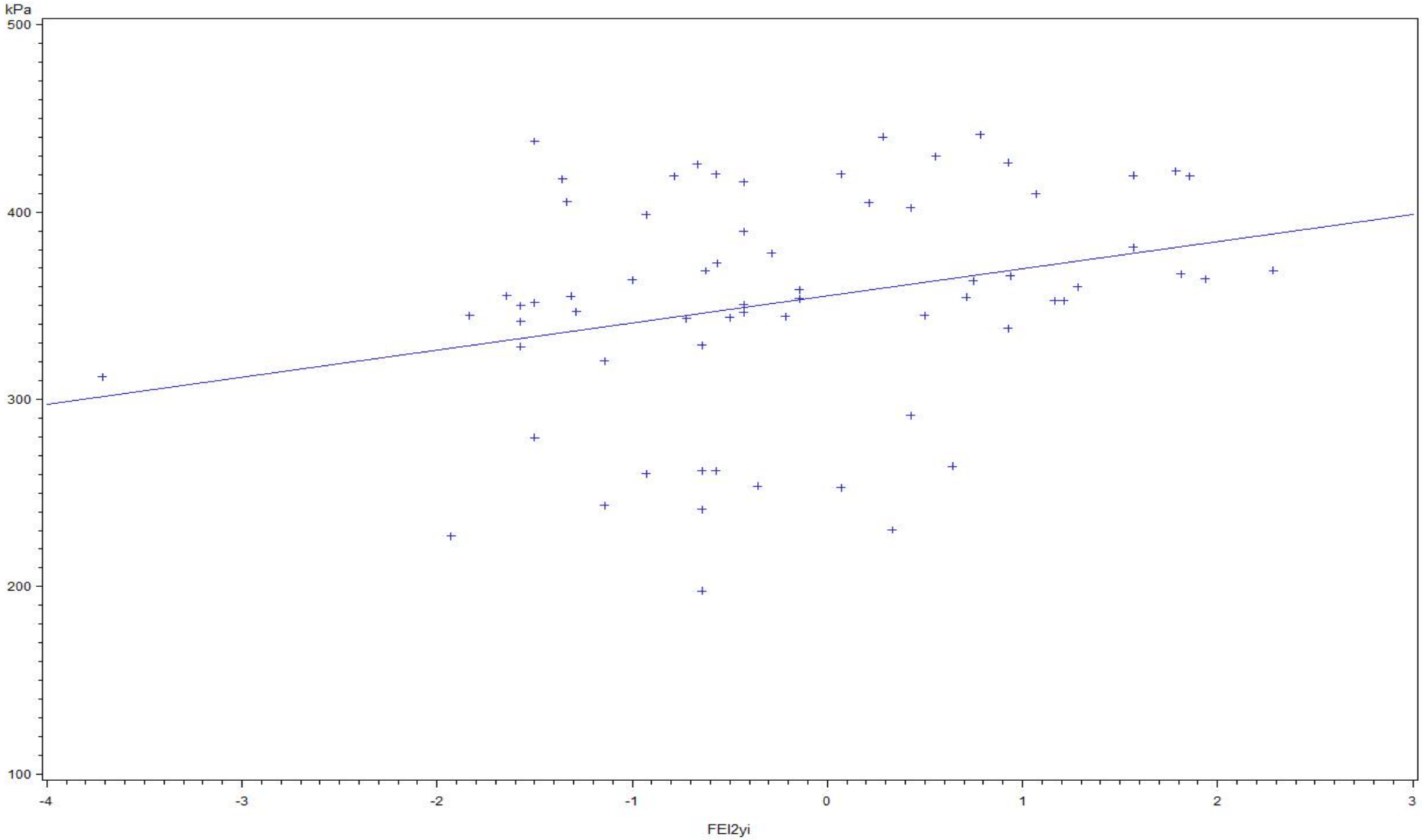
Plot of Oil Pressure versus FEI2YI
BLB2, Stage 2



r square 0.06

Sequence VID

Plot of Engine oil Pressure versus FEI2YI
BLB2, Stage 5



r square 0.08

A Program of ASTM International

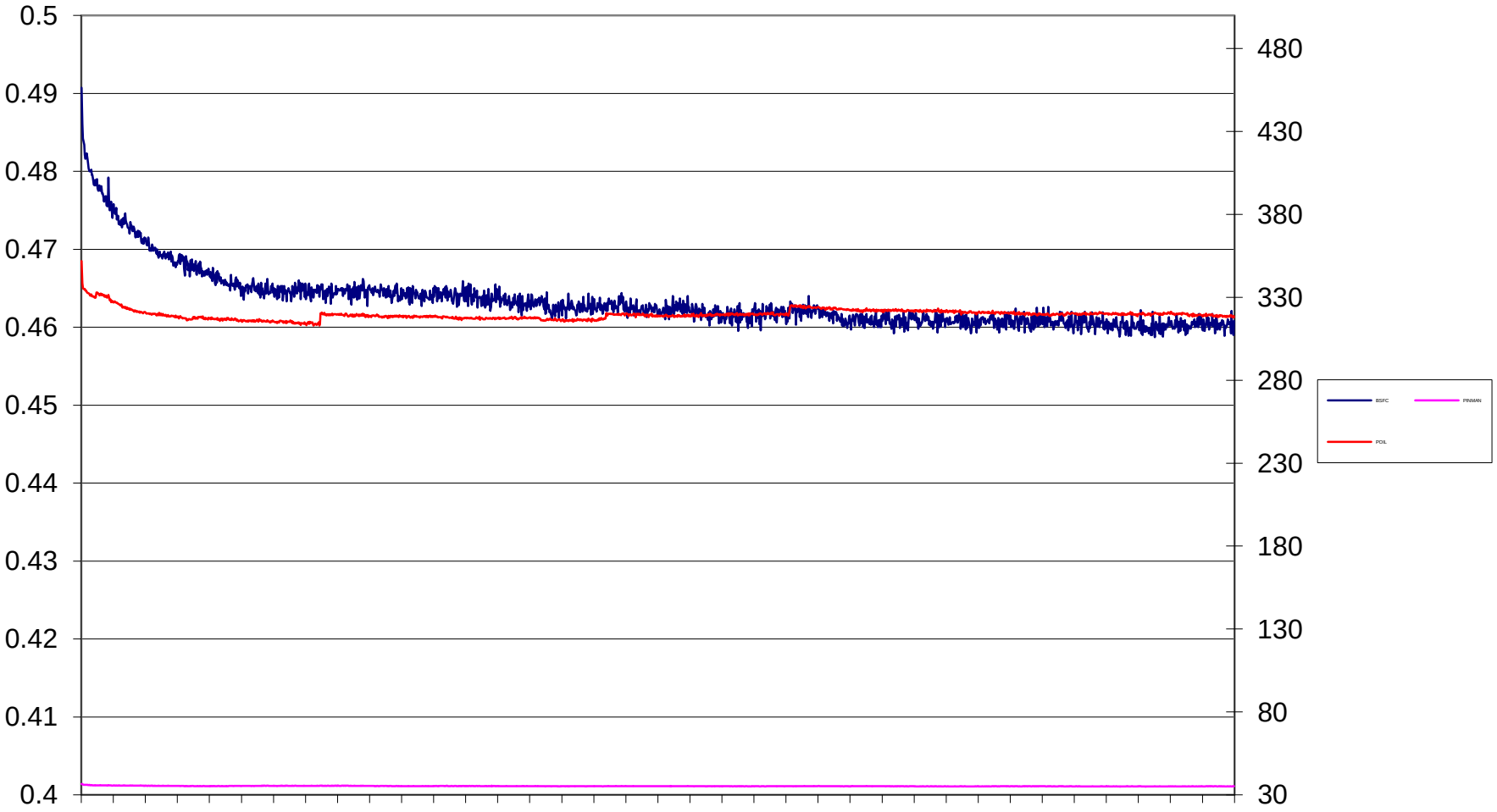
VID D7589 REVIEW

Section 6.4.1	Procedure calls for a Midwest 758. Midwest specs a 10.5 inch load arm. Most labs are using different load arm lengths. a. Specify a standard arm length or b. Specify a load cell effective range.
Section 6.4.2.3	We switched to piping air to a canister around the load cell. This gives very consistent control. A strip heater should only be needed for trim in cold conditions.
Section 6.5	There are optional engine cooling systems. Could we standardize? Make ours the golden stand and other labs copy?
Section 6.5.3	Specify a volume?
Section 6.5.4	Specify flow direction? Looks like multiple exchangers are approved for use.
Section 6.5.7	There are several valves possible. Standardize.
Section 6.5.16	There is no easy way to drain the coolant. 50% mixture has been recommended.
Section 6.6.5.1	We will need to define full again if larger plumbing is recommended for the external oil system. Again pick a golden stand and standardize.
Section 6.6.5.3	Ditto the Burkert valves. They are probably a major limiting factor in external plumbing.
Section 6.6.5.7	Could we finally specify the same micron filter for Vx and VIx?
Section 6.6.5.9	Standardize on one size Aeroquip and specify how assembled as crimped will be different diameter from slip in version of fitting. Also the crimped version can be damaged internally and not be easy to detect visually.

Section 6.7.1 Eliminate the GM fitting and use a Swage coupling.

SwRI VID Breakin Engine RE1 2012
BSFC

Oil Consumption 610 ml



Hours

Some additional things to consider:

1. SwRI can run each test at 1000 Hz [or even 1.3MHz if you pick 8 critical parameters], but this does slow down response and makes it difficult to share data [even at one second data rate].
   We would recommend this for development I f necessary, but go back to current VID data format for the VIE. We also have a concern the computer might delay finding a running control problem as it works to store data.
2. We feel there are some other areas where improvements can bring immediate benefits.
   a. Some labs are still using 12 bit AD modules. The attached file shows that 16 bit will give much better control to the VID specification limits. Labs with 12 bit may not be able to control to the VID limits on some parameters.
   b. There is huge variation in load arm length. We feel this should be standardized, along with load cells. See Attachment D7589 Review, which we actually did before the first call. Some of those issues have been resolved.
   c. The same with coolant temperature control. Our system hits control points in all stages. Rather than extend stabilization, which increases test price and reduces runs per engine [that we have already committed to purchase at the current VID conditions], we recommend we select a golden stand and all labs duplicate that.
   d. Ditto for oil pressure and temperature. Pick one version that matches other data and all labs standardize.
   e. BLB Delta was determined early in development. We feel it is higher with new engines [less than 1000 hours] and should be adjusted with that in mind. Also it is critically affected by how long an engine sits [as was the case in early development]. There are a series of stages that can be run to warm up the engine prior to load calibration that will resolve this. Also we start ours each evening so we can do repairs early each morning before the Stage 3 set that tend to stabilize the BLB Delta value.

f. We also feel the engine hour correction was done early on and needs to be reviewed again. The oldest engine at that time had 3000 hours and some now have well over 5000 hours before going out on oil consumption. Dave has mentioned the 2012 has better oil consumption so those may well last longer.
g. A copy of the BSFC and oil pressure from our store bought 2012 engine is attached. You can see BSFC is very stable well before 150 hours and a WHOLE lot easier to run than the VIA version.