Unconfirmed Minutes of Mack T-11 Task Force Meeting
April 22, 2003
San Antonio, TX

Attendance:
Jeff Clark – TMC; Jim Moritz, Tom Franklin, Joe Franklin, and John Haegelin – PerkinElmer; Jim Gutzwiller and Michael Minotti – Infineum; Jim Matasic, Bill Larch, Gita Krishnaswamy, John Carlson, and Phil Scinto – Lubrizol; Ron Buck – TEI; Riccardo Conti and Steve Kennedy – ExxonMobil; Bob Campbell – Ethyl; Wim van Dam, Mark Cooper, and Jim Rutherford – Chevron Oronite; Scott Richards, Jim Wells, and Andy Broff – SwRI; Greg Shank and Ken Goshorn – Mack Volvo Powertrain

Action Items:
1. Test labs to take all oil samples off the engine from the pre-filter pressure port
2. Test labs to submit all oil analysis data, using forms 6 through 8, for all references to Jeff Clark
3. Joe Franklin and Steve Kennedy are to organize a soot measurement method workshop to be conducted prior to June 15
4. ExxonMobil will generate T-11 low soot used oil drain for round robins
5. TMC is to set T-11 reference oil quantity to 28 gallons
6. Test labs are asked to follow guideline of 1.5% maximum soot at 48 hours
7. All MRV analysis is to be conducted at –20 degrees C
8. Jeff Clark to update procedure per noted changes and issue as Draft 3
9. Labs are to report fuel pressure and fuel dilution data for reference tests.

1. Task Force Membership – no changes

2. Meeting Minutes – minutes of the January 31 teleconference, February 13 meeting, March 3 teleconference, and April 4 teleconference were approved as issued. All are available from the TMC web site.

3. Scope & Objectives – Oil consumption was removed from evaluation as p/f parameter; test precision statement and elevation to an ASTM standard method were added to the objectives. The updated Scope & Objectives are shown in Attachment 1, and are available from the TMC web site.

4. Action Item Review – April 4, 2003 Conference Call
All action items have been completed.

5. Oil Sample Location
Discussion took place regarding oil analysis results from samples taken at both sampling locations. The samples analyses generally agreed very well. For ease of operation, it was decided that all oil samples are to be taken off the engine from the pre-filter pressure port. It was decided that the location / method for returning the purge oil to the engine would not be specified. Some concern was expressed that the differences seen in the analysis are probably due to the variability in the viscosity measurement. Labs are to submit all oil analysis data for all references to the TMC.

6. Soot Round Robin Data
Data from the most recent TMC round robin was reviewed at both one and two decimal places. After a short discussion it was decided that soot would continue to be reported to two decimals. It was also decided that a soot measurement method workshop will be conducted, to be hosted by PerkinElmer and Southwest Research. Steve Kennedy and Joe Franklin will organize the workshop which should be held prior to the June 16 meeting. Steve Kennedy offered that ExxonMobil will generate some future low soot round robin samples by running 75 hours at T-11 conditions.

7. Post Test Flush
The following wording, proposed by Jim Moritz, regarding the post test oil flush was approved:

"Within 30 minutes of EOT, drain the oil pan and auxiliary oil reservoir. Remove the oil filters, including the centrifugal filter. As soon as possible, install new oil filters, refill with Bulldog Premium Oil and run at test conditions (Table 2) for 30 min."

8. Auxiliary Oil Sump Size
This was set to be a minimum of 12 qts.

9. Status of Reference Testing
Nine tests have been completed so far on TMC 820-2. Two tests are currently running, both on existing builds (ie. not a newly rebuilt engine).

10. Preliminary Analysis of Results
A preliminary analysis was provided by Jim Rutherford and is shown in Attachment 2. In addition to looking at viscosity increase parameters, Jim also presented Soot at 10 cSt Vis Inc as a possible parameter. Regardless of parameter, concern was expressed over what viscosity value should be used as the minimum to calculate vis increases. Possibilities are SOT, minimum, or DIN shear viscosity.

11. Soot Windows
After a long discussion concerning the soot windows and injection timing changes, it was decided that the soot windows would remain unchanged. Data gathering will continue and the data will be forward for analysis to both Jim Rutherford and Gita Krishnaswamy. For the time being, the labs are asked to follow a guideline of 1.5% maximum soot at 48 hours.

12. Reference Oil Shipment Quantity
The TMC reference oil shipment quantity will be 28 gallons for the T-11.

13. Procedure Review
The T-11 procedure was reviewed in its entirety by the task force. All changes to the procedure will be listed when the updated version of the procedure, Draft 3, is released under separate cover.

14. New Stand / Lab Requirements
As part of the procedure review, Bob Campbell brought forward the concern that labs running different Mack tests should not be subject to new stand or lab referencing requirements based on time expiration. In general, there was not much support for this, but there was concern that the one-year requirement was a bit too restrictive. As a

result, a motion (Shank, Richards) was approved that after one year from the last calibration test, a lab/stand can attempt calibration using the reduced k scheme, and after two years from the last calibration test, the lab/stand is considered a new lab/stand and will require two tests. This motion passed with one waive. Also please note that this action affects only the T-11.

15. Next Meeting
A conference call will be held between May 6 and May 8.
The task force will meet on Monday, June 16th at ASTM in Norfolk.

The general meeting adjourned at this point and the O&H Group visited stands at both San Antonio labs.

Summary of Stand Visits

Humidity – it was noted that the San Antonio labs humidity measurements are different. One lab has the sensor downstream of the air conditioning and filter element. The other labs uses wet/dry bulb, upstream of the filter and conditioning. Feedback from the other labs indicated that the method varies greatly throughout the industry. Some measure it prior to the filter element but after any conditioning. Some concern was expressed that the measurement doesn't make much sense unless it is at the intake manifold since the aftercooler provides another source of conditioning. It was agreed that the task force should address this issue.

Fuel Pressure and Fuel Pressure Regulator – it was noted that different fuel pressure regulators were being used by the two labs and that fuel pressures were different. The fuel pressure regulator p/n is 691GC227M2. Labs are asked to report fuel pressure data for their reference tests.

Fuel Dilution – subsequent to the fuel pressure discussion, concern was expressed over fuel dilution and its possible effects on viscosity. Labs are asked to report fuel dilution data for their reference tests.

Attachment 1
Mack T-11 Task Force

Scope and Objectives

Scope:

Develop a new ASTM standardized engine test method to evaluate the soot handling capability of heavy-duty diesel lubricants in a non-condensing EGR environment using a modified version of the Mack T-10 engine. This new test will be available for future OEM and industry specifications, including the proposed PC-10 category for oils to lubricate engines meeting EPA 2007 emission requirements.

Objectives:

- Finalize test conditions, engine operating parameters, test validity criteria, and test precision
- Evaluate potential pass/fail parameters based on kinematic, relative, rotational, and MRV viscosity measurements, as well as filter pressure increase
- Complete test method development by July 2003

Attachment 2

Mack T-11 Reference Test Soot and Viscosity Profiles

For Mack T-11 Task Force Meeting
San Antonio
04/22/2003
jar

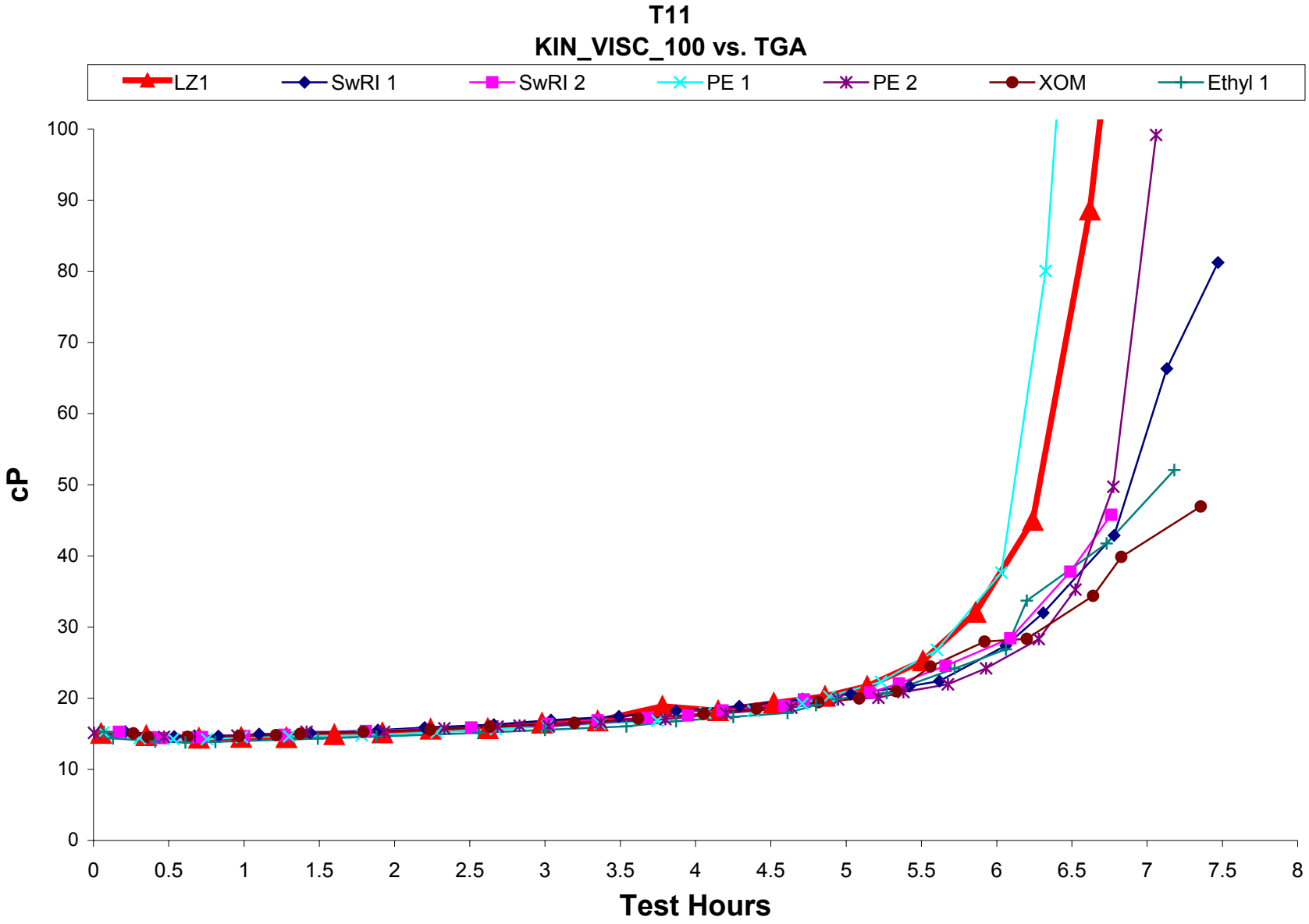
Changing Axes

In plot of viscosity versus soot from the Mack T-11, especially as viscosity increase is accelerating, there is greater variability in the vertical (viscosity) than the horizontal (soot) axis.

A limit expressed as maximum viscosity at a specified soot loading can be equivalently expressed minimum soot rate before a specified viscosity is attained.

For example, delta KV100 < 10 cSt at 5.5% is the same as soot > 5.5% when KV100 = 10 cSt.

This conversion improves test reproducibility


T11
KIN_VISC_100 vs. TGA
LZ1
SwRI 1
SwRI 2
PE 1
PE 2
XOM
Ethyl 1
cP
100
90
80
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
Test Hours

General Algorithm

Fitted values in the area of interest were obtained by

- deleting the first two data points (test hours 0 and 12);
- splitting the remaining data into two groups;
- fitting a straight line to the first group;
- fitting a polynomial to the second group; and
- optimizing the split based on total SSE.

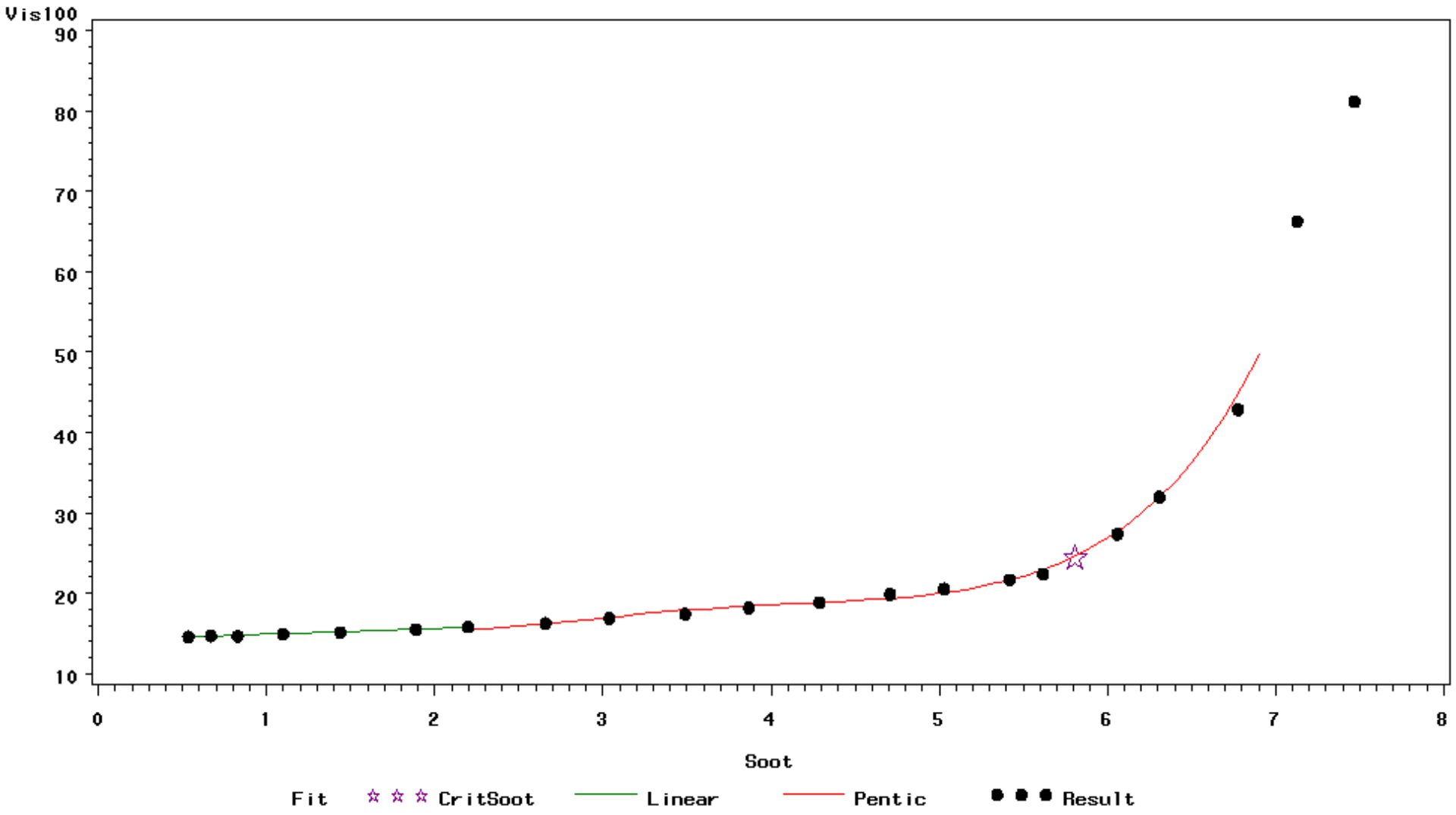
- The criteria were assessed versus the fitted polynomial.

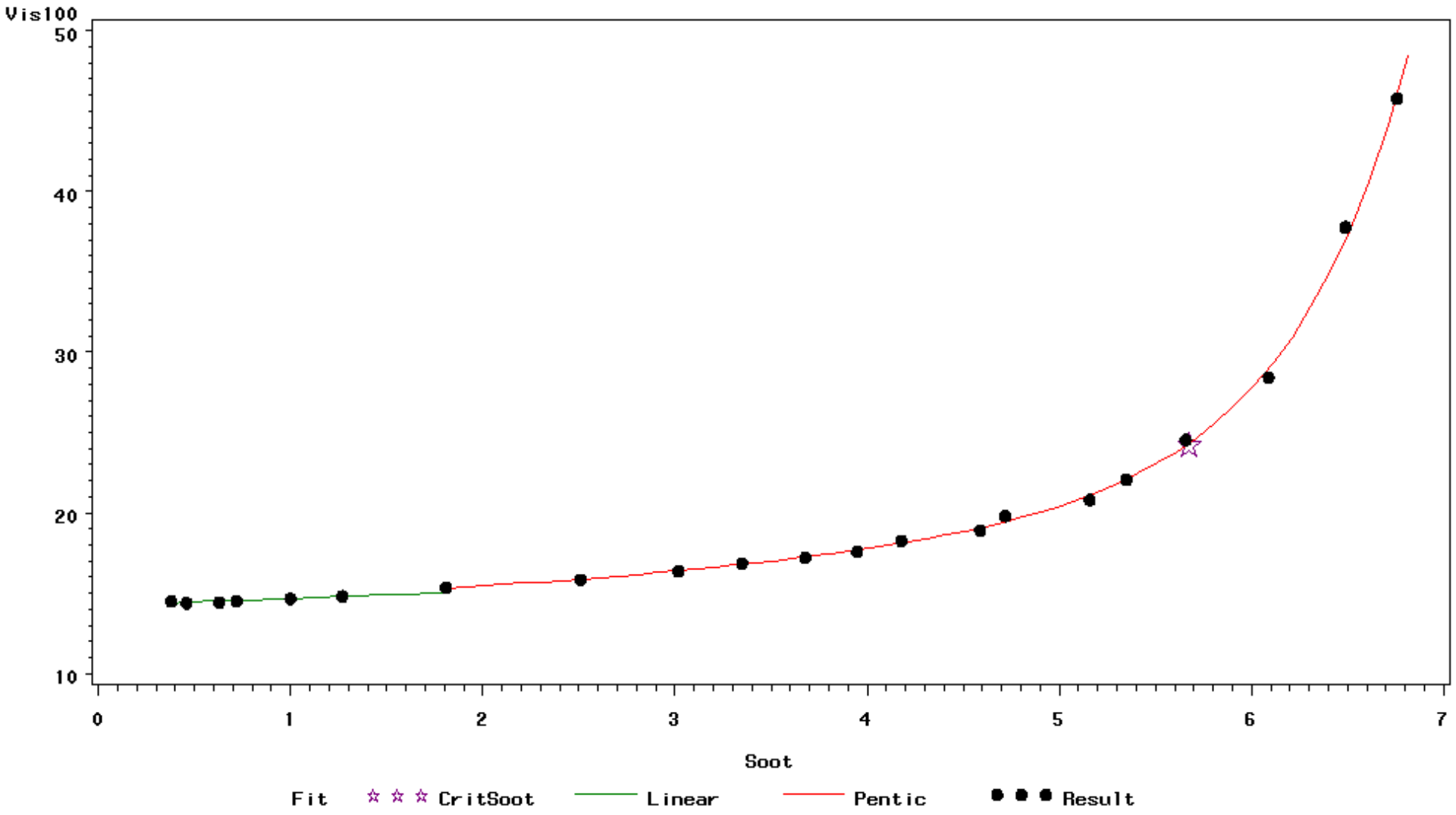
General Algorithm

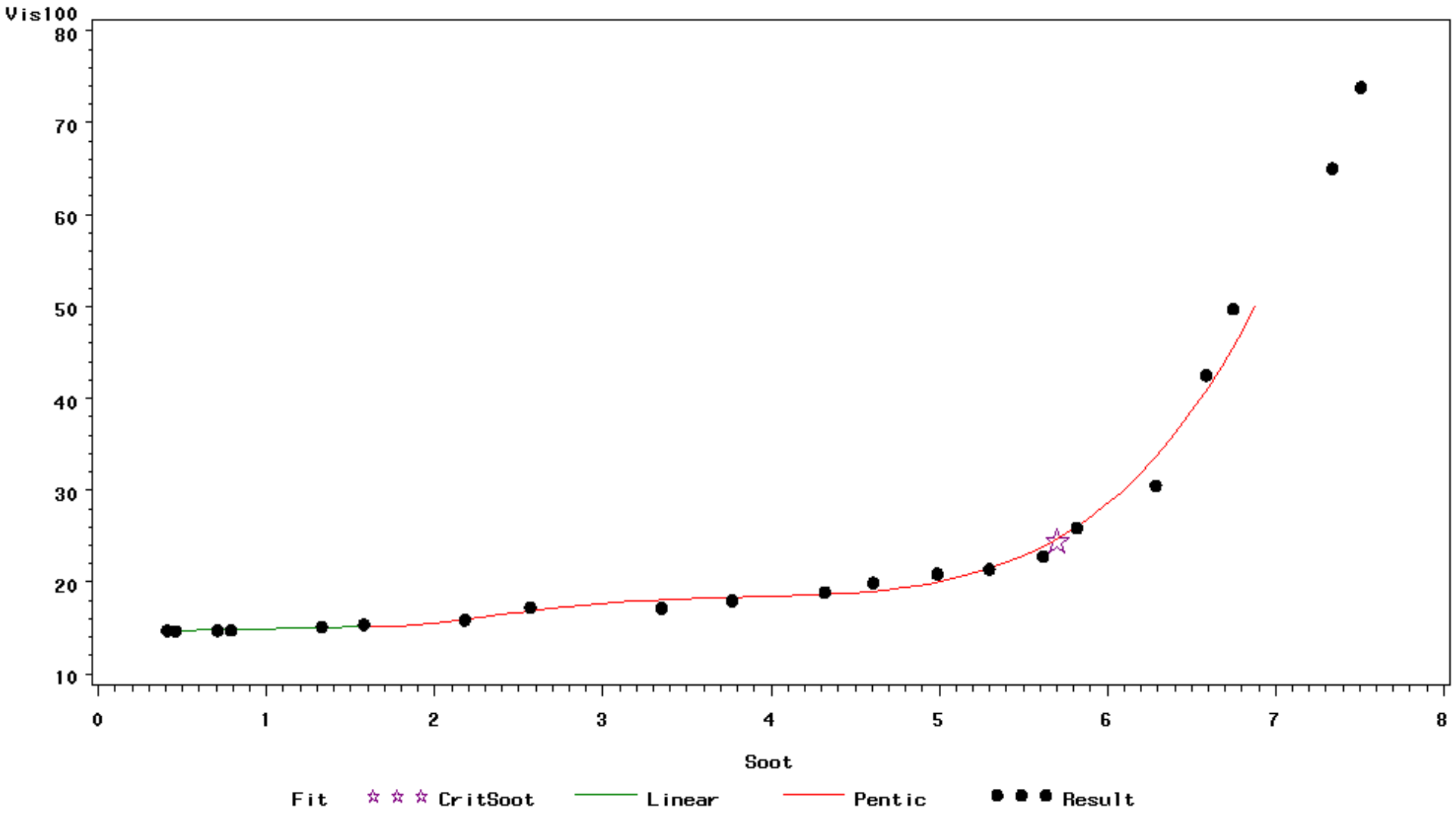
Estimates are robust.

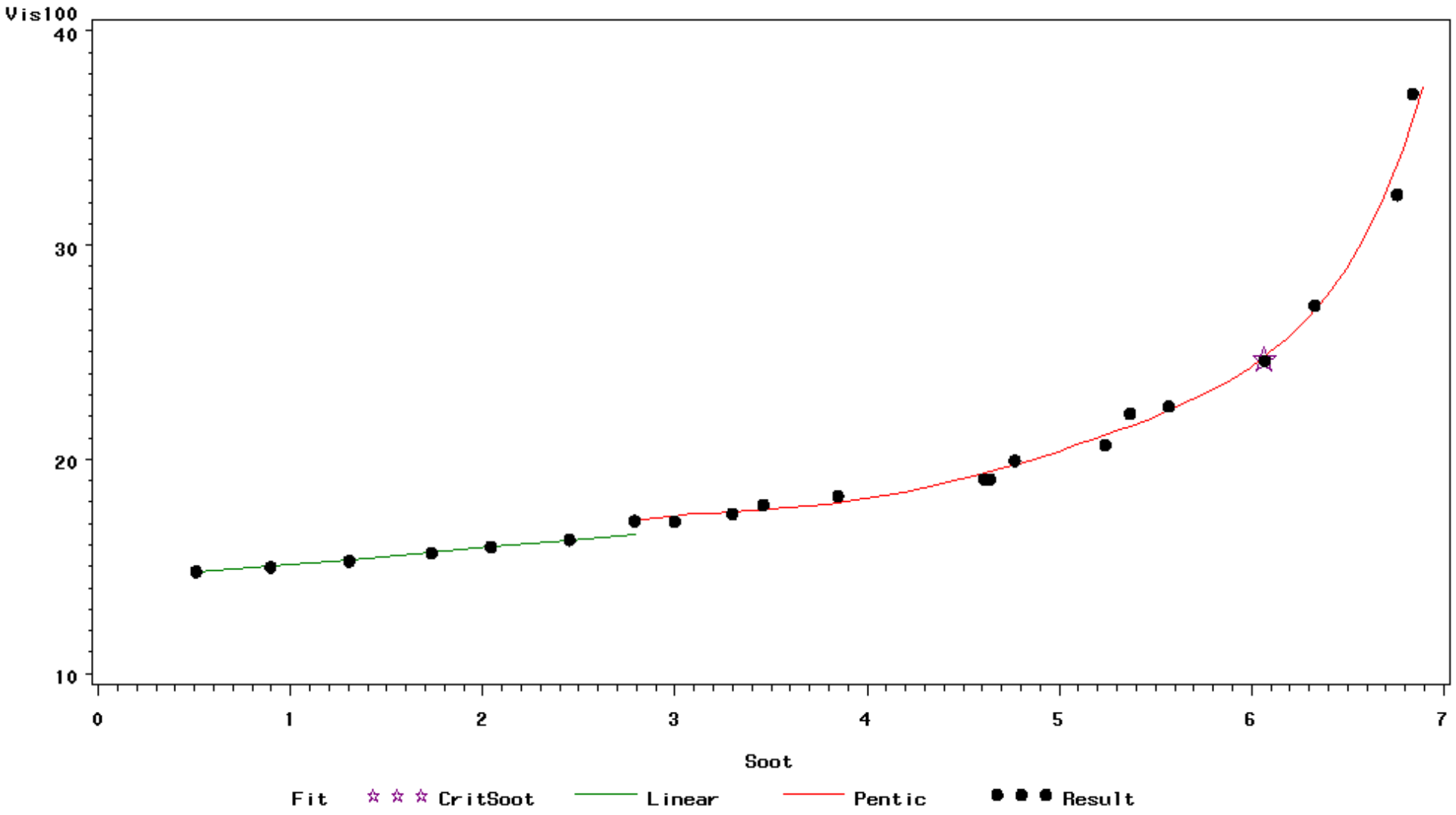
Criteria in various forms could be assessed with fitted values.

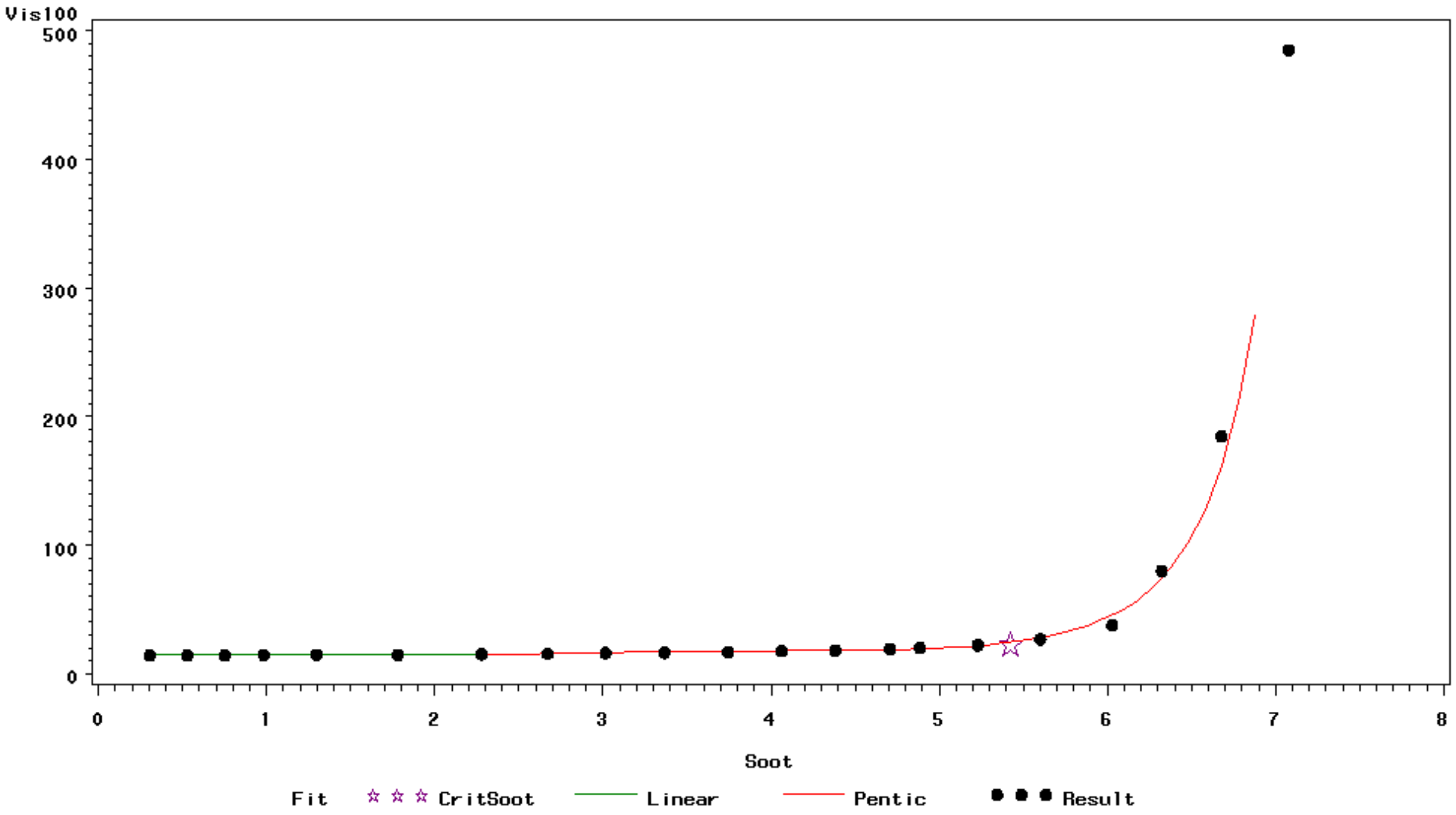
The algorithm was written in SAS but could be converted to Visual Basic for use as an Excel Macro.

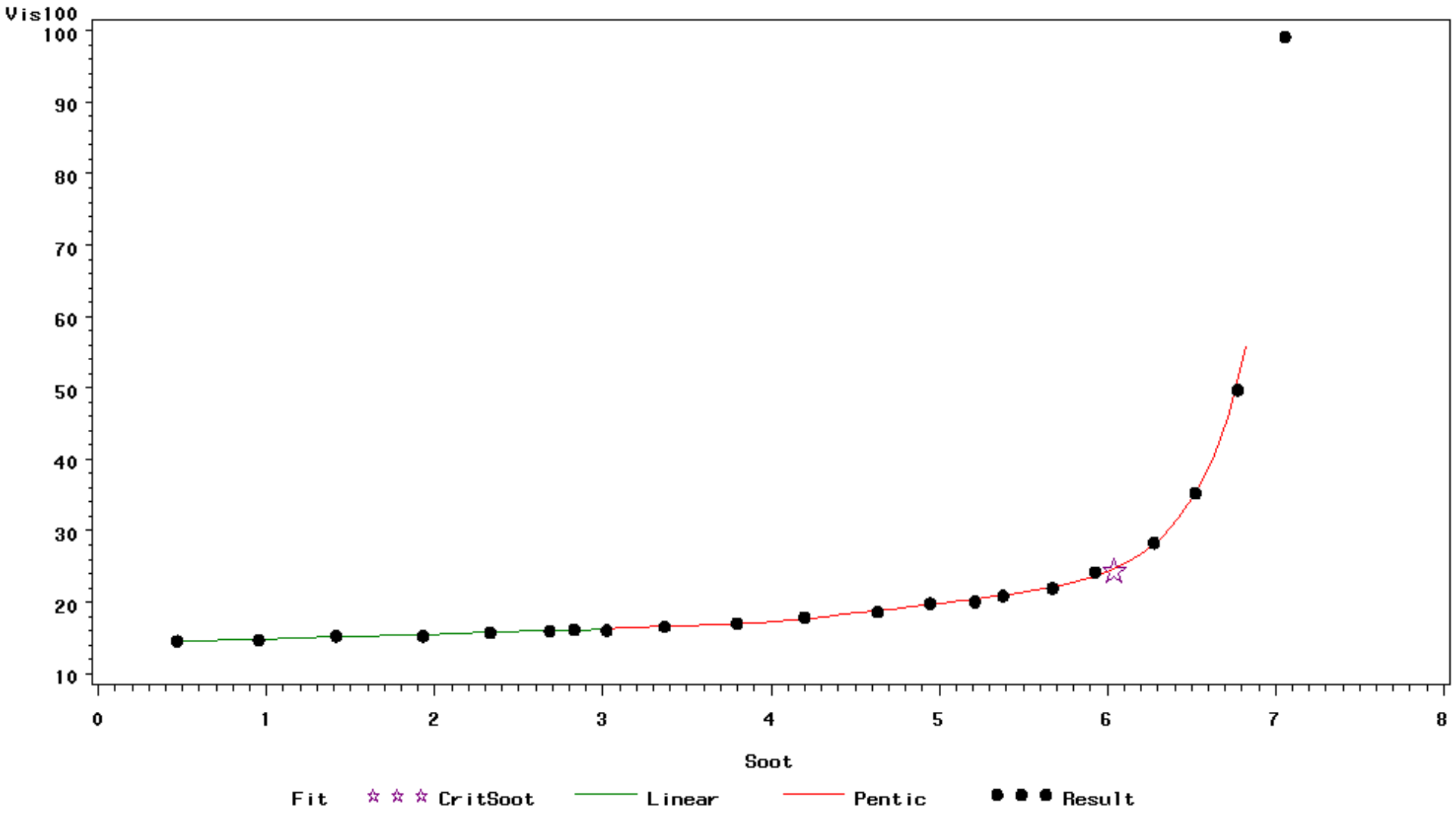

Fitted Kinematic Viscosity = f (TGA Soot) for Test: SwRI1
KV100 increased by 10 from minimum at soot= 5.8
(Delta KV100 at 5.5% TGA Soot from Minimum= 7.5)
Vis100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result

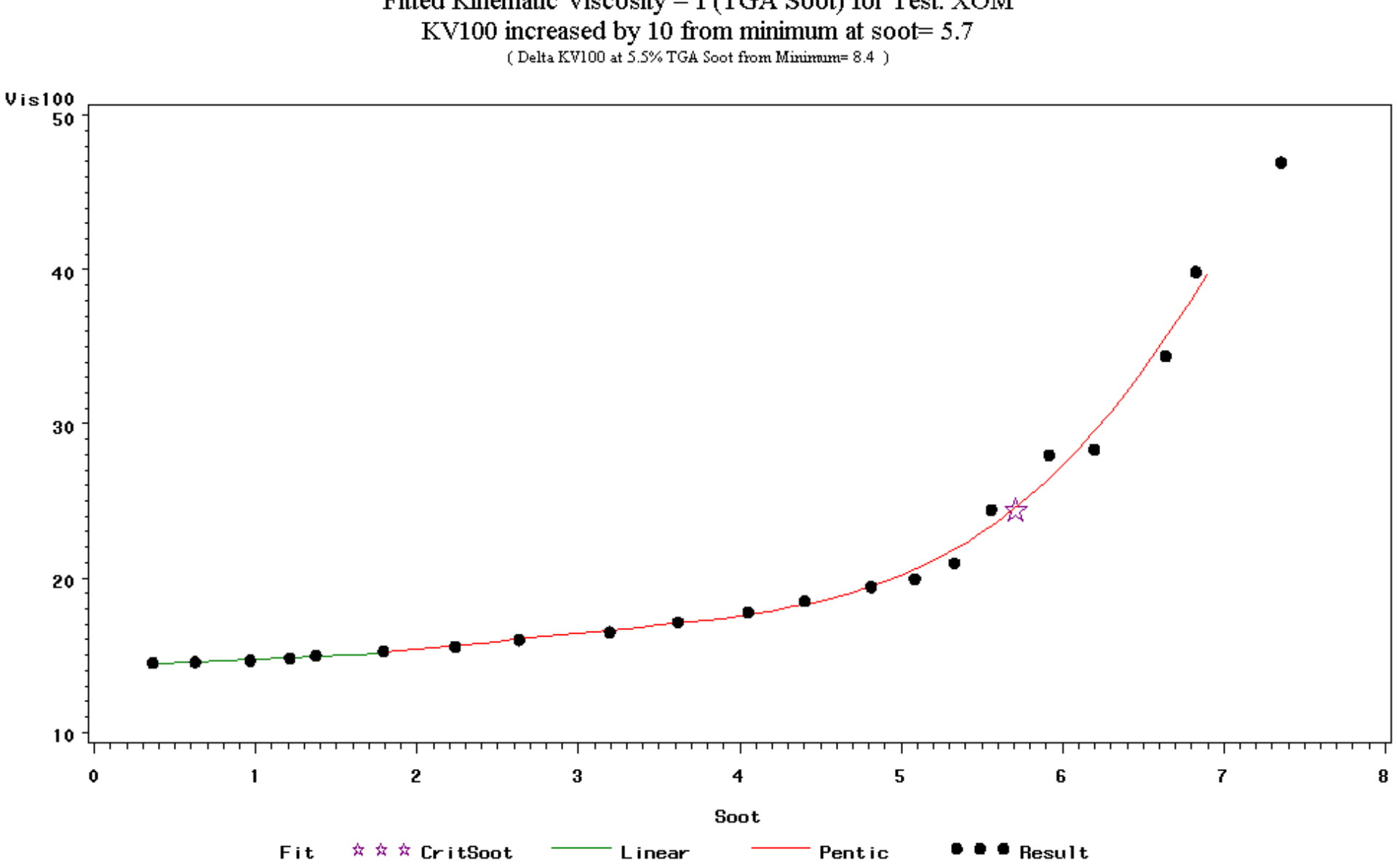

Fitted Kinematic Viscosity = f (TGA Soot) for Test: SwRI2
KV100 increased by 10 from minimum at soot= 5.7
(Delta KV100 at 5.5% TGA Soot from Minimum= 8.6)
Vis100
50
40
30
20
10
0
1
2
3
4
5
6
7
Soot
Fit
CritSoot
Linear
Pentic
Result

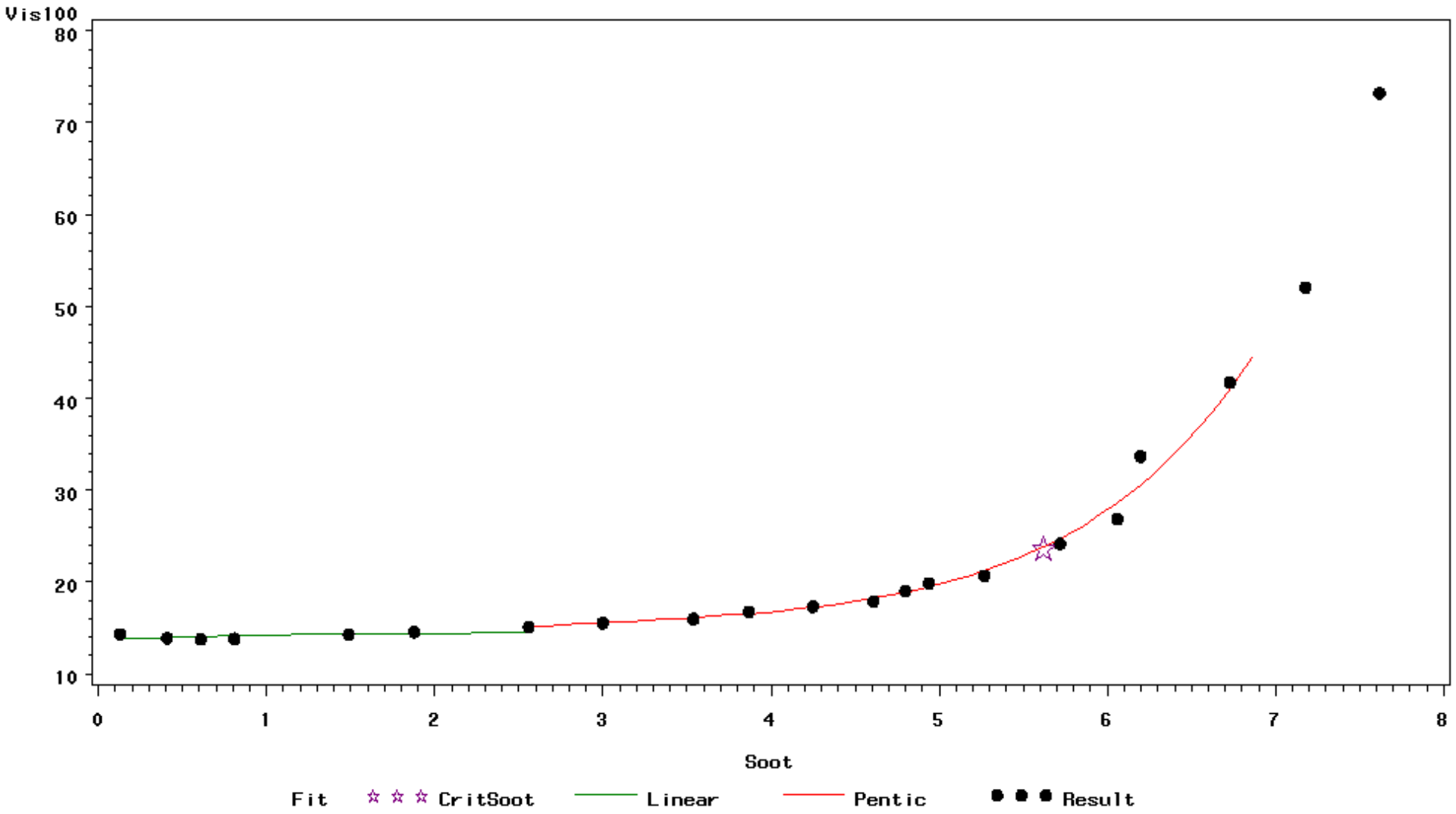

Fitted Kinematic Viscosity = f (TGA Soot) for Test: SwRI3
KV100 increased by 10 from minimum at soot= 5.7
(Delta KV100 at 5.5% TGA Soot from Minimum= 8.2)
Vis100
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result

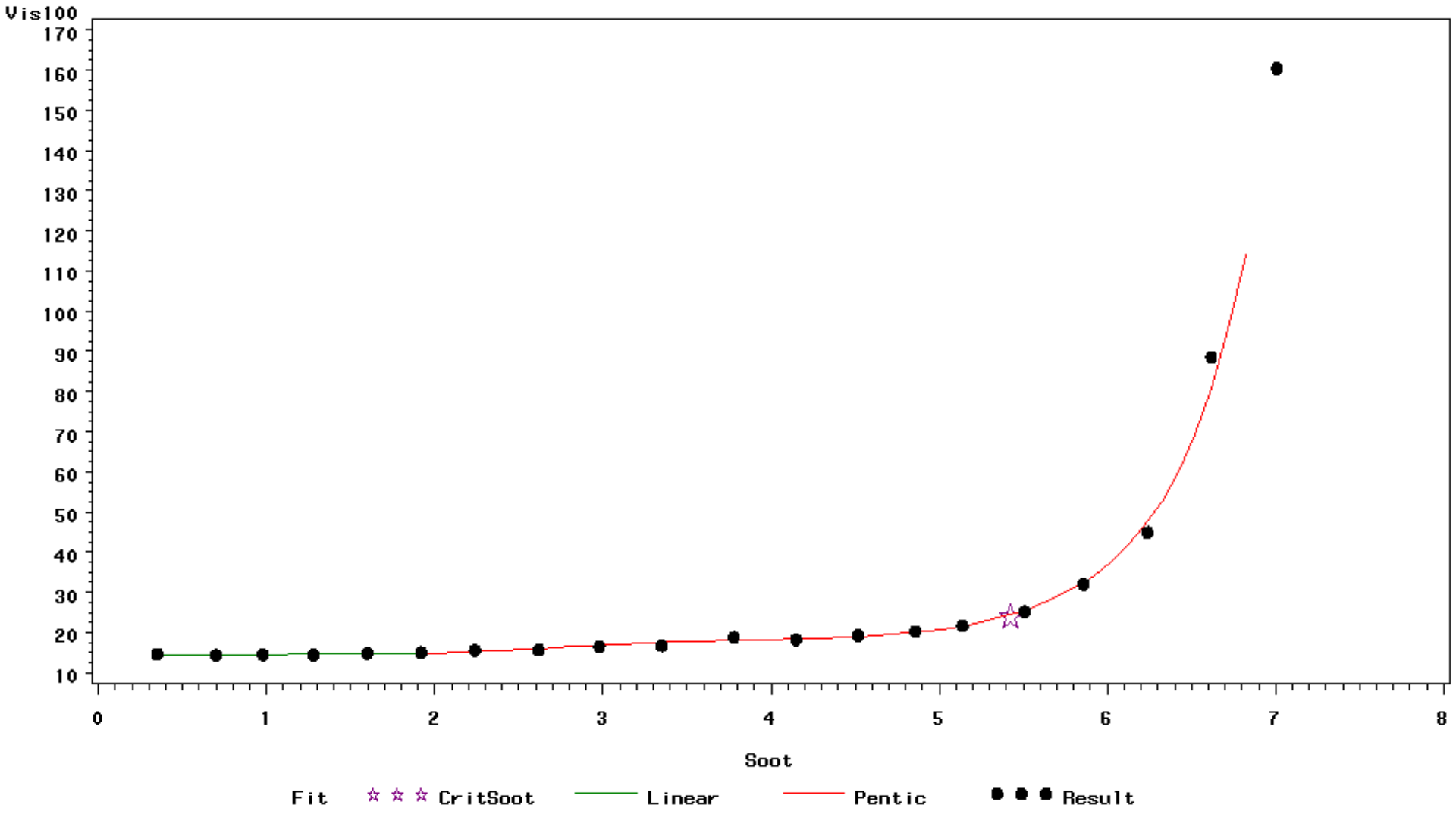

Fitted Kinematic Viscosity = f (TGA Soot) for Test: SwRI4
KV100 increased by 10 from minimum at soot= 6.1
(Delta KV100 at 5.5% TGA Soot from Minimum= 7.3)
Vis100
40
30
20
10
0
1
2
3
4
5
6
7
Soot
Fit
CritSoot
Linear
Pentic
Result

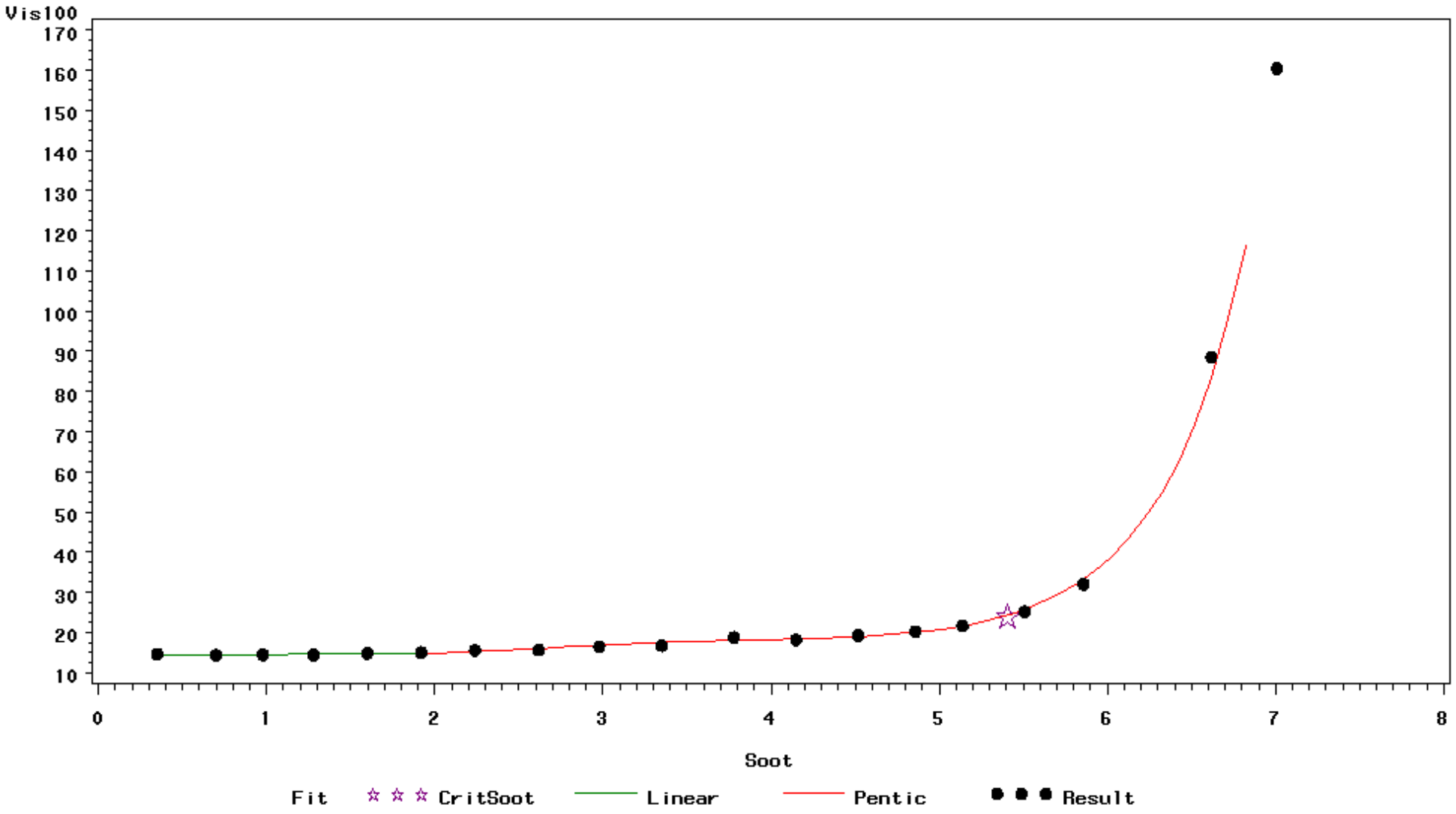

Fitted Kinematic Viscosity = f (TGA Soot) for Test: PE1
KV100 increased by 10 from minimum at soot= 5.4
(Delta KV100 at 5.5% TGA Soot from Minimum= 11.4)
Vis100
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result


Fitted Kinematic Viscosity = f (TGA Soot) for Test: PE2
KV100 increased by 10 from minimum at soot= 6
(Delta KV100 at 5.5% TGA Soot from Minimum= 6.8)
Vis100
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result

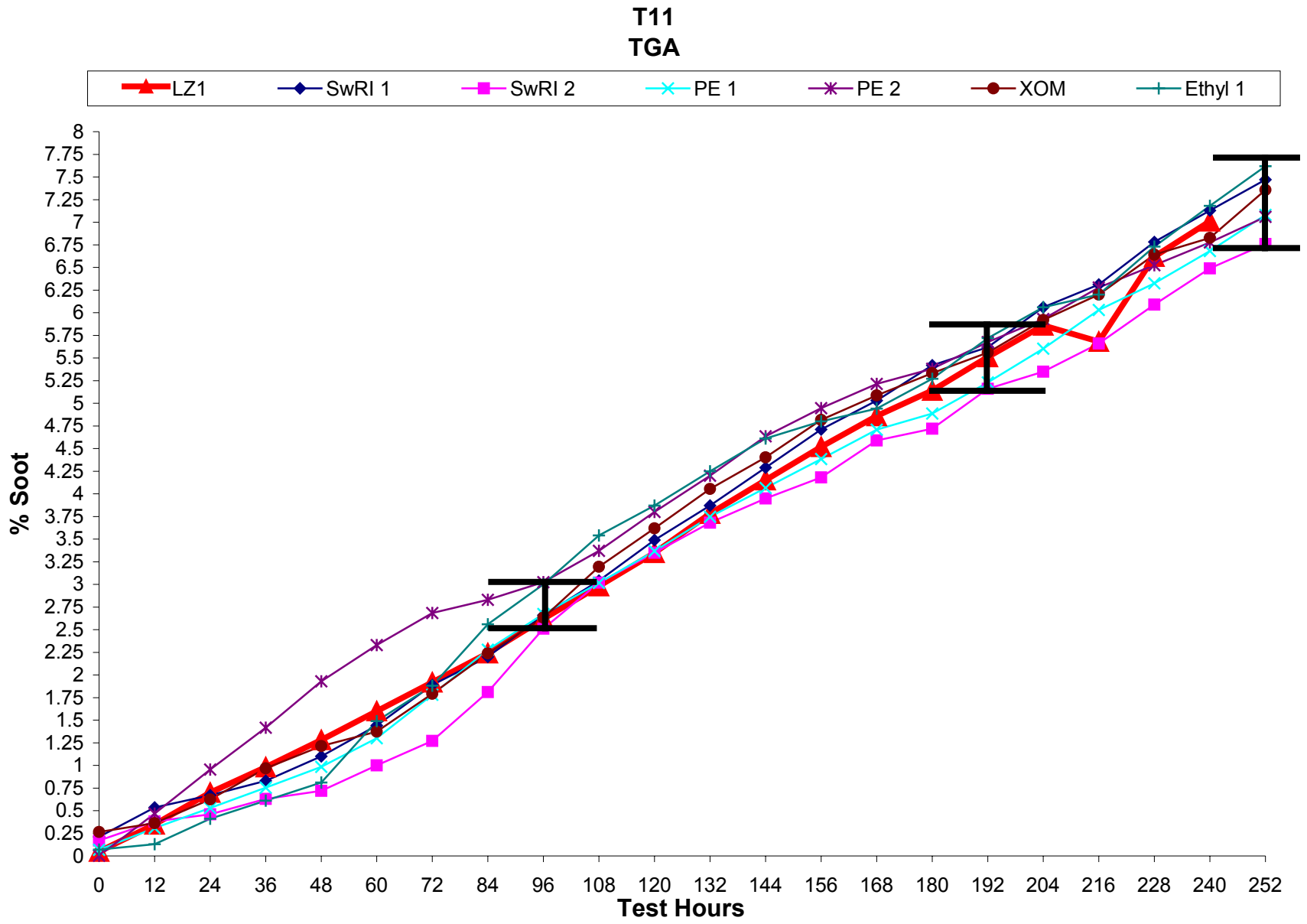

Fitted Kinematic Viscosity = f (TGA Soot) for Test: XOM
KV100 increased by 10 from minimum at soot= 5.7
(Delta KV100 at 5.5% TGA Soot from Minimum= 8.4)
Vis100
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result

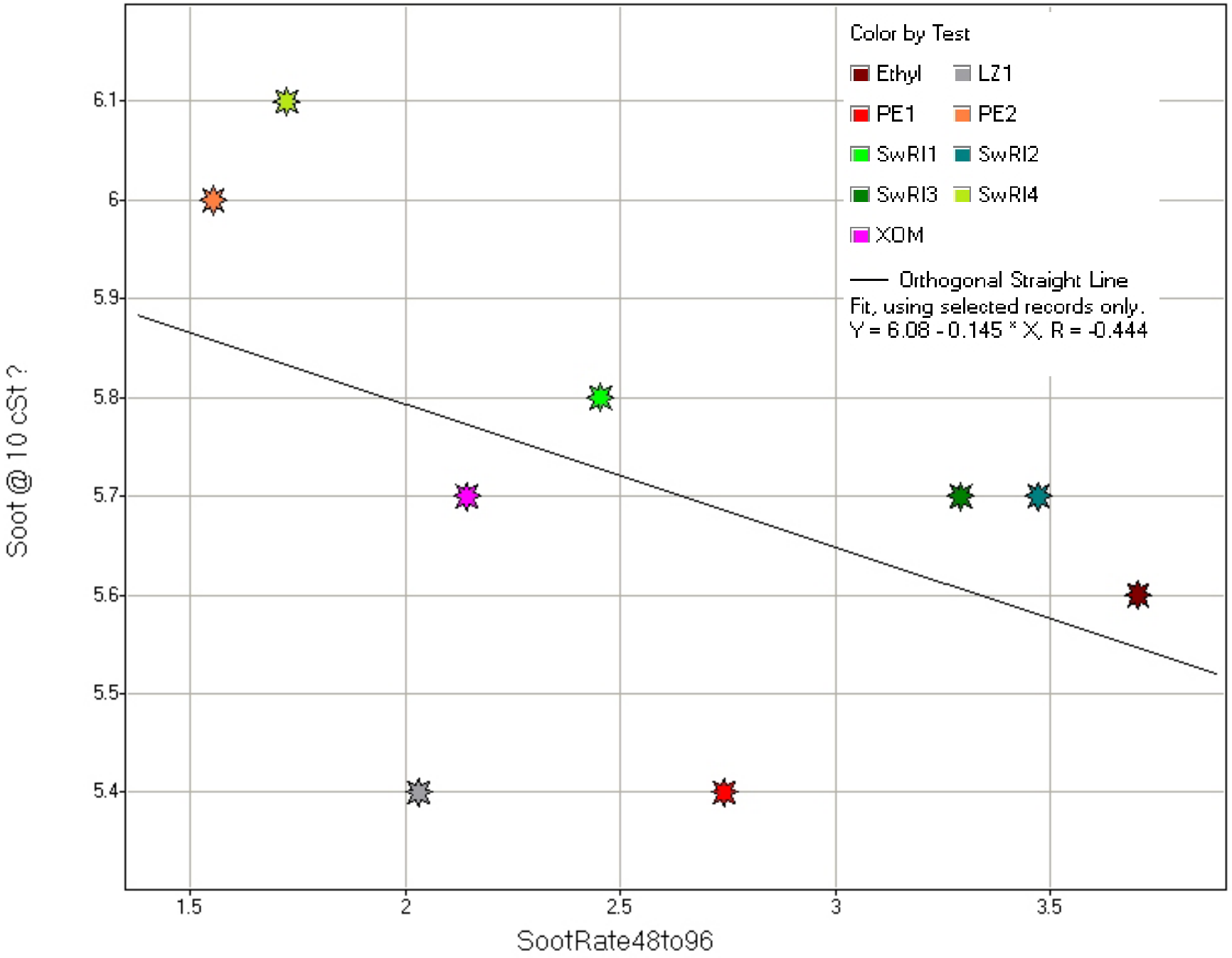

Fitted Kinematic Viscosity = f (TGA Soot) for Test: Ethyl
KV100 increased by 10 from minimum at soot= 5.6
(Delta KV100 at 5.5% TGA Soot from Minimum= 9.0)
Vis100
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result


Fitted Kinematic Viscosity = f (TGA Soot) for Test: LZ1
KV100 increased by 10 from minimum at soot= 5.4
(Delta KV100 at 5.5% TGA Soot from Minimum= 11.0)
Vis100
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result


Fitted Kinematic Viscosity = f (TGA Soot) for Test: LZ1
KV100 increased by 10 from minimum at soot= 5.4
(Delta KV100 at 5.5% TGA Soot from Minimum= 11.3)
Vis100
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Soot
Fit
CritSoot
Linear
Pentic
Result

Test	Soot @ 10 cSt Δ	cSt Δ @ 5.5% Soot
SwRI1	5.8	7.5
SwRI2	5.7	8.6
SwRI3	5.7	8.2
SwRI4	6.1	7.3
PE1	5.4	11.4
PE2	6.0	6.8
XOM	5.7	8.4
Ethyl	5.6	9.0
LZ1	5.4	11.3
Average	5.7	8.7
Standard Deviation	0.24	1.64
Coefficient of Variation	4%	19%


T11
TGA
LZ1
SwRI 1
SwRI 2
PE 1
PE 2
XOM
Ethyl 1
% Soot
Test Hours
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
3.25
3.5
3.75
4
4.25
4.5
4.75
5
5.25
5.5
5.75
6
6.25
6.5
6.75
7
7.25
7.5
7.75
8
0
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
192
204
216
228
240
252


Color by Test
Ethyl
LZ1
PE1
PE2
SwRI1
SwRI2
SwRI3
SwRI4
XOM
Orthogonal Straight Line
Fit, using selected records only.
Y = 6.08 - 0.145 * X, R = -0.444
Soot @ 10 cSt ?
SootRate48to96
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
1.5
2
2.5
3
3.5

Improving Precision

Could precision be improved by putting a gate

- at 48 hours for soot or timing;
- on the soot rate between 48 and 96 hours; or
- the initial timing?