MATERIAL TESTING RESEARCH AND INDENTER EQUIPMENT MODIFICATIONS FOR DETERMINING AGING OF WIRES IN AIRCRAFT

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DISCUSSION TOPICS

I. Materials Tested and Test Methods

II. Test Results

MATERIALS USED FOR TESTS

Insulation Material or System	**Referenced Specification**
PVC	MIL-DTL-16878/1C
PVC/glass/nylon	MIL-W-5086/2C
XL-ETFE (Cross-linked Tefzel®)	MIL-W-22759/42B (nickel-coated conductor)
Composite TKT (Teflon®-Kapton®- Teflon®)	MIL-DTL-22759/90A (nickel-coated conductor)
Polyimide (Kapton®)	MIL-W-81381/12C (nickel-coated conductor) Instrument Cable
Polyimide (Kapton®)	BMS 13-60 Type 1 Class 1 #10 AWG Power Cable

TYPES OF TESTS PERFORMED

Material	EAB Tests	Indenter Tests	WIDAS Tests
PVC	X	X	
PVC G-N		X	
XL-ETFE	X	X	
Composite TKT		X	
POLYIMIDE INST		X	X
POLYIMIDE POWER		X	X

EAB= Elongation-at-Break

WIDAS = Wire Insulation Deterioration Analysis System

THERMAL AGING EXPOSURES

Insulation System	Aging Temp.	Weeks of Aging	Sampling Rate
PVC	125°C	8	Remove 10 samples every two weeks
PVC/glass/nylon	125°C	8	Remove 10 samples every two weeks
XL-ETFE (Cross-linked Tefzel®)	220°C	12	Remove 10 samples every three weeks
Composite TKT (Teflon®-Kapton®-Teflon®)	280°C	12	Remove 10 samples every three weeks
Polyimide (Kapton®) (instrument wire)	220°C	12	Remove 10 samples every three weeks
Polyimide (Kapton®) (#10 AWG power)	220°C	12	Remove 10 samples every three weeks

Aging temperature was 20°C higher than the Maximum Temperature Rating of each wire type .

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PVC G-N		X	
XL-ETFE	X	X	
Composite TKT		X	
POLYIMIDE INST		X	X
POLYIMIDE POWER		X	X

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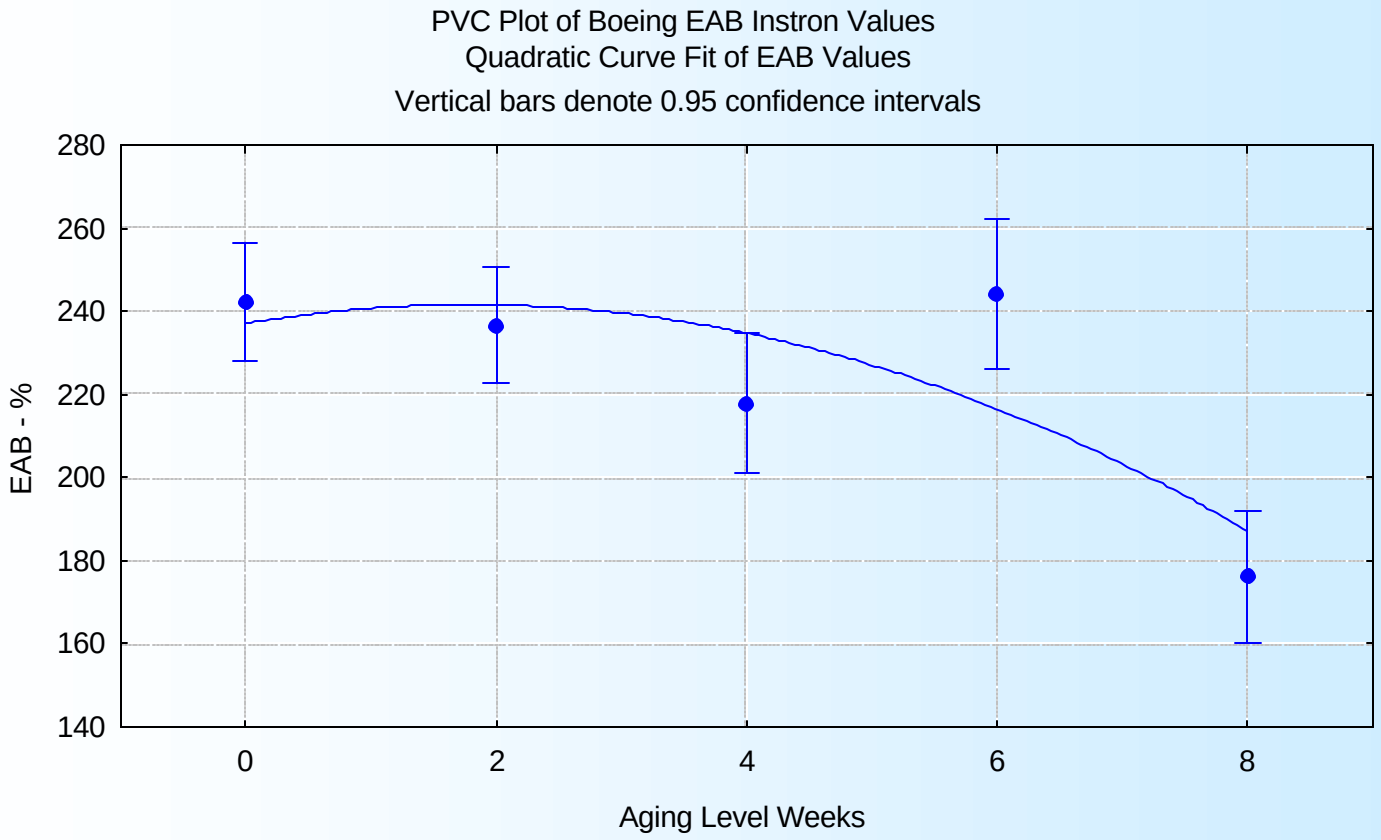
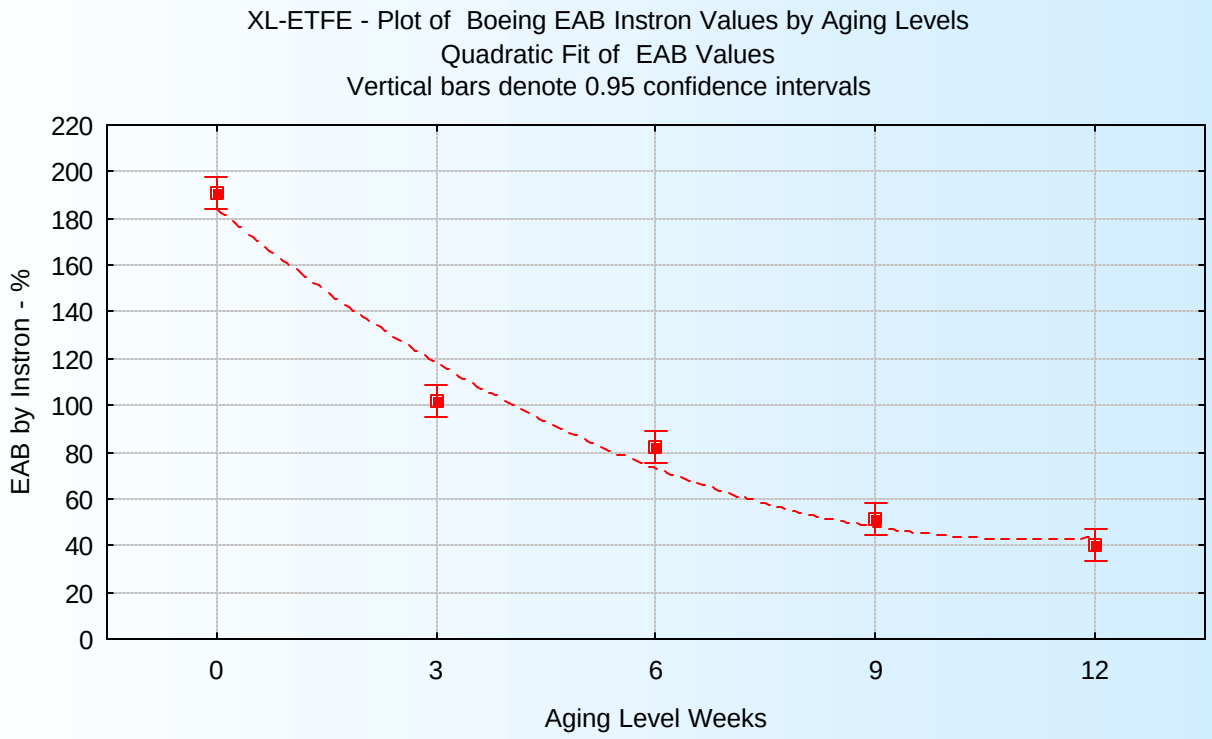
CORRELATION BETWEEN EAB AND AGING



Correlation Between EAB and XL-ETFE



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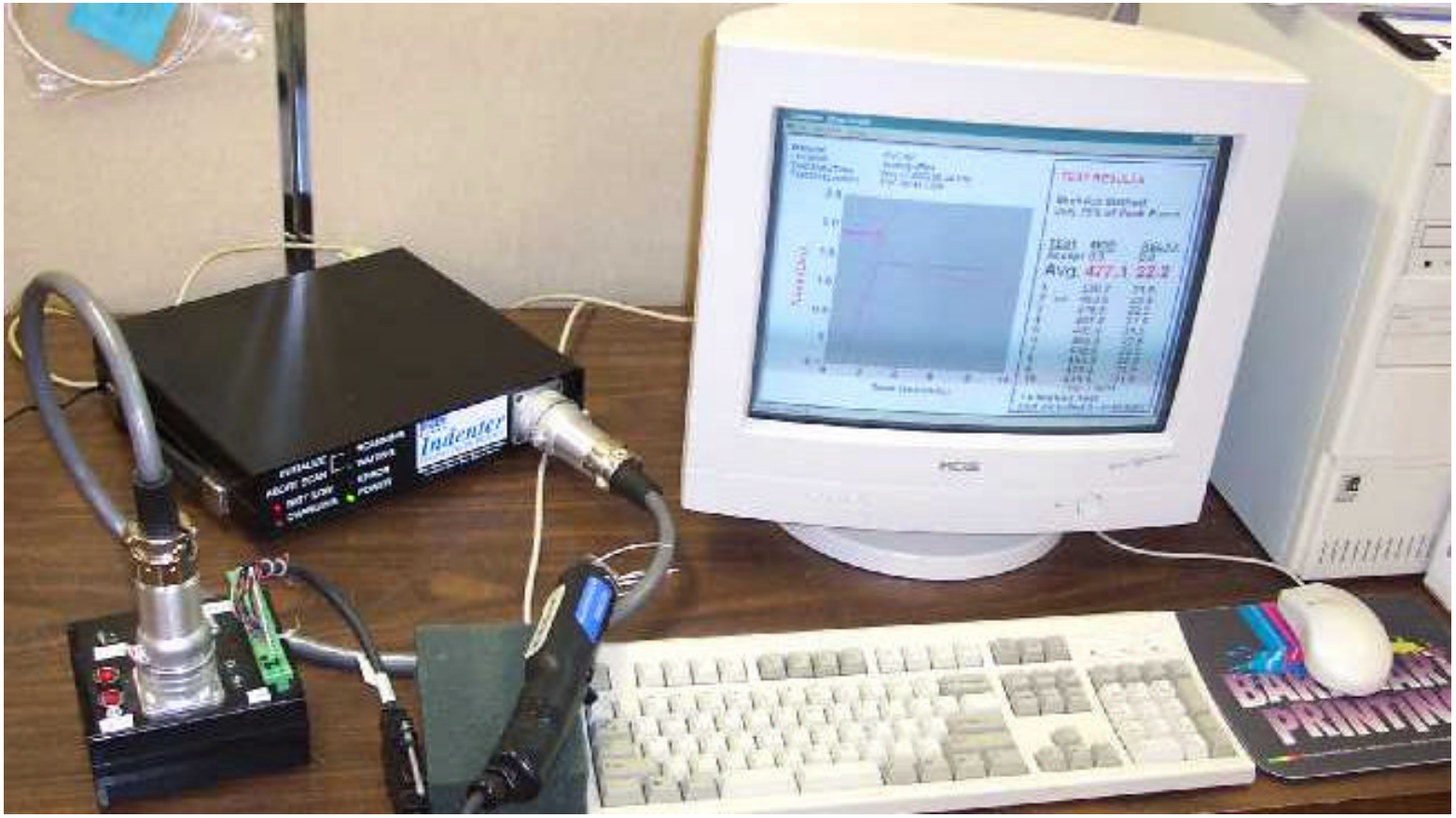
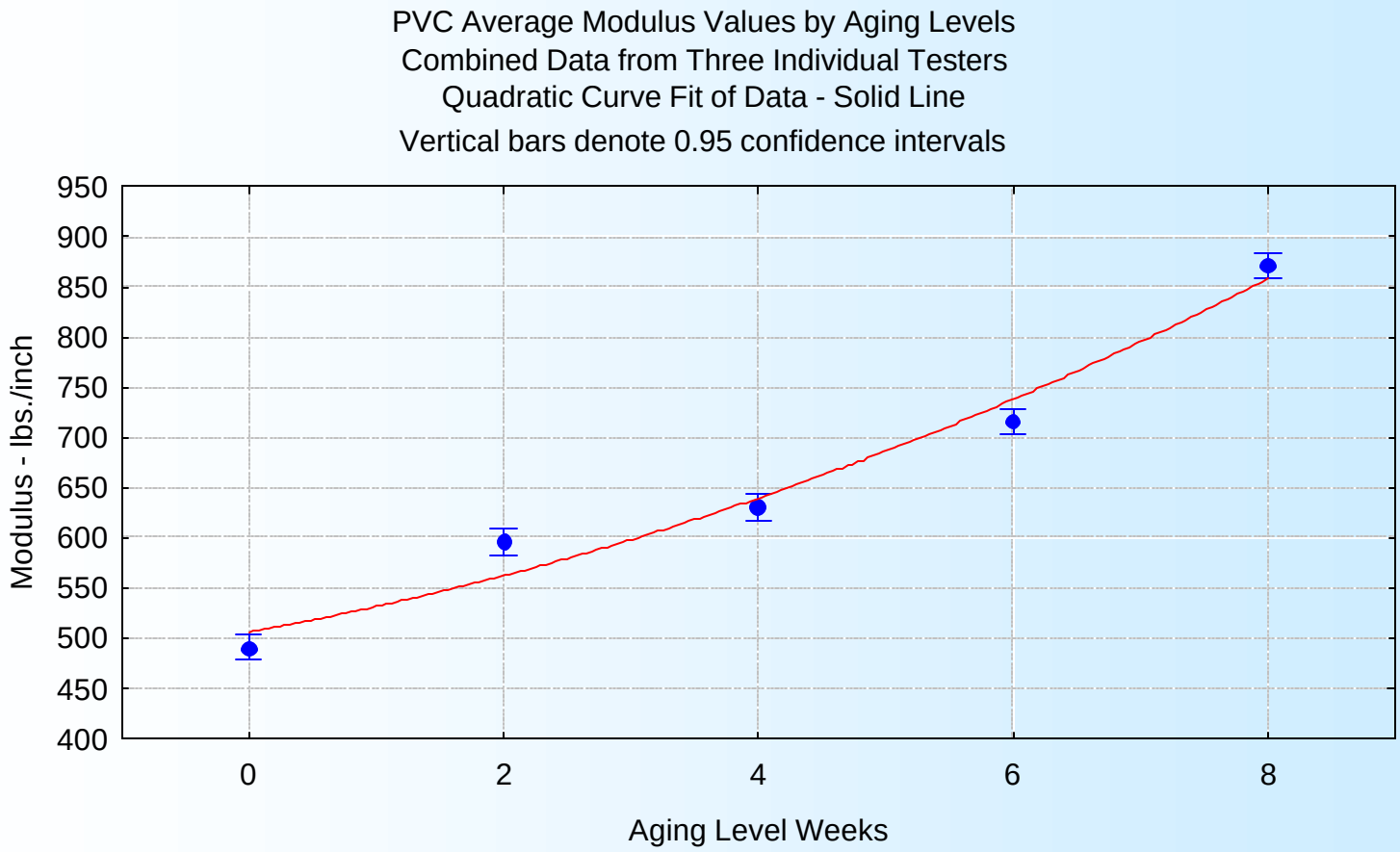


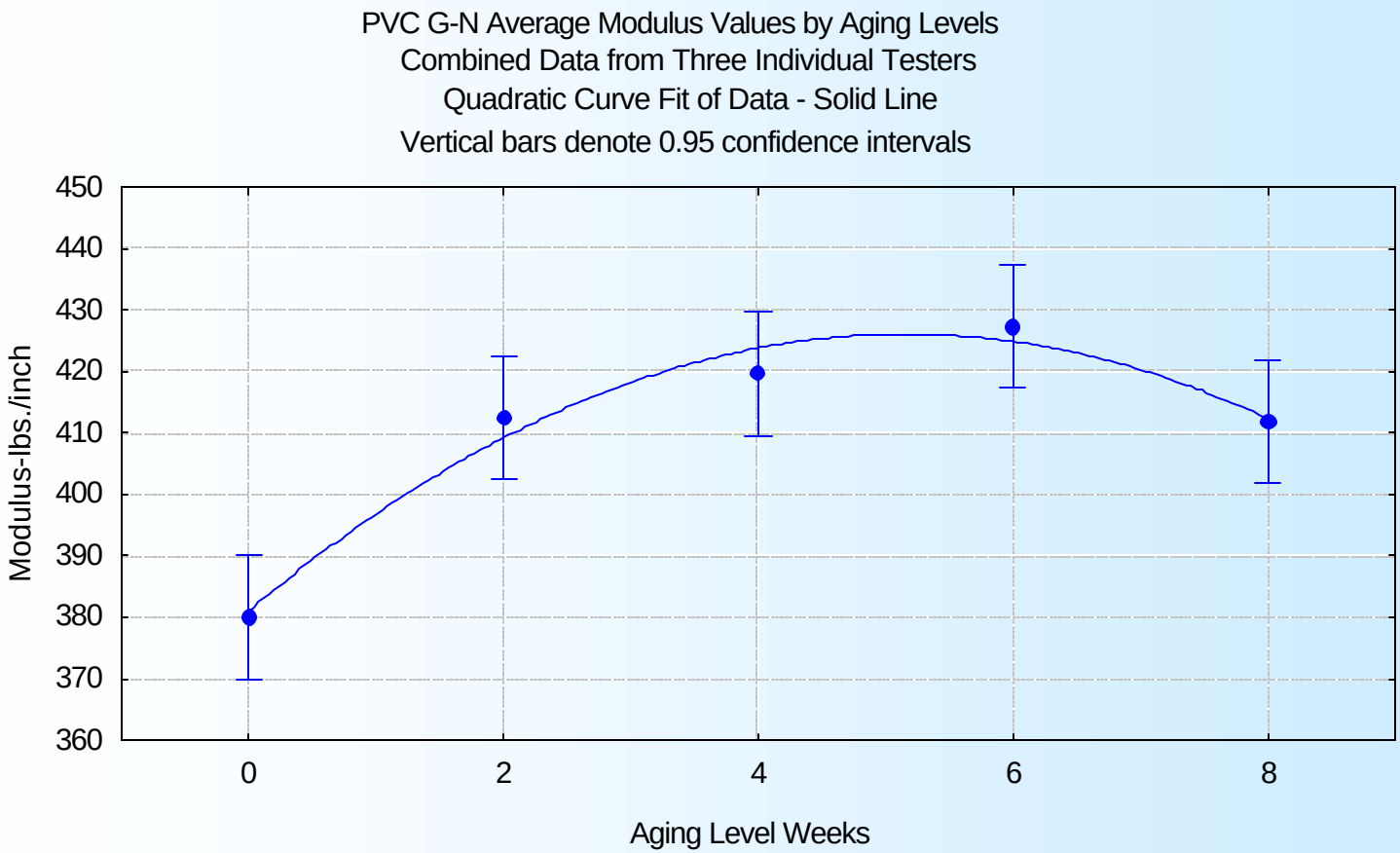
SYSTEM SETUP FOR INDENTER TESTING

PERFORMING A TEST ON POLYIMIDE POWER WIRE

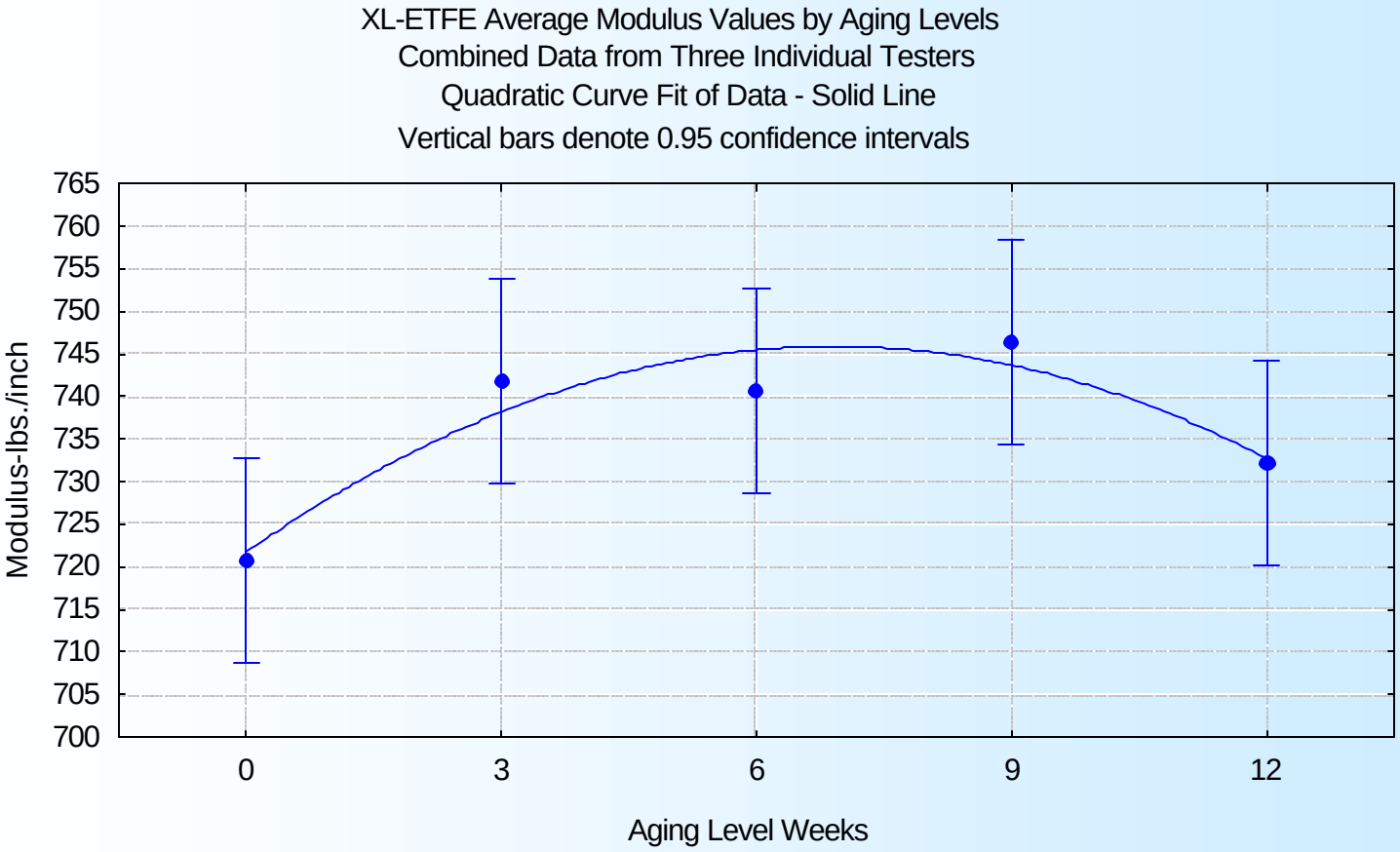
PVC MODULUS AVERAGES



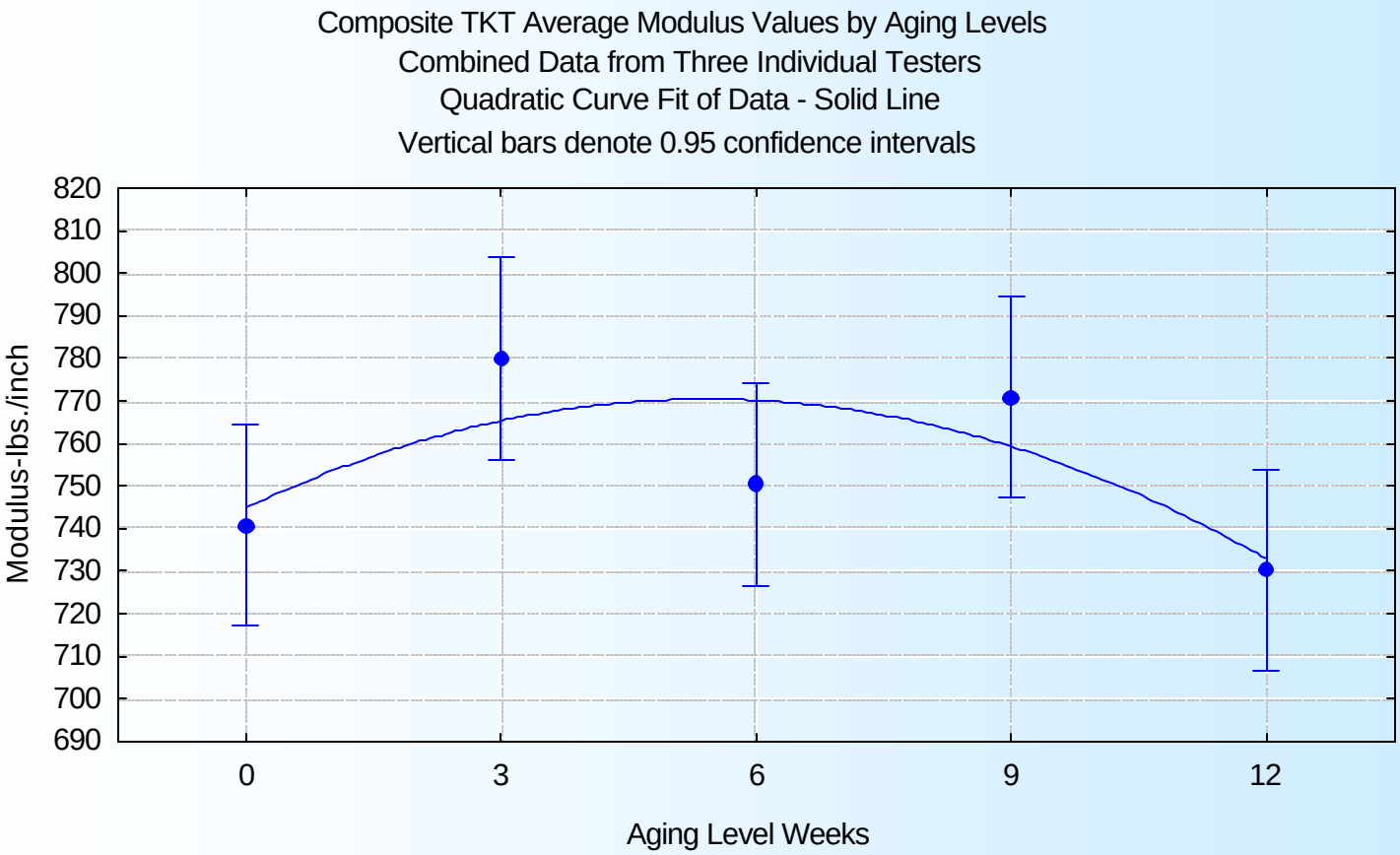
PVC G-N MODULUS AVERAGES



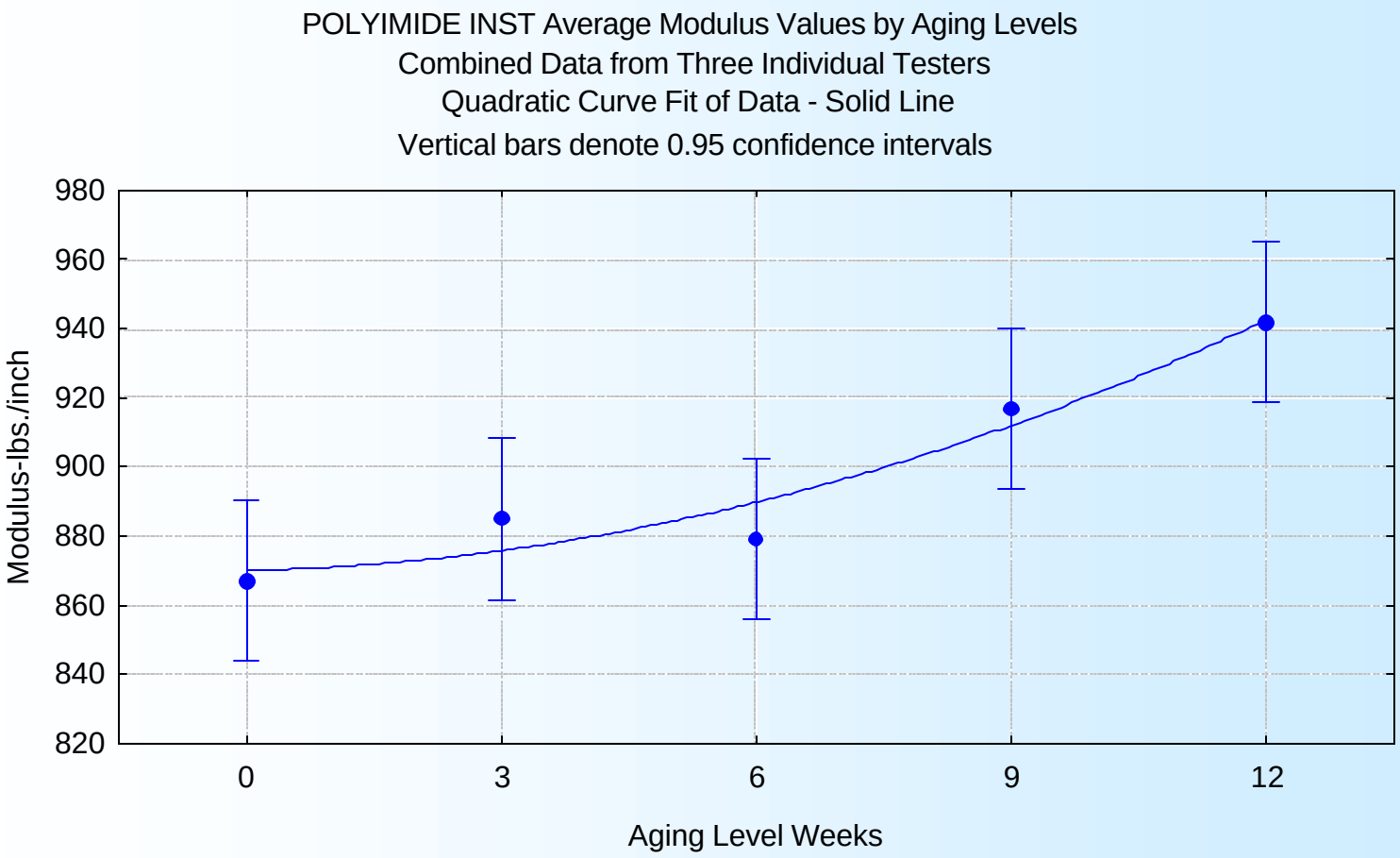
XL-ETFE MODULUS AVERAGES



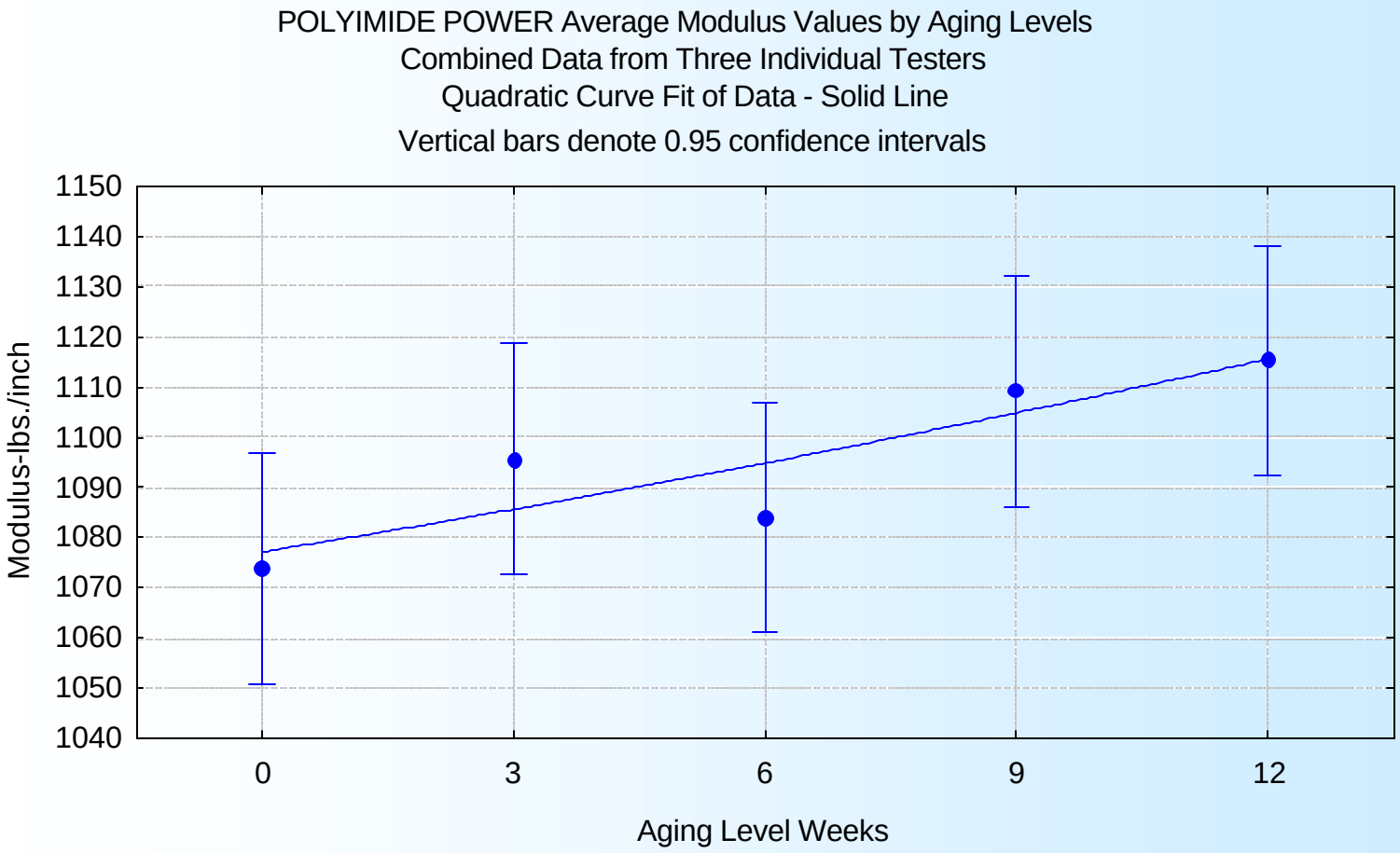
COMPOSITE TKT MODULUS AVERAGES

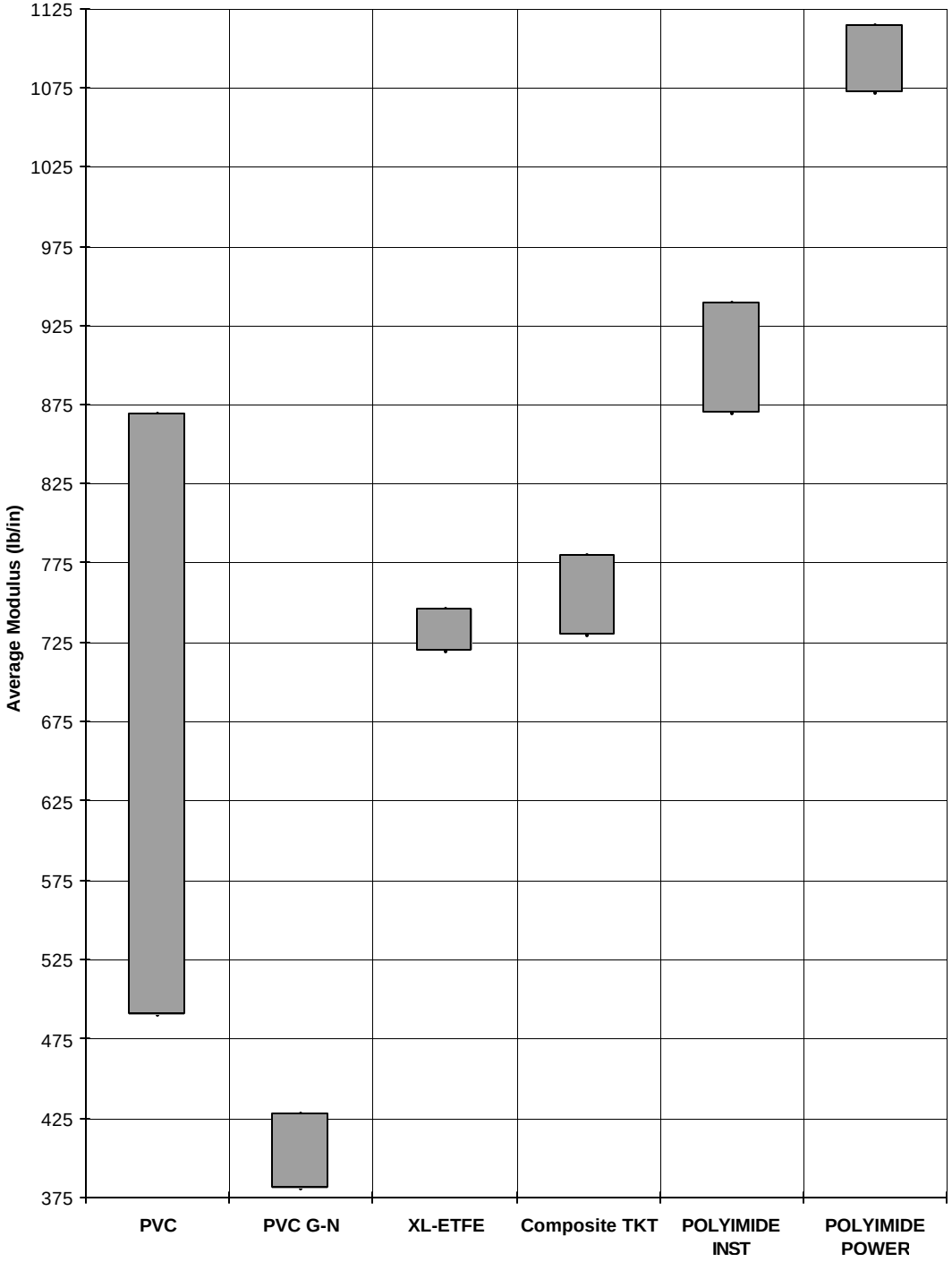


POLYIMIDE INST MODULUS AVERAGES



POLYIMIDE POWER MODULUS AVERAGES




Average Modulus (lb/in)
1125
1075
1025
975
925
875
825
775
725
675
625
575
525
475
425
375
PVC
PVC G-N
XL-ETFE
Composite TKT
POLYIMIDE INST
POLYIMIDE POWER

TYPES OF TESTS PERFORMED

Material	EAB Tests	Indenter Tests	WIDAS Tests
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PVC G-N		X	
XL-ETFE	X	X	
Composite TKT		X	
POLYIMIDE INST		X	X
POLYIMIDE POWER		X	X

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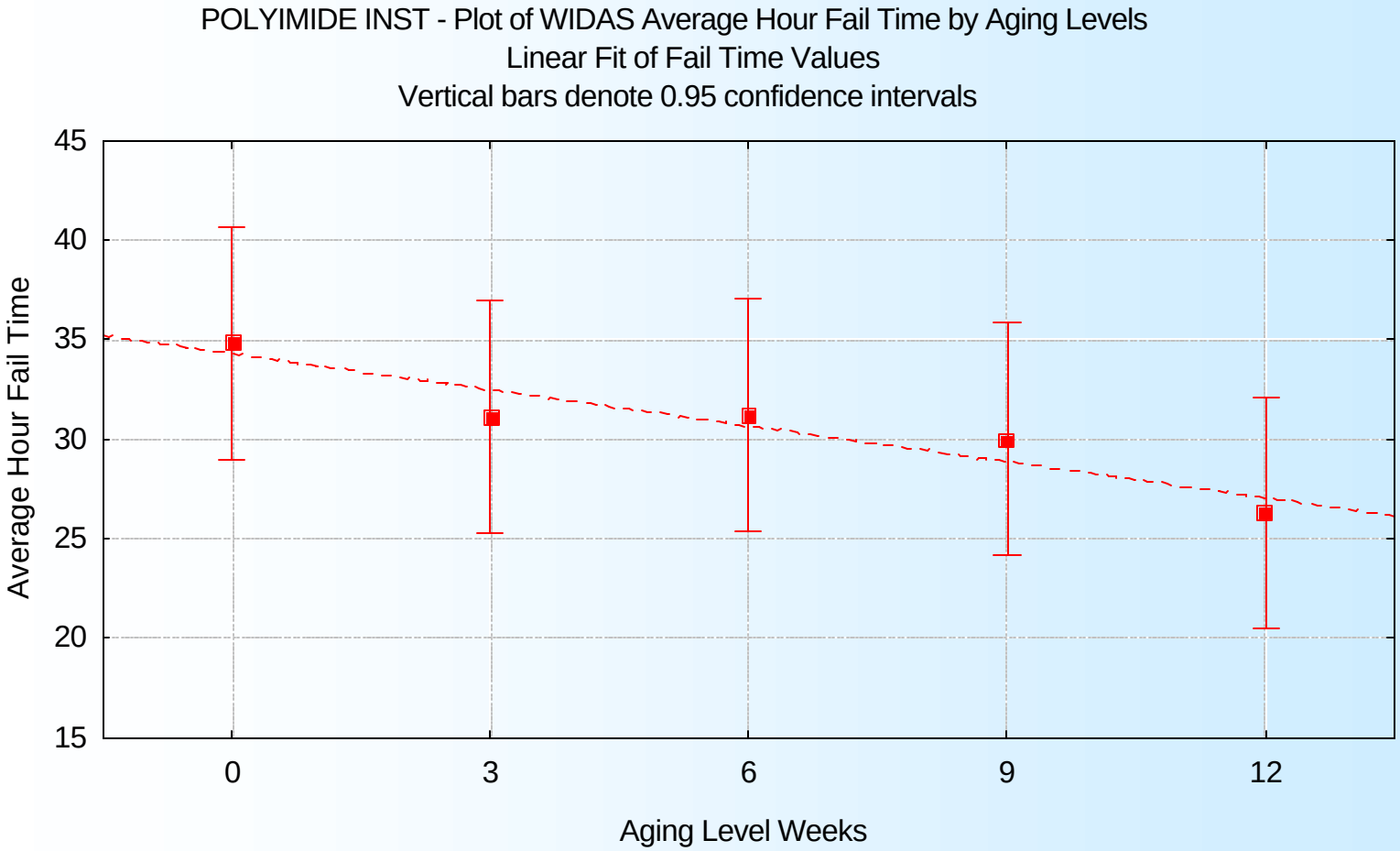
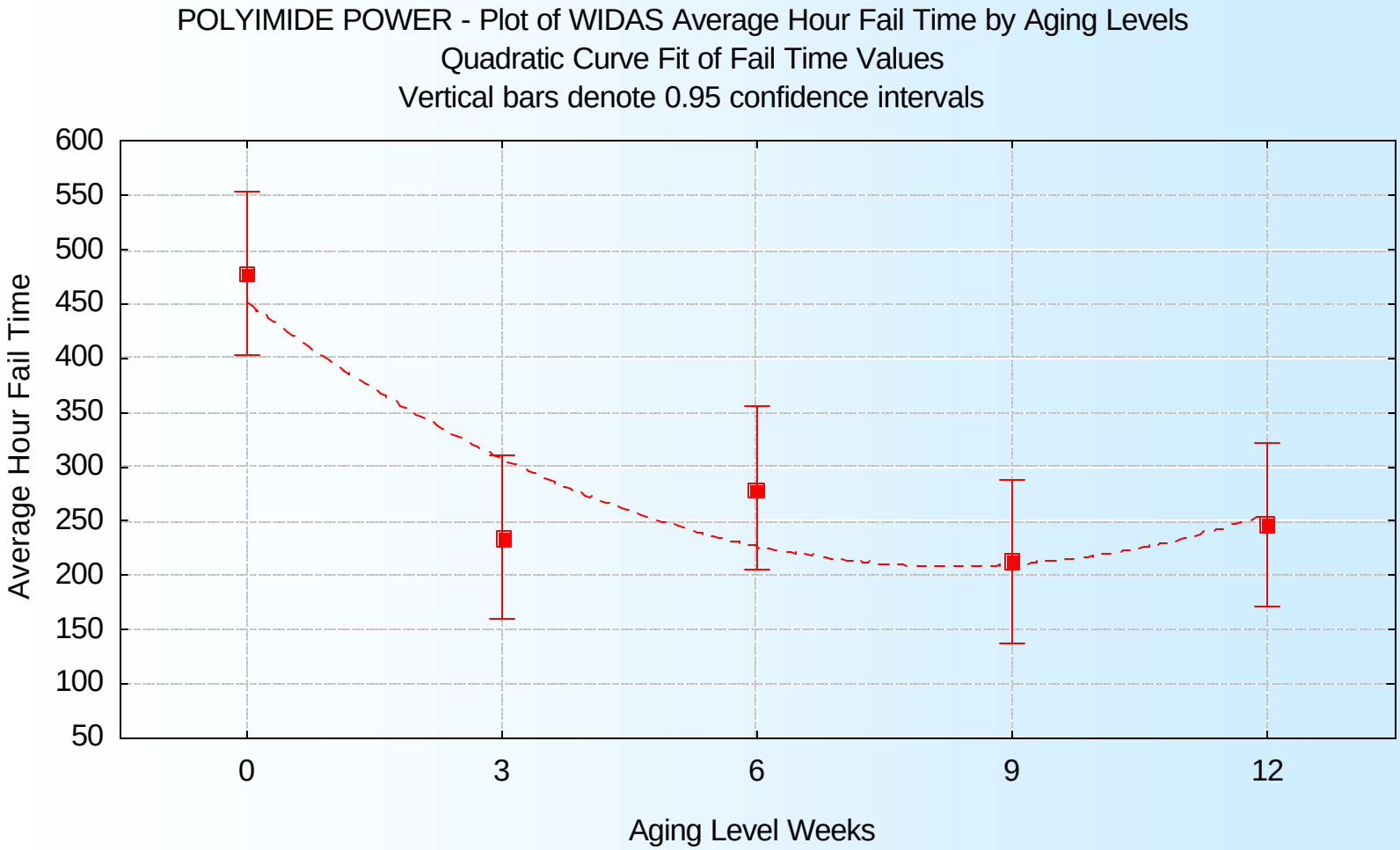
POLYIMIDE INST – WIDAS LIFE VERSUS AGING LEVELS



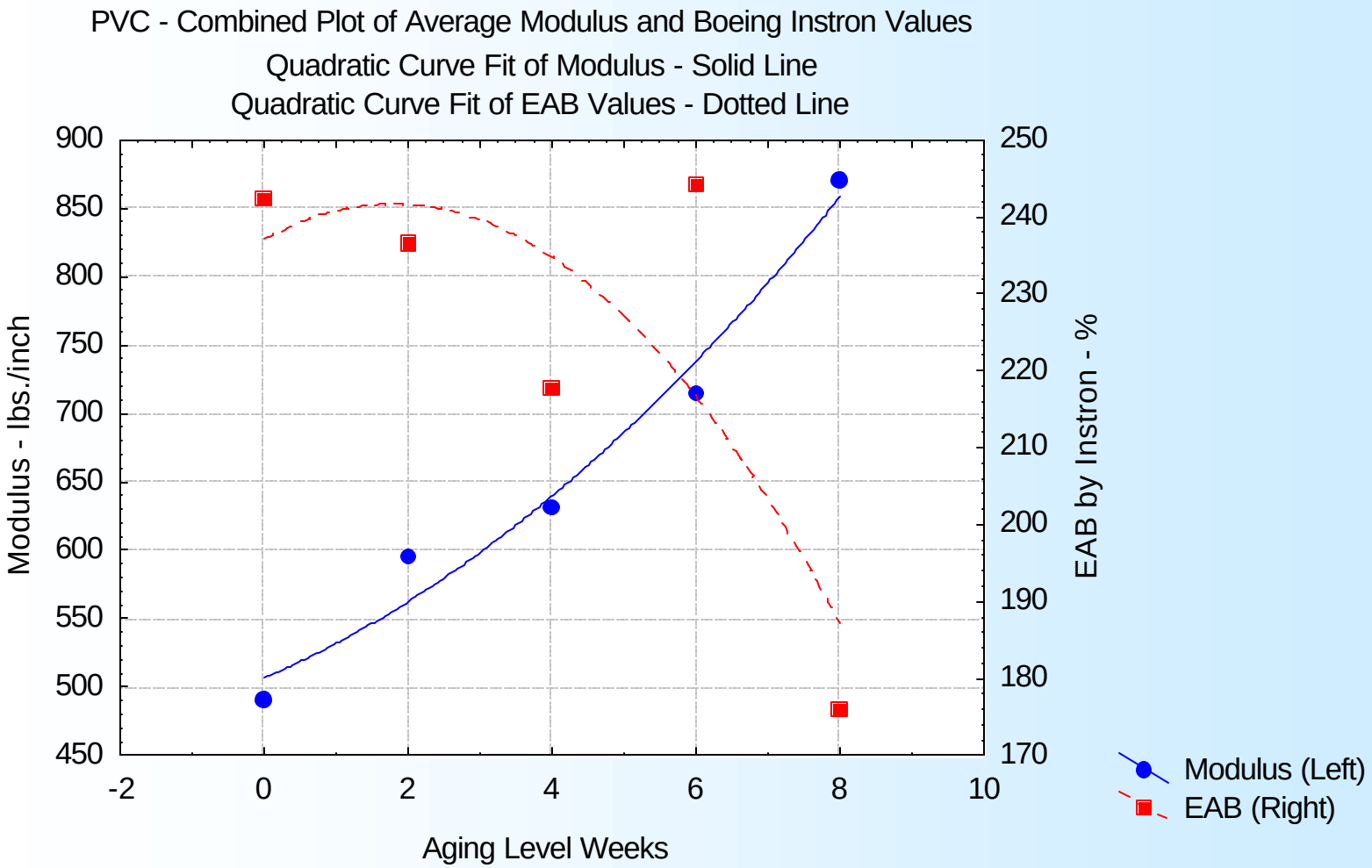
POLYIMIDE POWER – WIDAS LIFE VERSUS AGING LEVELS



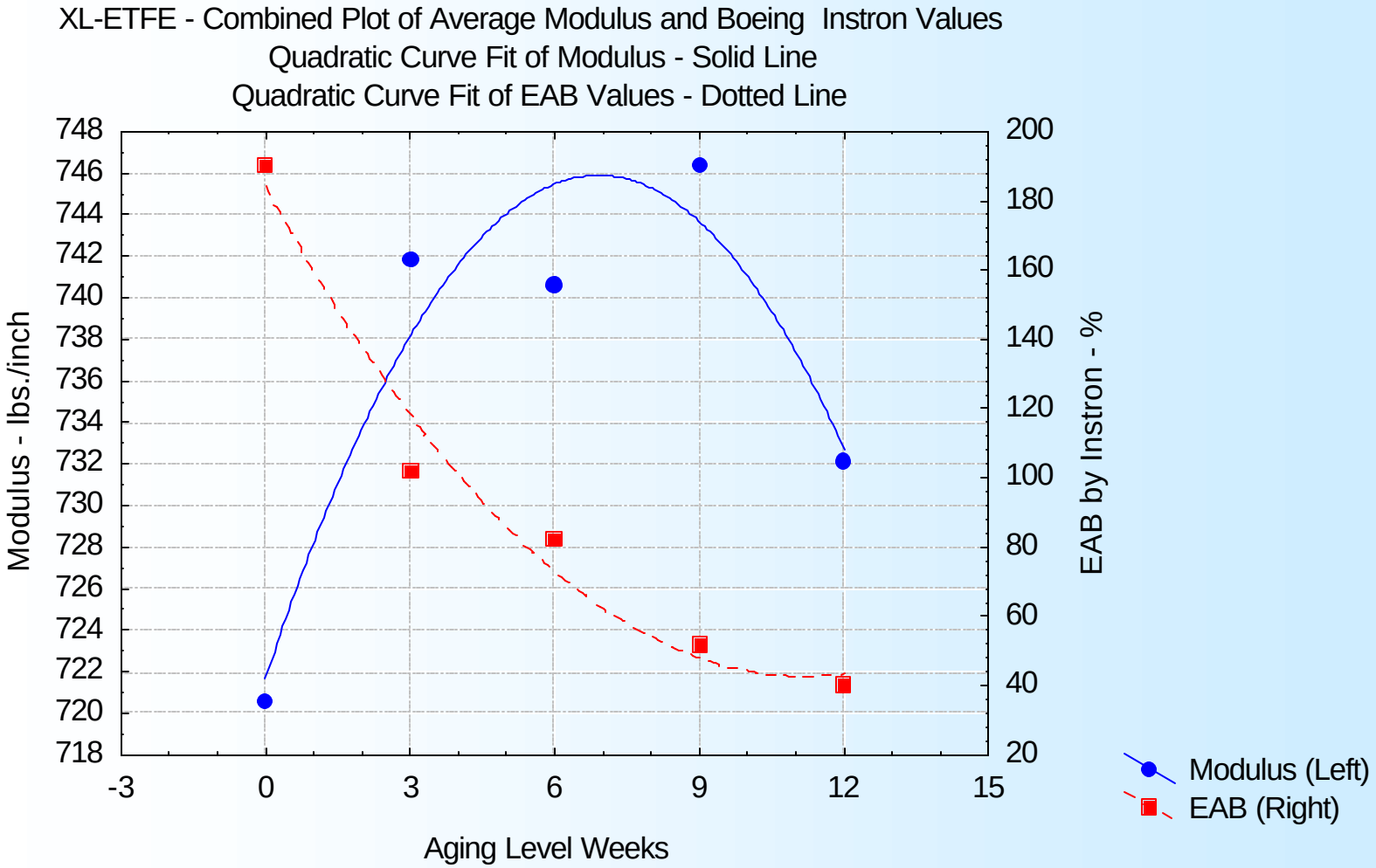
COMPARISON OF

EAB versus INDENTER

PVC – MODULUS AND ELONGATION-AT-BREAK VERSUS AGING



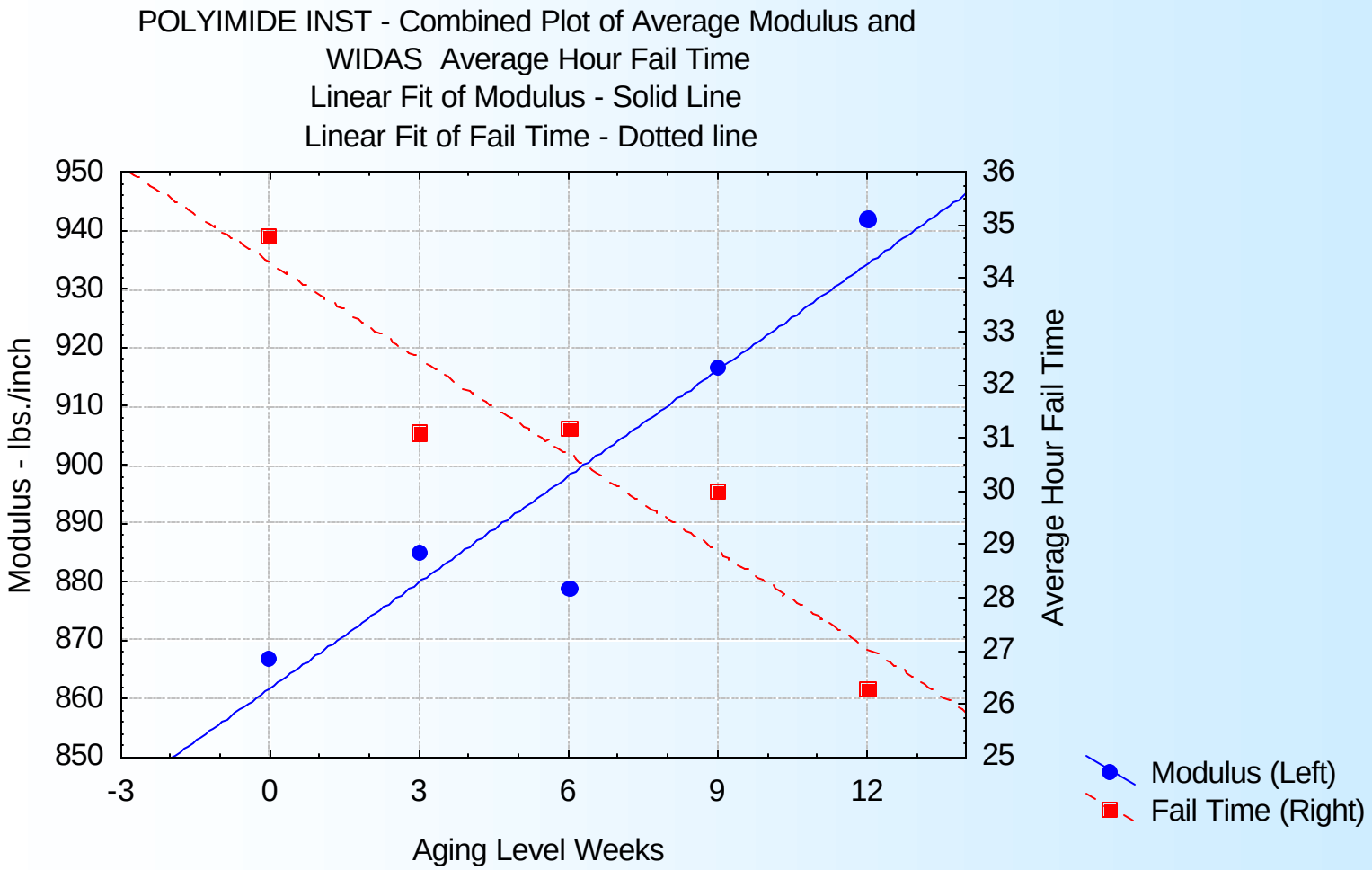
XL-ETFE – MODULUS AND ELONGATION-AT-BREAK VERSUS AGING



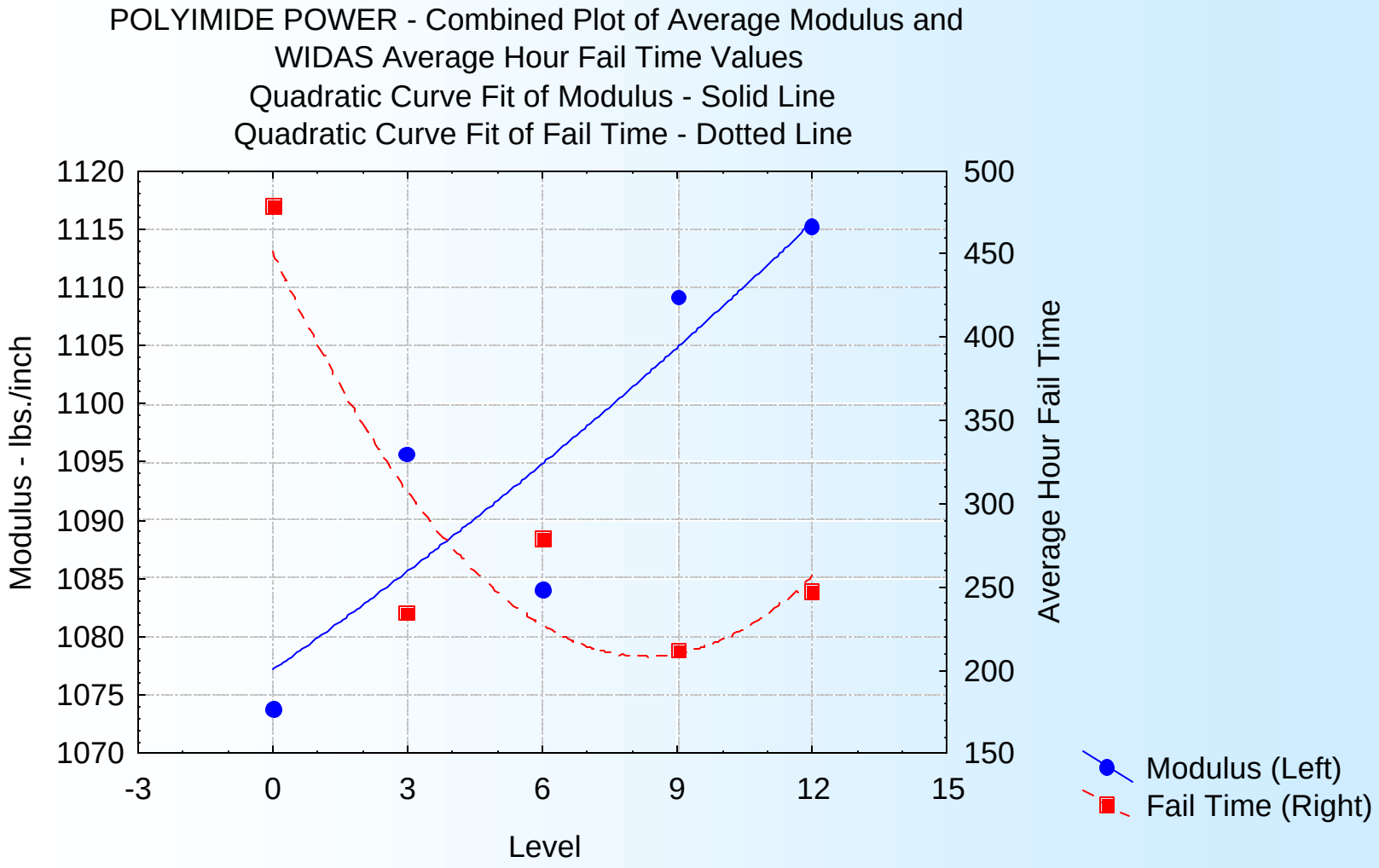
COMPARISON OF

WIDAS versus INDENTER

POLYIMIDE INST – MODULUS AND WIDAS FAILURE TIME VERSUS AGING



POLYIMIDE POWER – MODULUS AND WIDAS FAILURE TIME VERSUS AGING



SUMMARY OF RESULTS

Material	Correlation Between EAB and Aging	Correlation Between Indenter and Aging	Correlation Between WIDAS and Aging	Correlation Between Indenter and EAB	Correlation Between Indenter and WIDAS
PVC	**Good**	**Very Good**	---	**Good**	---
PVC G-N	---	Moderate	---	---	---
XL-ETFE	**Good**	Cannot Be Determined	---	Moderate	---
COMPOSITE TKT	---	None	---	---	---
POLYIMIDE INST	---	**Good**	**Good**	---	**Good**
POLYIMIDE POWER	---	Cannot Be Determined	Slight	---	Moderate

CONCLUSIONS

- Indenter hardware performance excellent
- Correlation of indenter measurements and aging established for PVC and small gauge polyimide
- Further investigation of PVC/G/N, XL-ETFE, Composite TKT, and larger gauge polyimide required
- Additional wire types
- Investigate relationship between hardness modulus and wire performance (Wire Degradation Program)