

Discussion of Burnthrough Test Method for Aircraft Thermal Acoustic Insulation Blankets



Tim Marker
FAA Technical Center



Round Robin VI

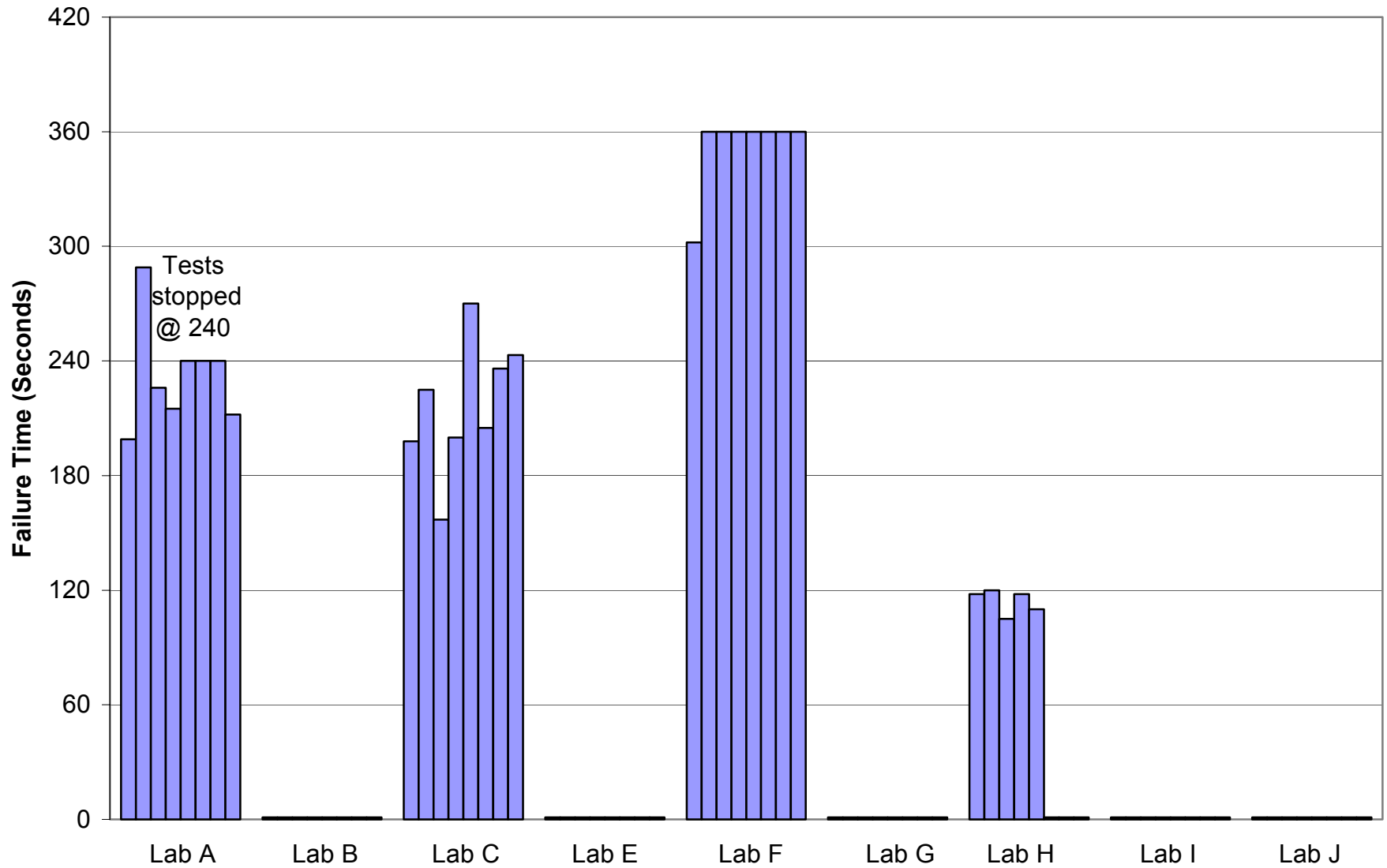
Initiated: Spring 2004

(3 materials, 8 tests each)

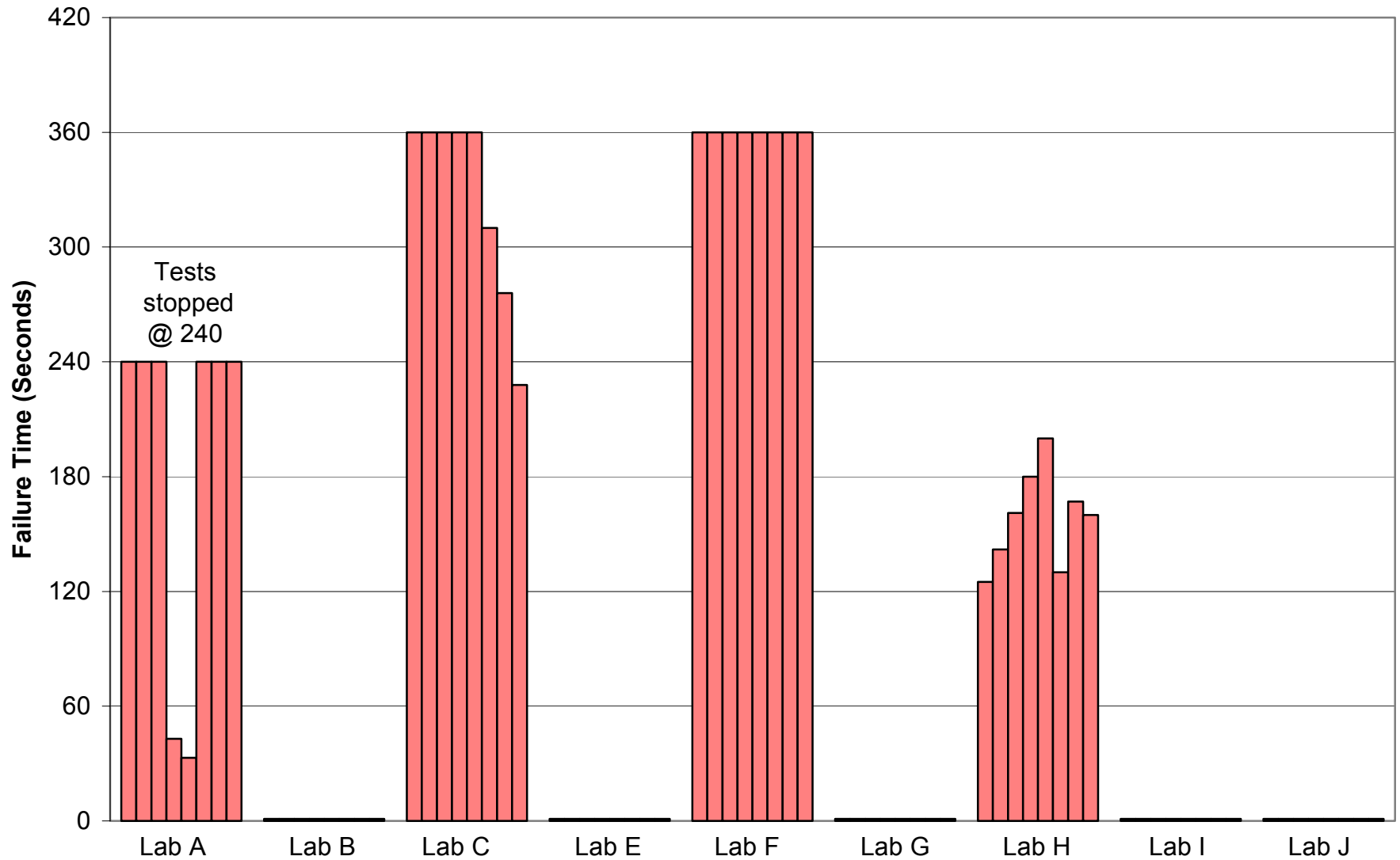
Approach: Visit each lab prior to running tests, utilizing Boeing calibration tools to correct any deficiencies with equipment set-up. Once calibration is achieved, tests could be completed.

Result: Labs A, B, I, and J visited during 2004. Difficulties encountered at each lab during calibration process, preventing completion of tests.

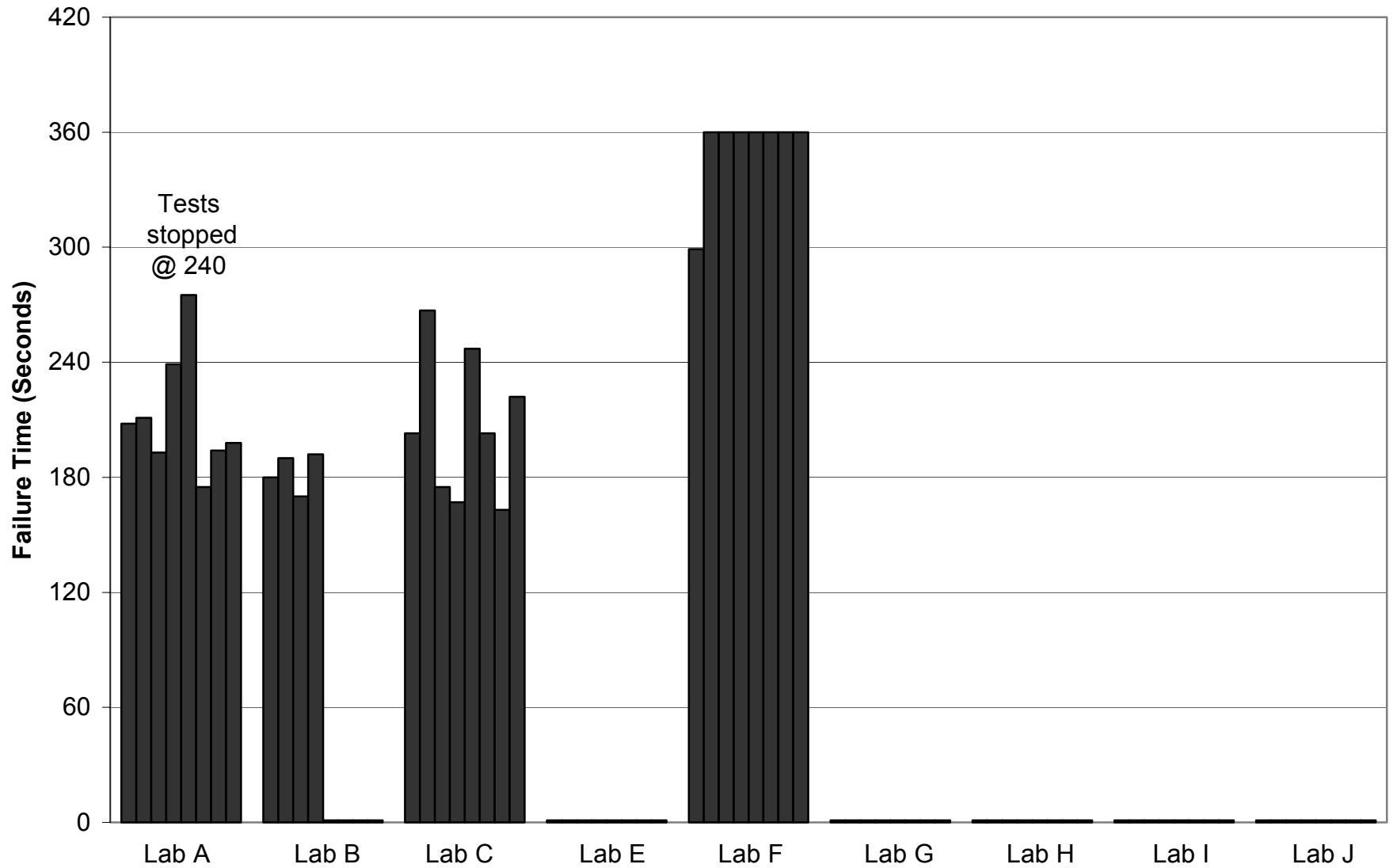
RR VI Material A Results



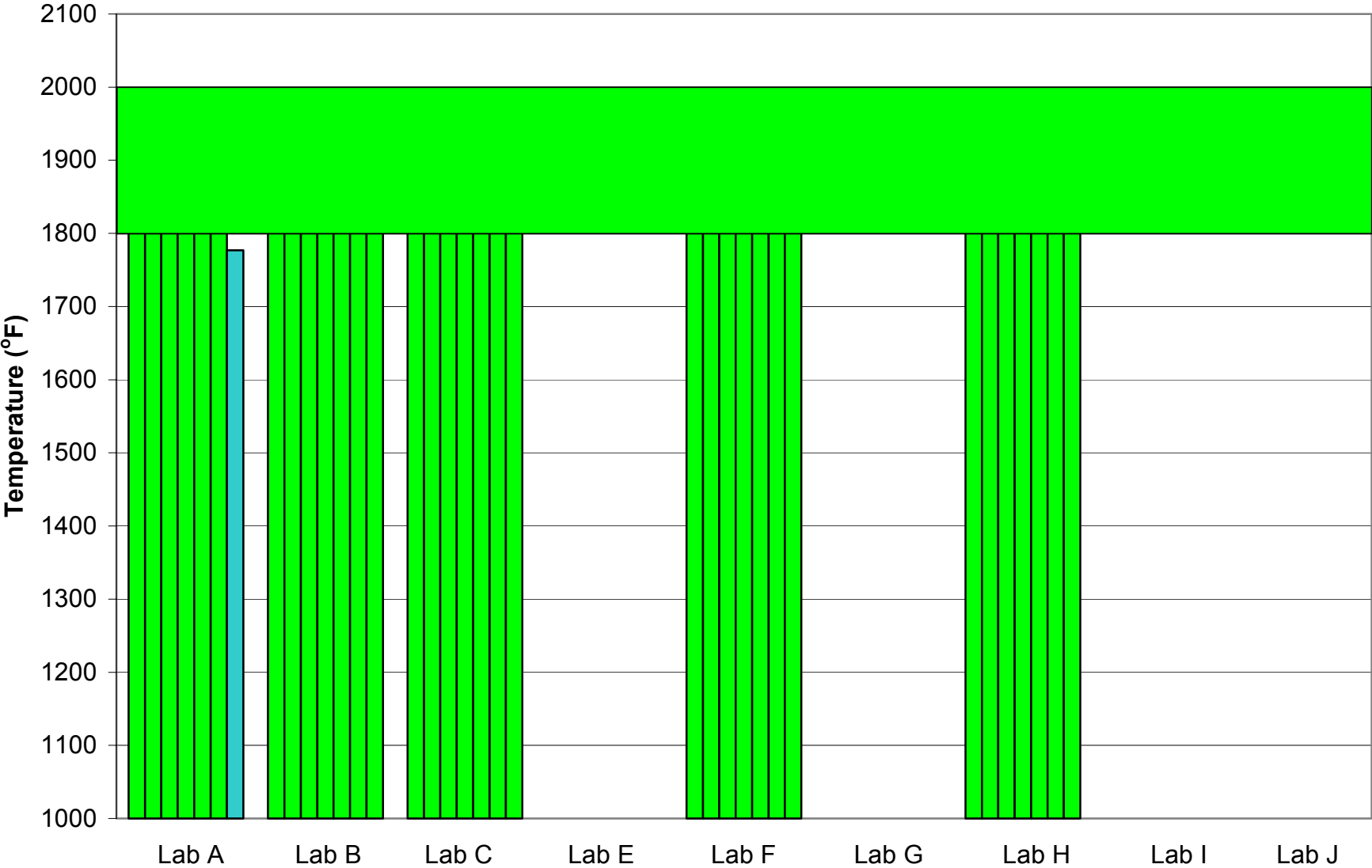
RR VI Material B Results



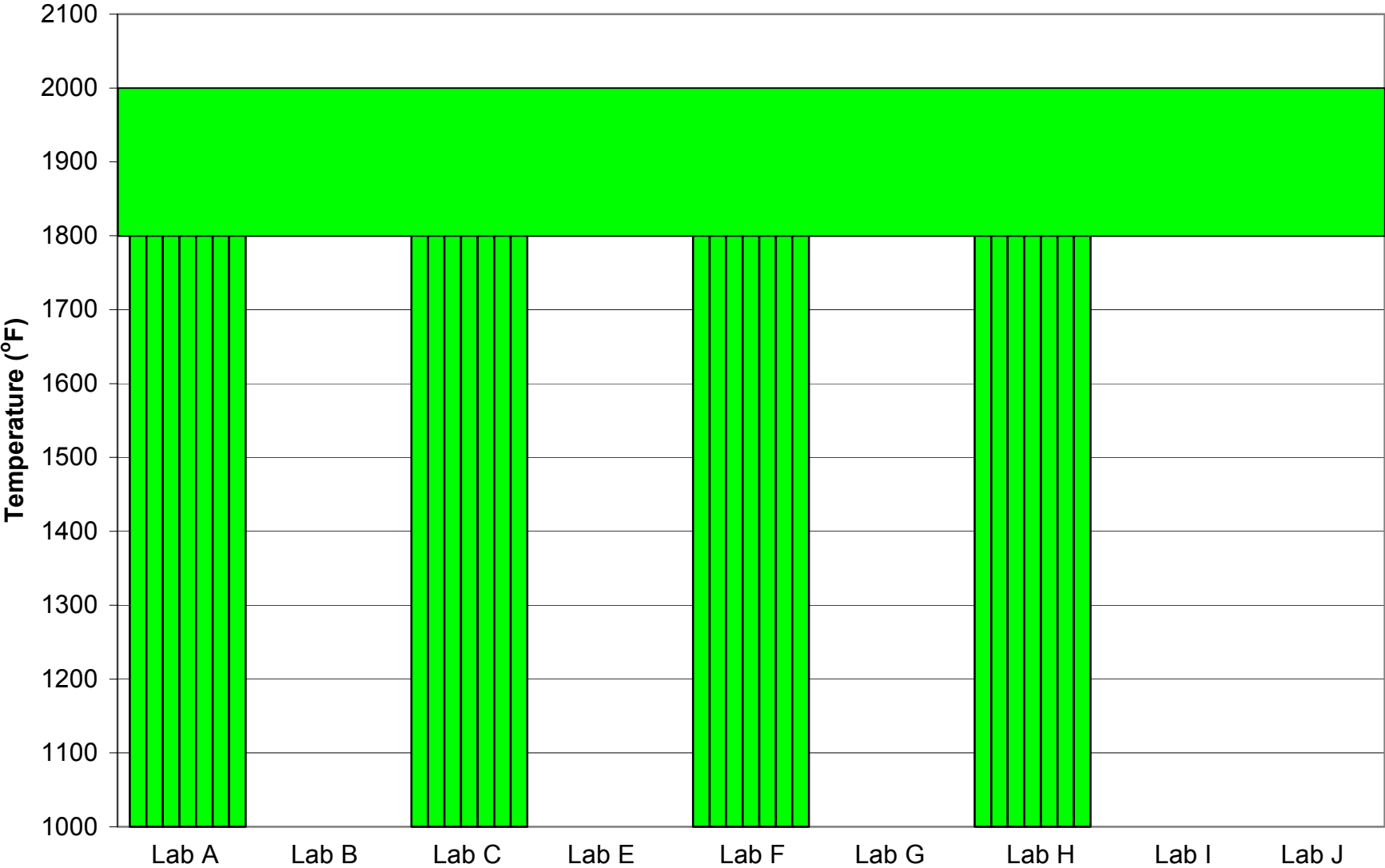
RR VI Material C Results



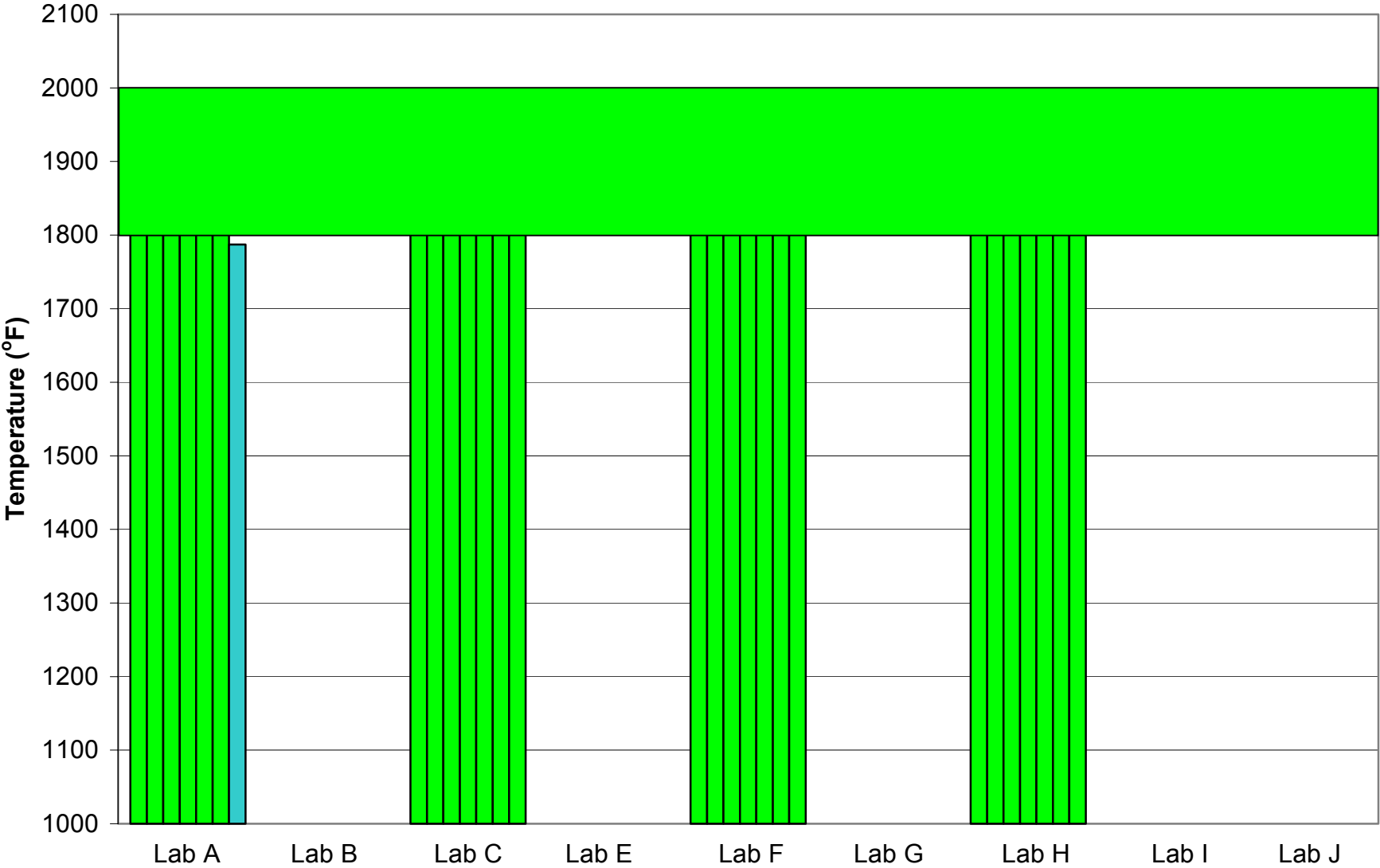
RR VI Temperature Calibration #1



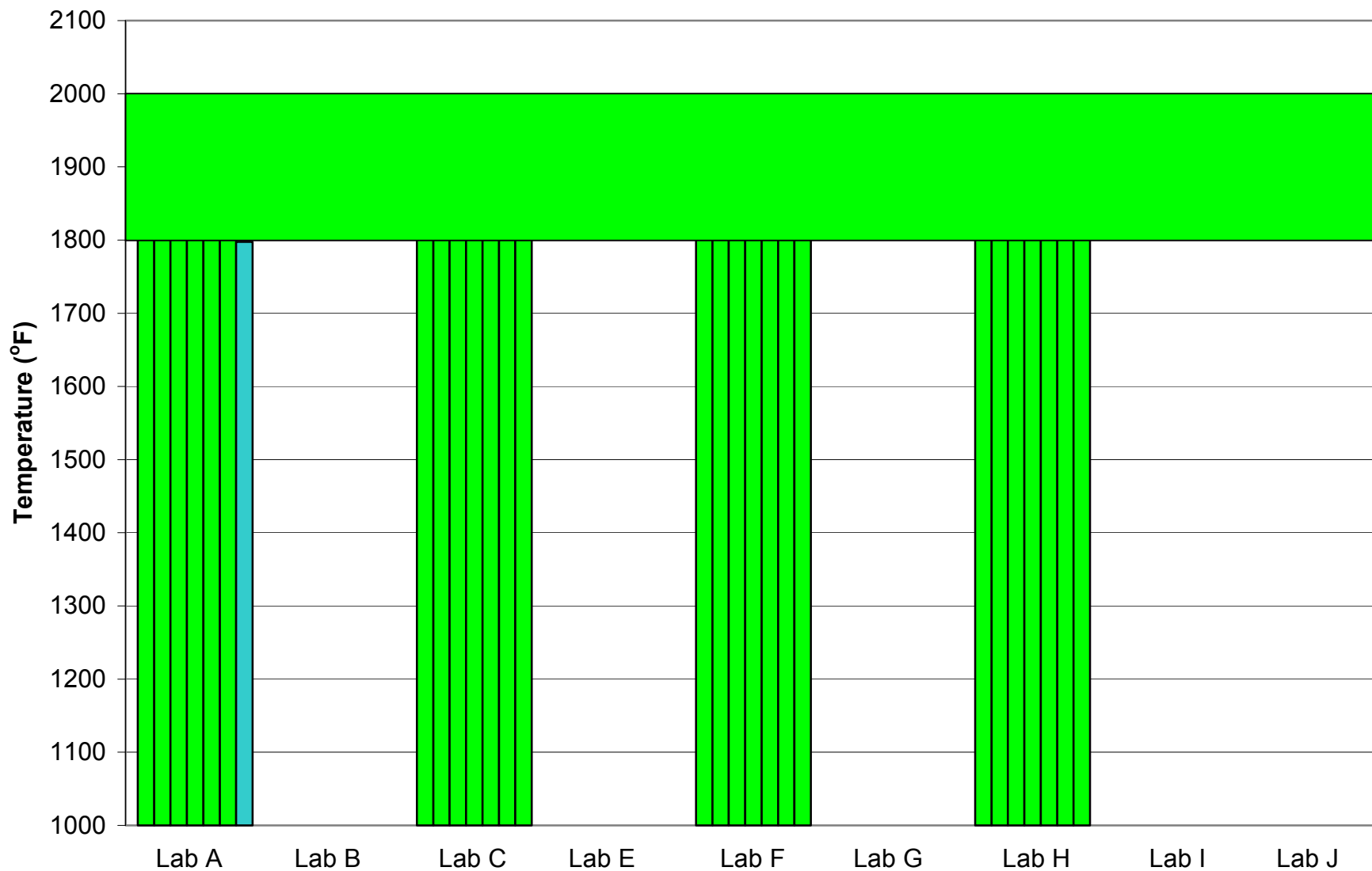
RR VI Temperature Calibration #2



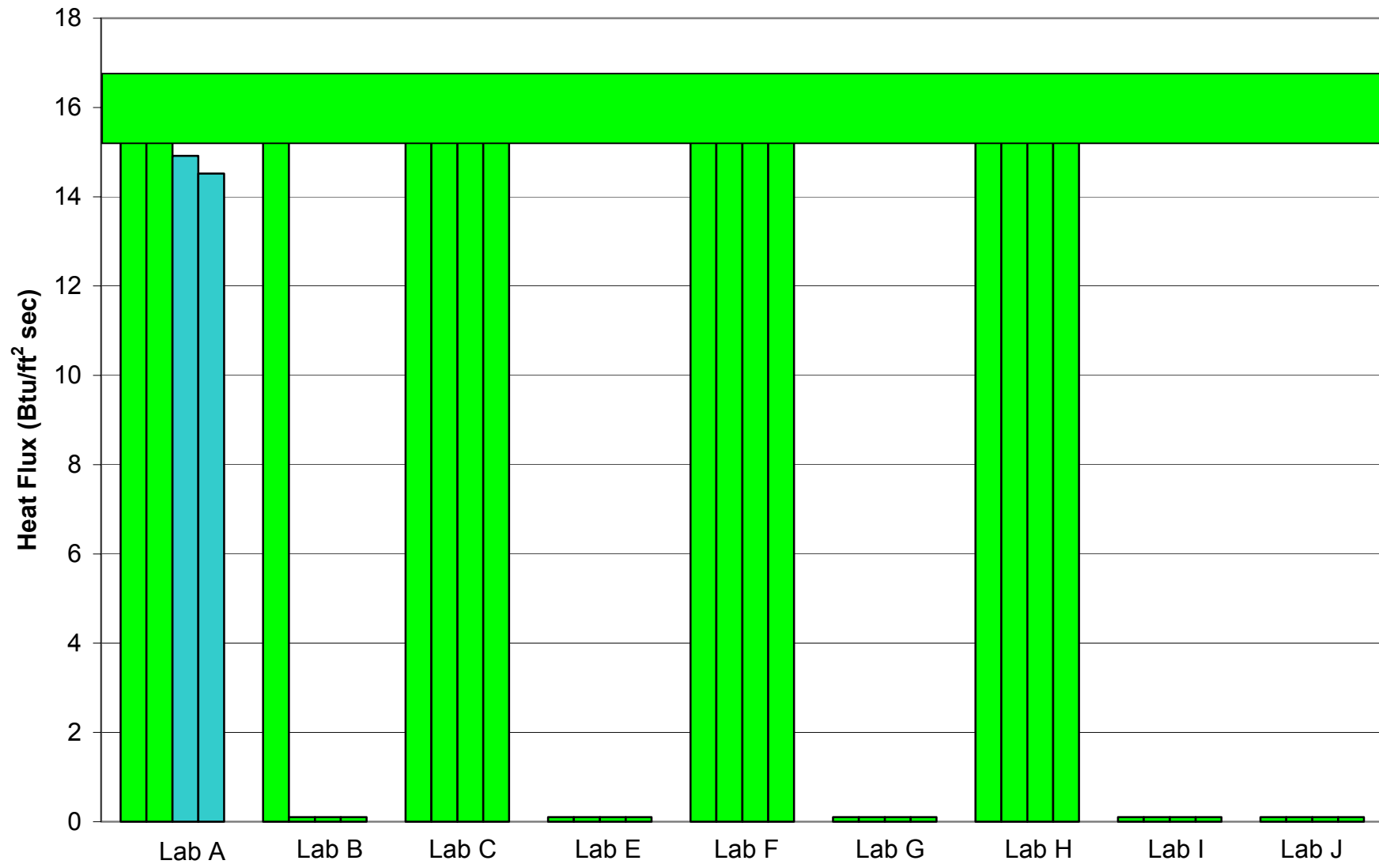
RR VI Temperature Calibration #3



RR VI Temperature Calibration (Final)



RR VI Calibration Heat Flux





RR VI Summary

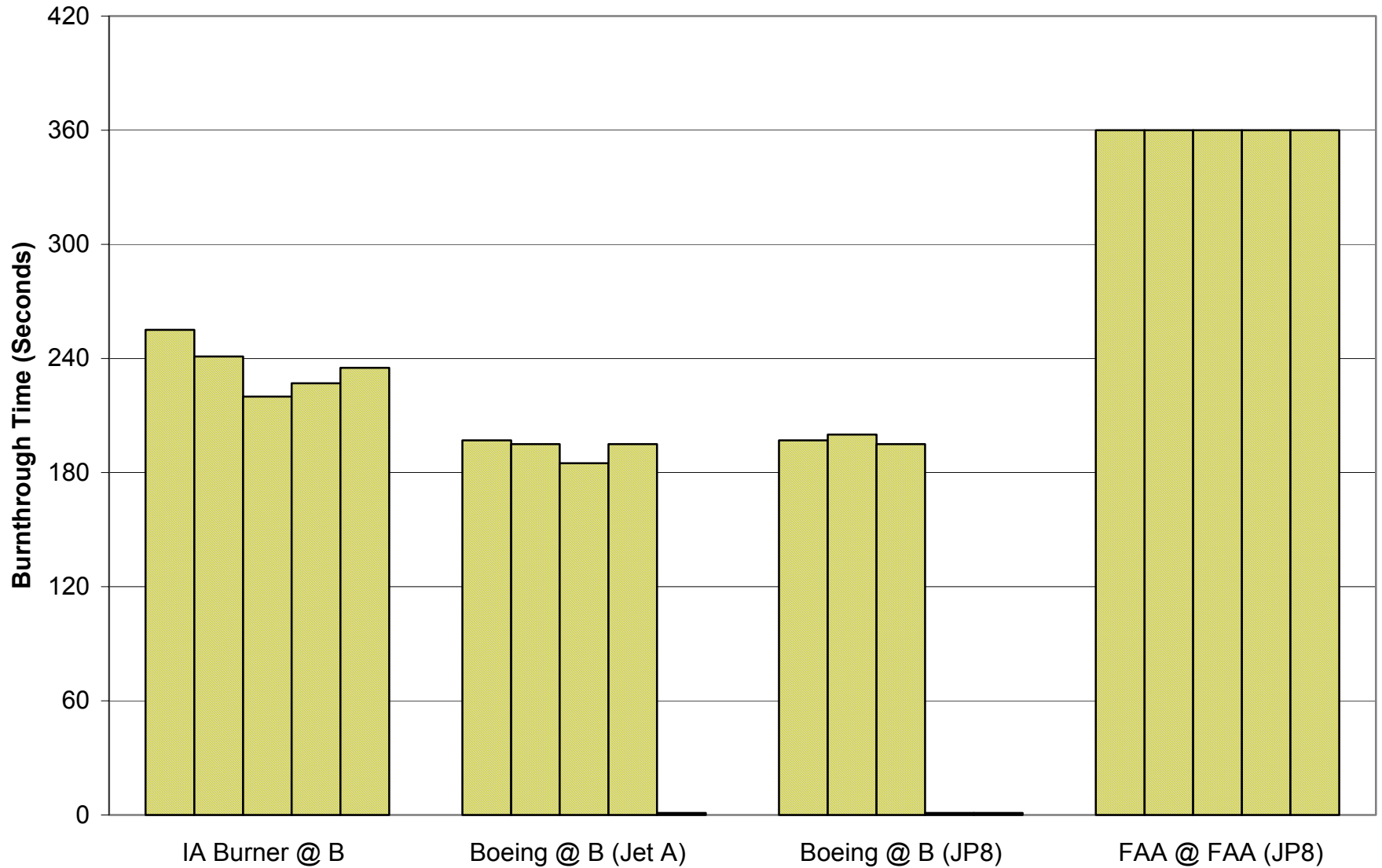
All labs reporting were capable of obtaining correct temperature profile.

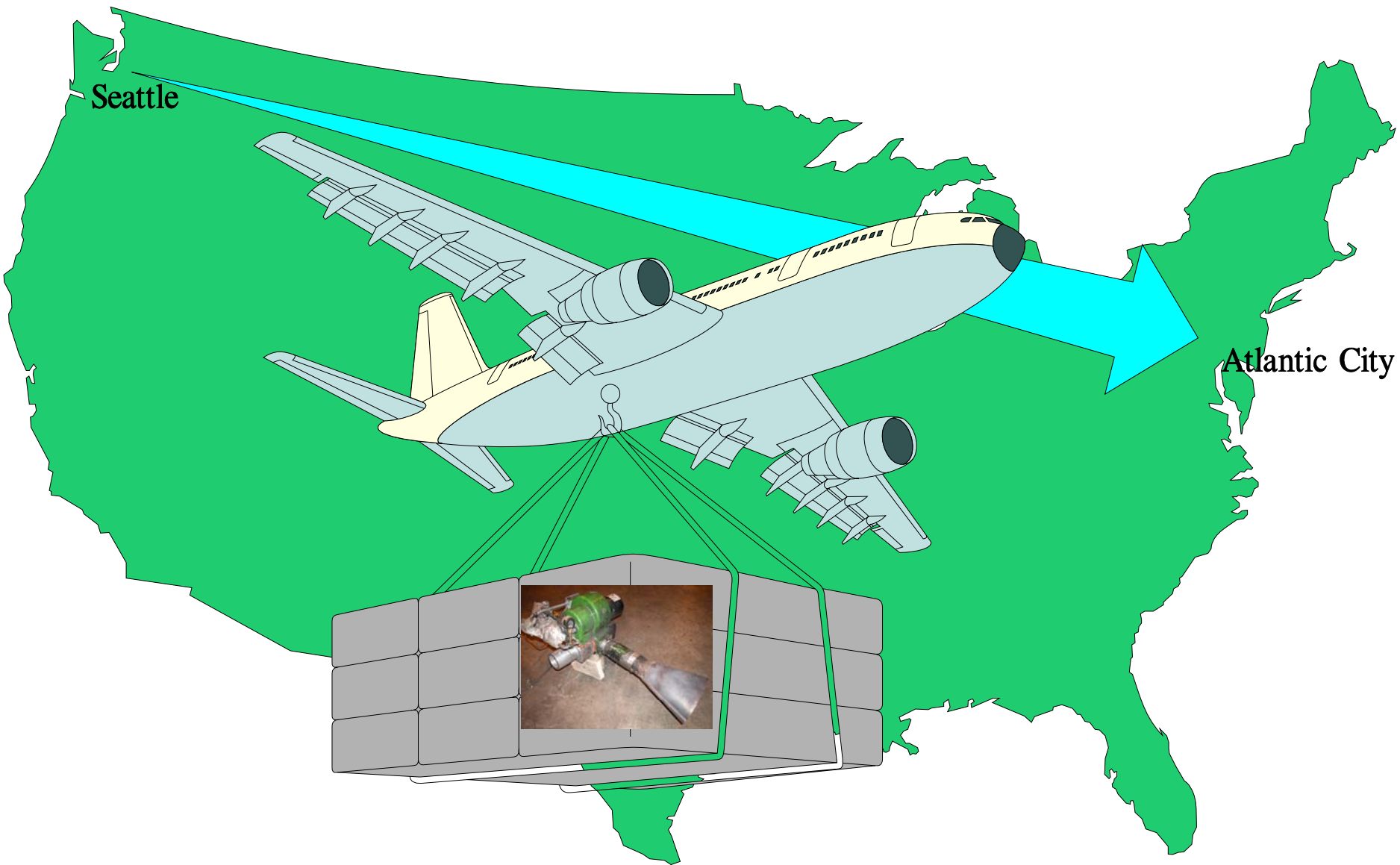
4 of 5 labs reporting were capable of obtaining correct heat flux.

All labs indicate a more severe test than FAA lab; quicker burnthrough times and higher backface heat flux.

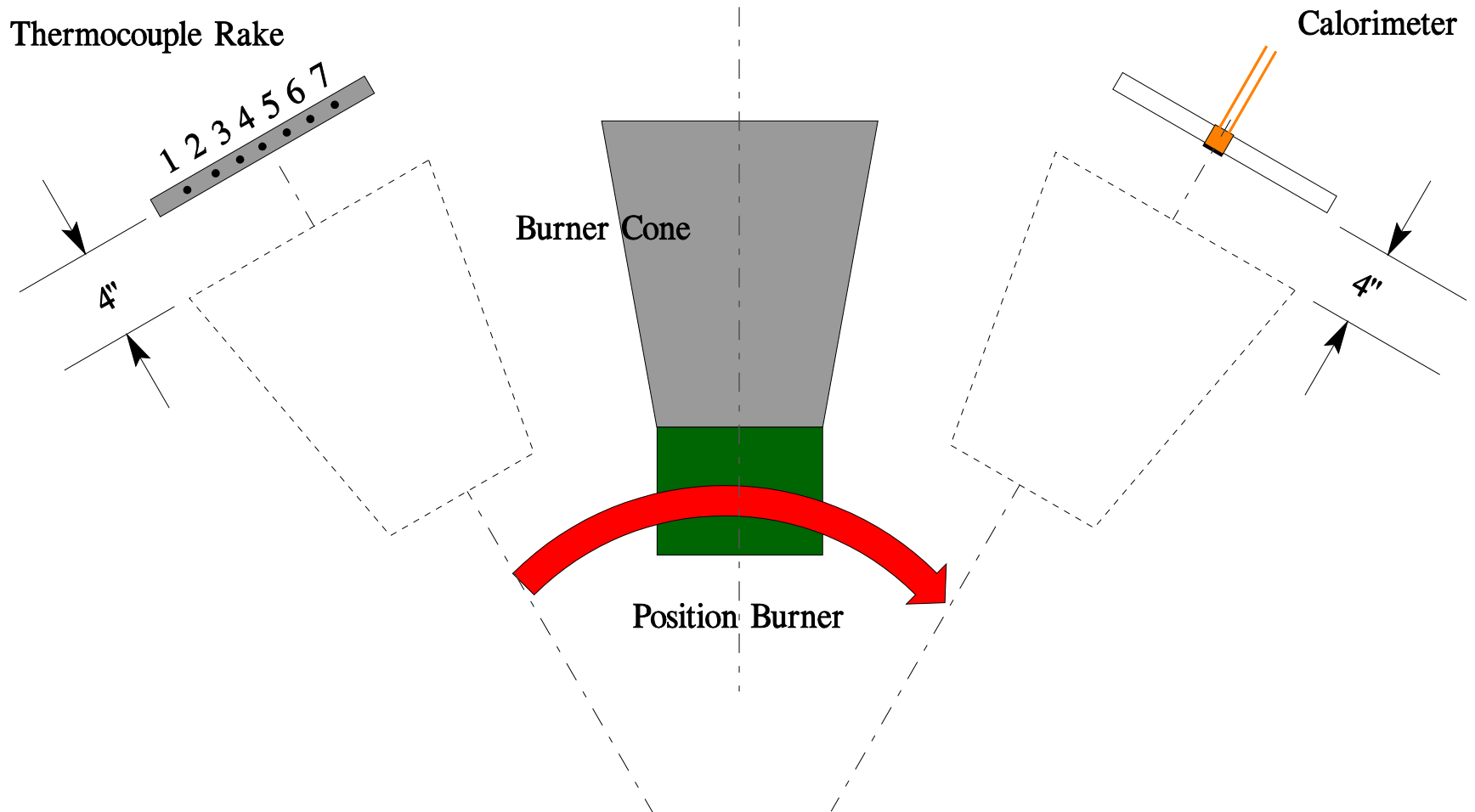
Preliminary Conclusion: Calibration results not always a clear indicator of test results.

Mini Round Robin Using TexTech/Fiberglass Blankets

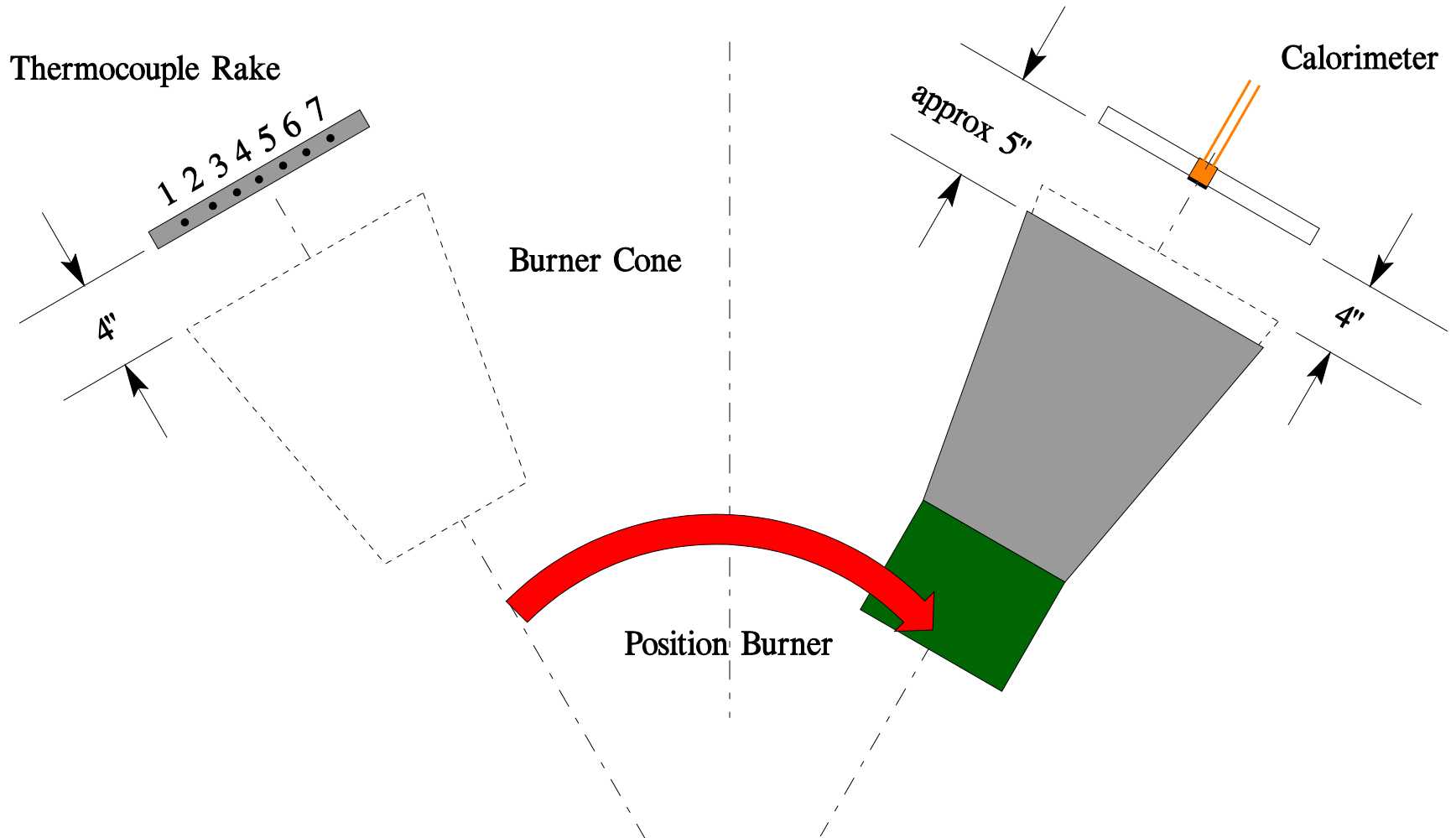




Boeing Burner at FAA Lab



Boeing Burner at FAA Lab



Burnthrough Testing at FAA Lab

	Housing	Stator	Turb	Motor (HP)	Fuel Nozzle	Heat Flux	Test Result	Comments
1	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.74	X	Boeing burner @ FAA lab using Boeing settings
2	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:00	Boeing burner @ FAA lab using Boeing settings
3	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.23	X	Move Boeing draft tube out approx 1 inch
4	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:15	Move Boeing draft tube out approx 1 inch
5	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.12	X	Boeing burner @ FAA lab using FAA settings
6	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Boeing burner with FAA air velocity meter
7	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 0.4-inch wide draft tube restriction ring
8	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 1-inch wide draft tube restriction ring
9	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install smaller I.D. restriction ring in draft tube
10	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Increase air velocity to 2400 fpm
11	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.60	X	Increase air velocity to 2600 fpm
12	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 3:00	premature burnthrough
13	Socket	H215 replicate	F124	1/4	Monarch PL (Boeing)	13.30	X	Install FAA motor on Boeing burner
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15	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	SampleX B/T @ 1:45	Same as previous result
16	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:00	Blankets horizontal
17	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG no B/T	Blankets Vertical
18	Flange	H215 original	F124	1/3	Monarch PL (FAA)	15.63	X	Install Pat's Flanged burner using FAA settings
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Effect of Different Draft Tube?



Flanged vs. Socket Type Housing





FAA Burner
←
Flanged-Type



Boeing Burner
→
Socket-Type

Survey Results: 4 Flanged, 5 Socket

Burner Type

Flanged-Type with re-manufactured H215 stator

Socket-Type with re-manufactured H215 stator

Socket-Type with re-manufactured H215 stator

Flanged-Type with re-manufactured H215 stator

Flanged-Type with original H215 stator

Flanged-Type with re-manufactured H215 stator

Socket-Type with re-manufactured H215 stator

Socket-Type with re-manufactured H215 stator

Socket-Type with re-manufactured H215 stator

Lab A

Lab B

Lab C

Lab E

Lab F

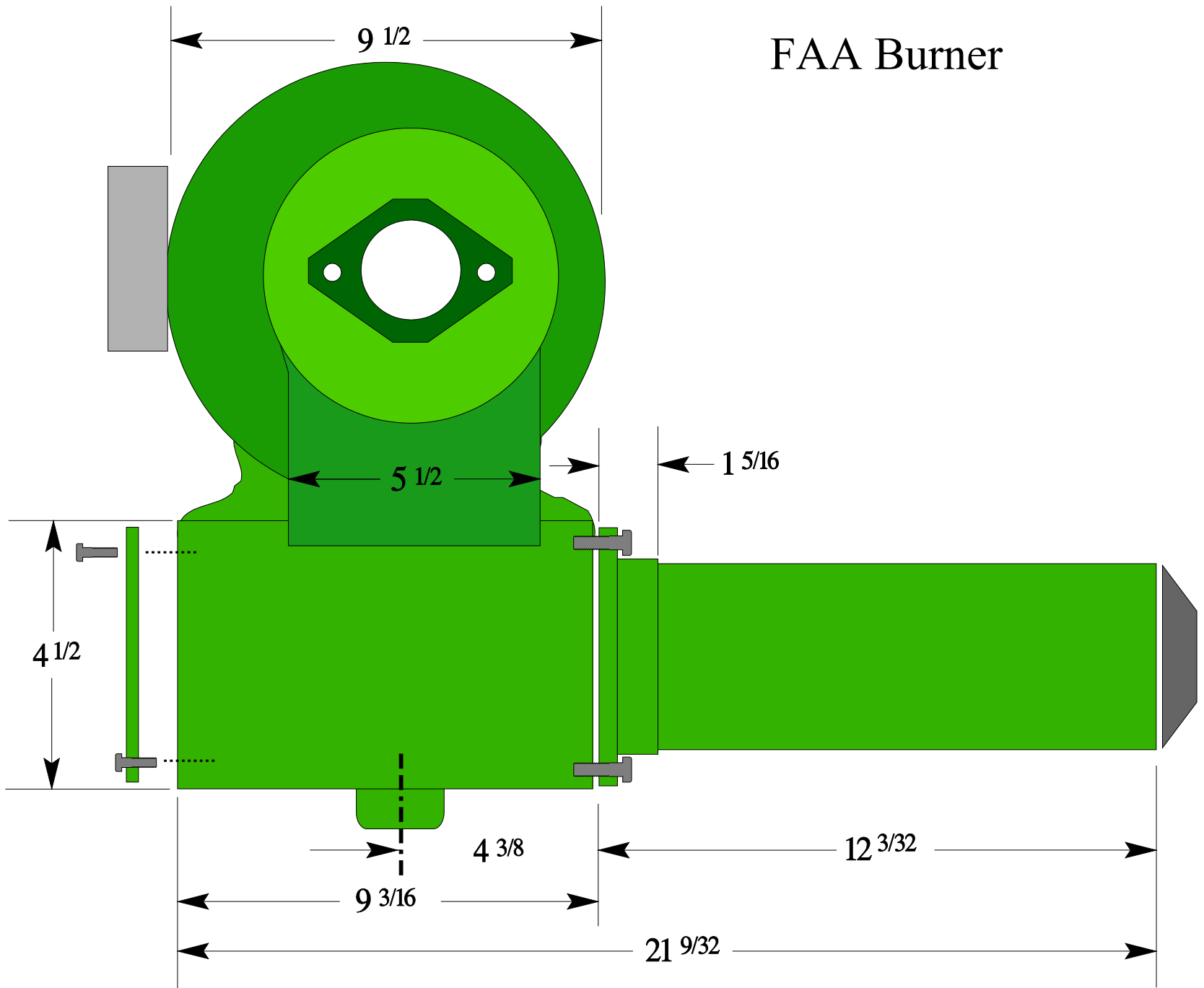
Lab G

Lab H

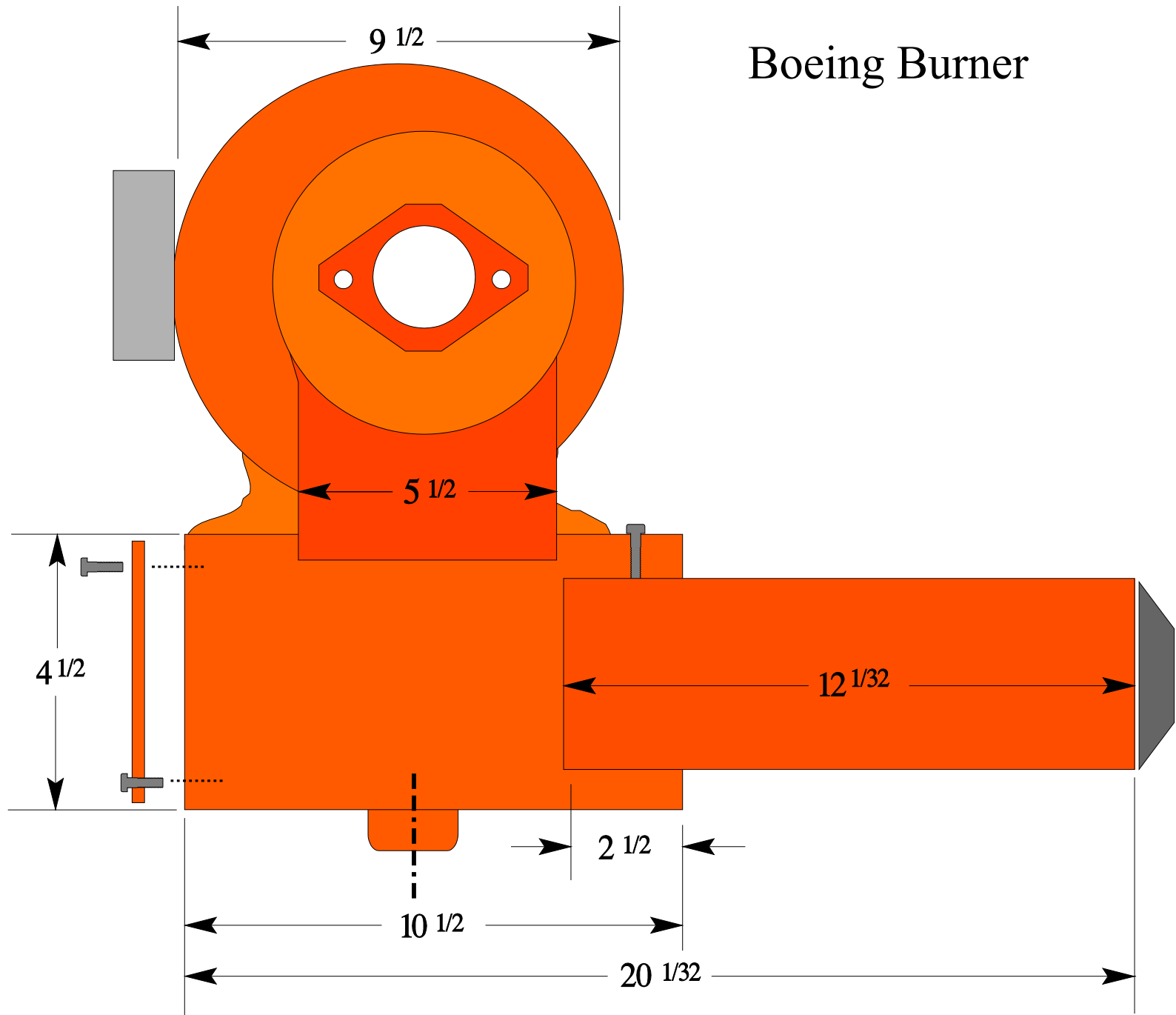
Lab I

Lab J

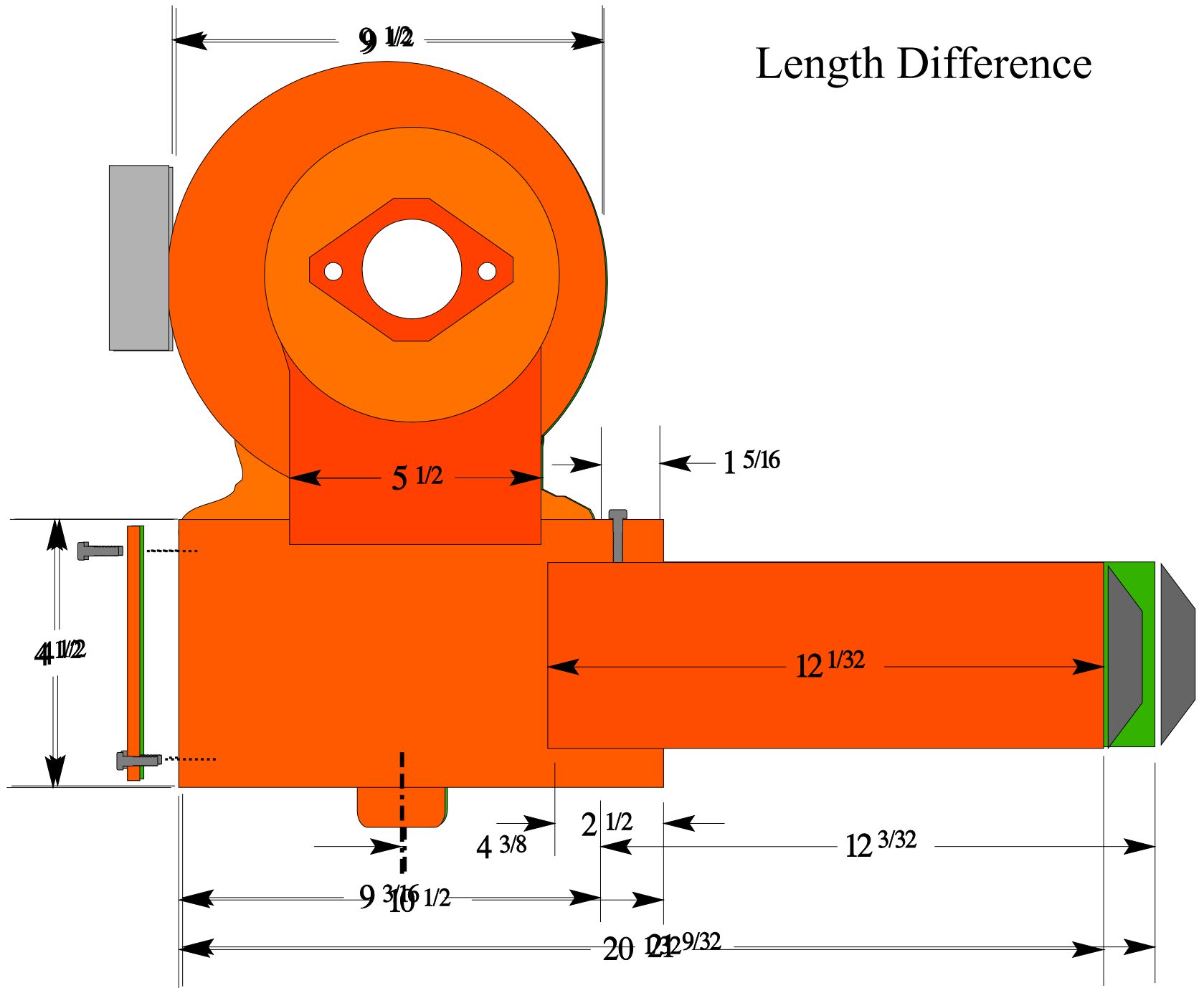
FAA Burner



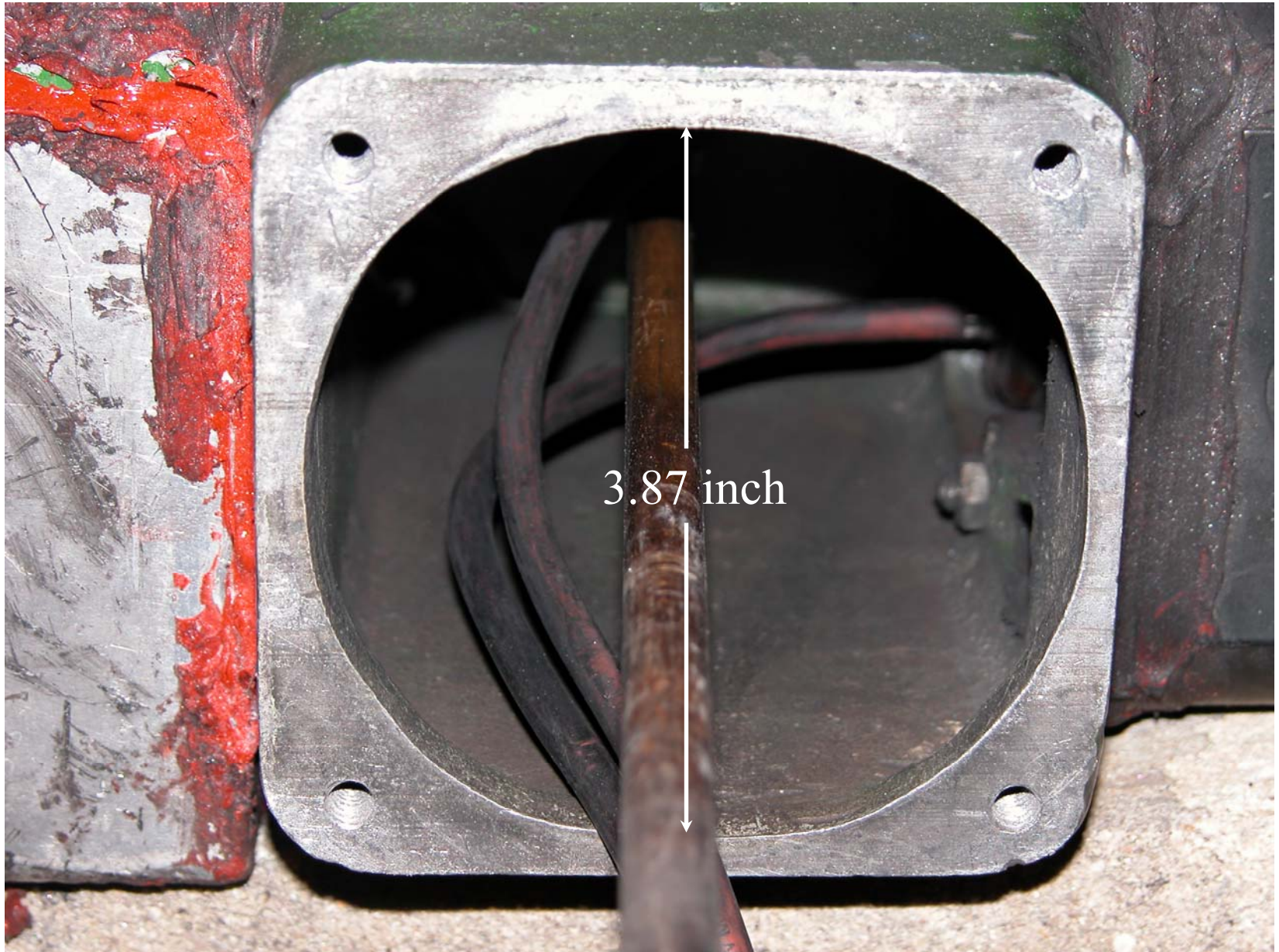
Boeing Burner



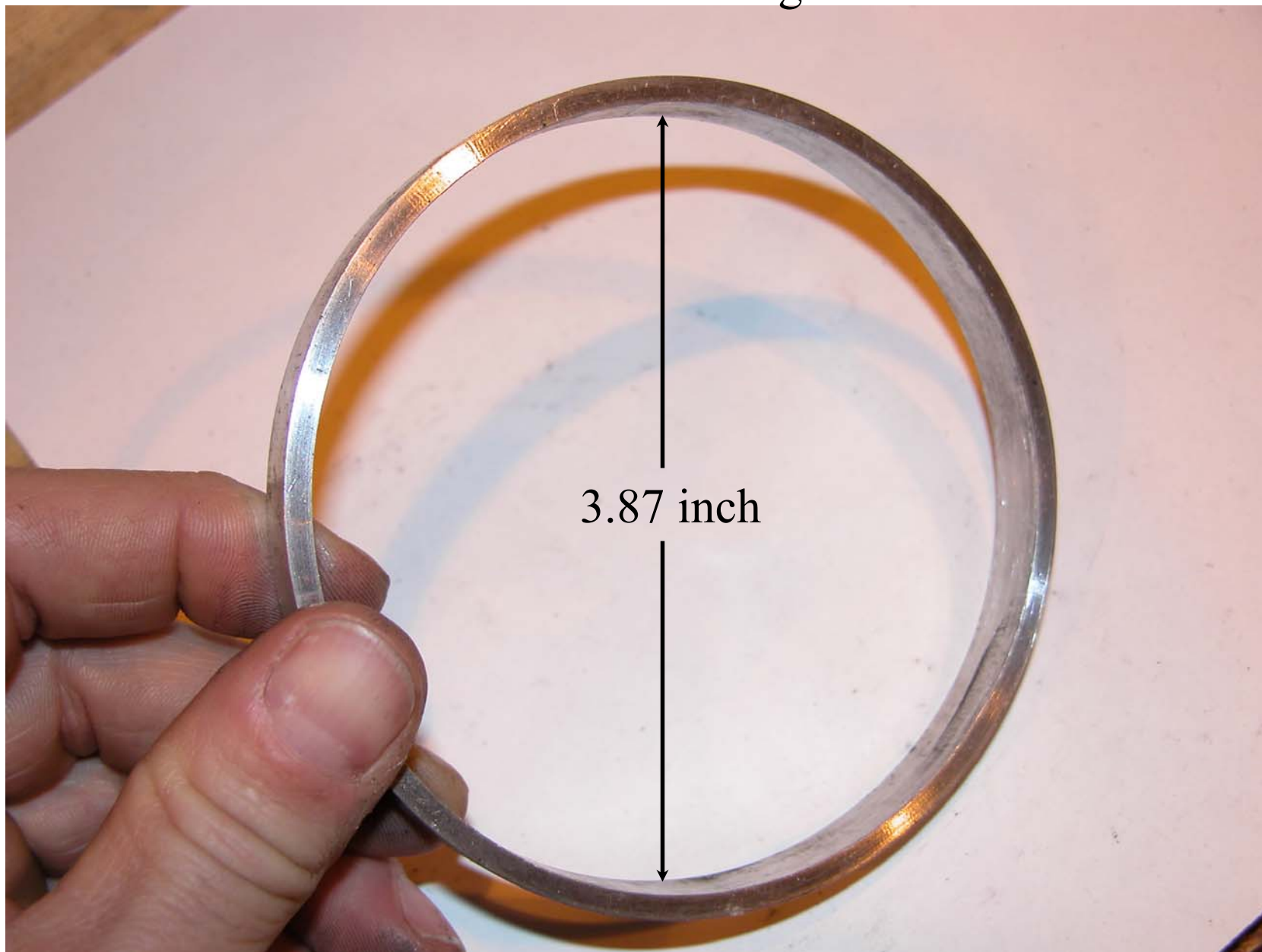
Length Difference



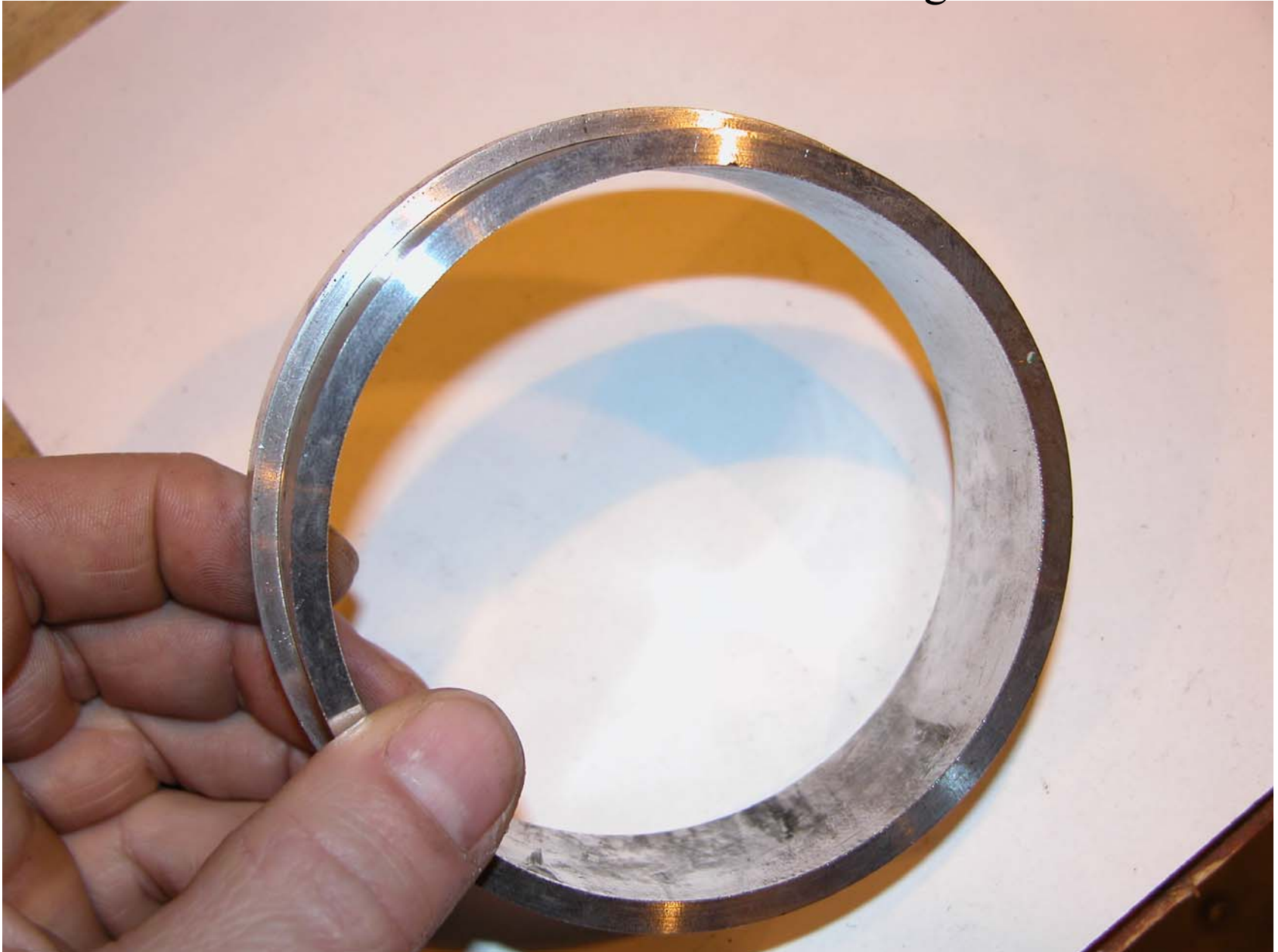
Oval Opening in Flanged Burner



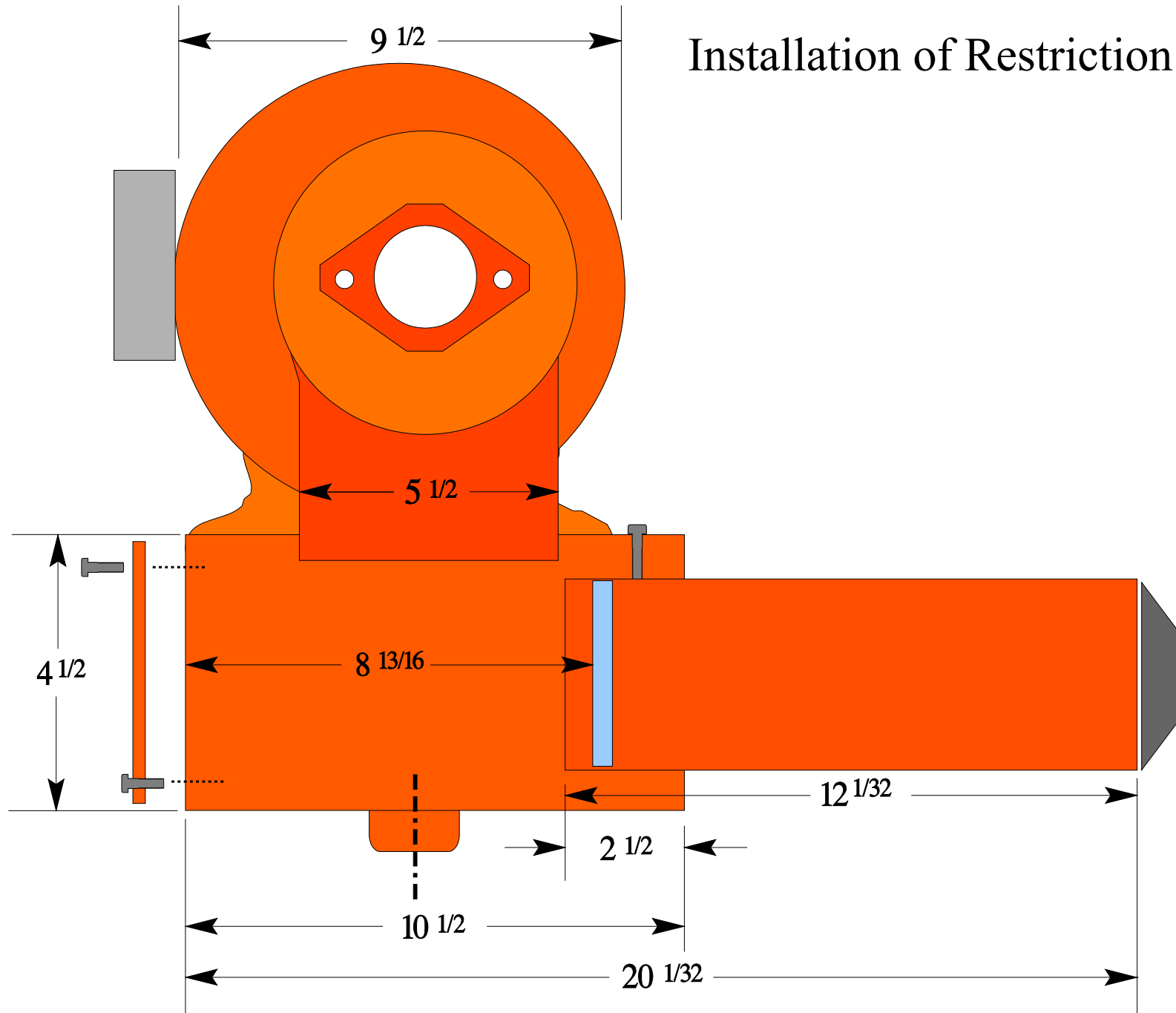
Restriction Ring



Smaller I.D. Restriction Ring



Installation of Restriction Ring



Installation of Restriction Ring



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15	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	SampleX B/T @ 1:45	Same as previous result
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18	Flange	H215 original	F124	1/3	Monarch PL (FAA)	15.63	X	Install Pat's Flanged burner using FAA settings
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FAA Motor
←
1/4 Horsepower



Boeing Motor
→
1/3 Horsepower

FAA Motor



**GE Motors &
Industrial Systems**

**A-C MOTOR
THERMALLY PROTECTED**

STK NO: 4785

- WARNING -

TERMINAL COVER MUST BE IN PLACE FOR SAFE OPERATION.
GROUND IN ACCORDANCE WITH LOCAL & NATIONAL ELECTRICAL CODES.
KEEP FINGERS & OBJECTS AWAY FROM OPENINGS & ROTATING PARTS.
DISCONNECT POWER SOURCES BEFORE TOUCHING INTERNAL PARTS.

MOD 5KH32EN5015BU

HP 1/4

HZ 60

V 115

PH 1

RPM 3450

CODE P

A 4.10

SF 1.00

SFA

FR46N

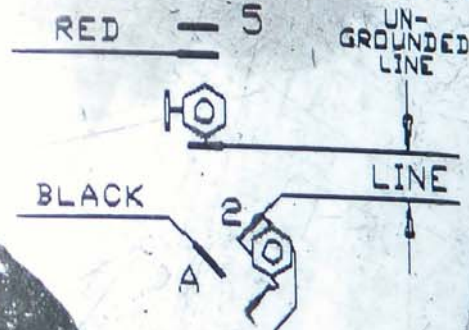
AMB 40 C

**NEMA
DESIGN**

**TIME
RATING CONT**

OIL BURNER DUTY

PUSH BUTTON TO RESET



OPERATION AS SHOWN, TO REVERSE
ROTATION INTERCHANGE BLACK & RED

CAT NO 4785

ACCESSORIES:

OMJ140035



**Assembled in
MEXICO**

Boeing Motor

GENERAL



ELECTRIC

A-C MOTOR
THERMALLY PROTECTED

MOD 5 K C 3 9 Q N 3 1 9 2 U

SER NO XEJ (SA)

HP 1/3 HZ 60

V 115 230 PH 1

RPM 3450 CODE K

OIL BURNER DUTY
PUSH BUTTON TO RESET

A 6.0 / 3.0 SF 1.35

SFA 7.0 / 3.5 FR 48 N

AMB 40 c INSUL CLASS B NEMA DESIGN

TIME RATING CONT.

CAT. N o: 4788

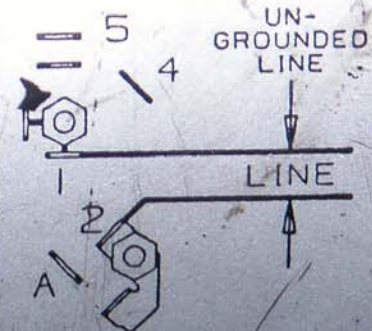
LUBRICATION: SLEEVE BRG—SAE 10 OIL AFTER 3 YRS NORMAL OR 1 YR HEAVY

DUTY BALL BRG—REGREASE AFTER 10 YRS. NORMAL SERVICE

MADE IN MEXICO

VOLTAGE CONNECTIONS

LEAD	LOW VOLT	HIGH VOLT
BROWN	5	4
WHITE	2	5
RED	5	5
BLACK	A	A



CCW ROTATION AS SHOWN. TO REVERSE
ROTATION INTERCHANGE BLACK & RED

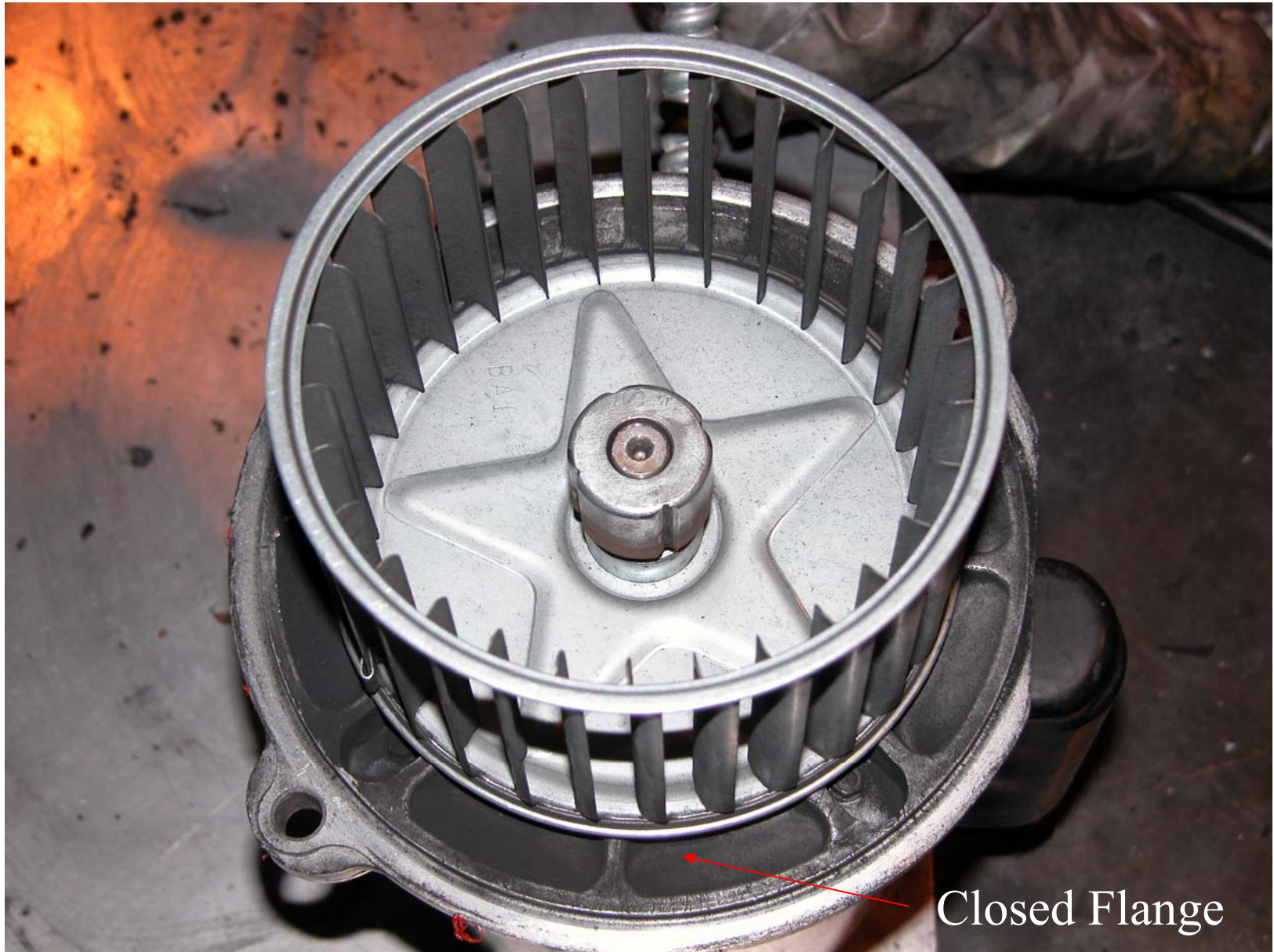
GROUND IN ACCORDANCE WITH LOCAL AND
NATIONAL ELECTRICAL CODES.
KEEP FINGERS AND FOREIGN OBJECTS AWAY
FROM OPENINGS AND ROTATING PARTS

FAA Motor



Open Flange

Boeing Motor



	Housing	Stator	Turb	Motor (HP)	Fuel Nozzle	Heat Flux	Test Result	Comments
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3	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.23	X	Move Boeing draft tube out approx 1 inch
4	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:15	Move Boeing draft tube out approx 1 inch
5	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.12	X	Boeing burner @ FAA lab using FAA settings
6	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Boeing burner with FAA air velocity meter
7	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 0.4-inch wide draft tube restriction ring
8	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 1-inch wide draft tube restriction ring
9	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install smaller I.D. restriction ring in draft tube
10	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Increase air velocity to 2400 fpm
11	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.60	X	Increase air velocity to 2600 fpm
12	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 3:00	premature burnthrough
13	Socket	H215 replicate	F124	1/4	Monarch PL (Boeing)	13.30	X	Install FAA motor on Boeing burner
14	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.30	X	Re-install FAA burner using FAA settings
15	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	SampleX B/T @ 1:45	Same as previous result
16	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:00	Blankets horizontal
17	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG no B/T	Blankets Vertical
18	Flange	H215 original	F124	1/3	Monarch PL (FAA)	15.63	X	Install Pat's Flanged burner using FAA settings
19	Flange	H215 original	F124	1/3	Monarch PL (FAA)	16.27	X	Install Pat's Flanged burner using FAA settings
20	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner
21	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 2:00	Same result as FAA burner
22	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.23	X	Pat's burner w/Boeing stator and ignitors
23	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.12	X	Pat's burner w/Boeing fuel nozzle
24	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.33	X	Pat's burner w/Boeing fuel nozzle
25	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.21	X	Pat's burner w/Boeing fuel nozzle
26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

	Housing	Stator	Turb	Motor (HP)	Fuel Nozzle	Heat Flux	Test Result	Comments
1	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.74	X	Boeing burner @ FAA lab using Boeing settings
2	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:00	Boeing burner @ FAA lab using Boeing settings
3	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.23	X	Move Boeing draft tube out approx 1 inch
4	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:15	Move Boeing draft tube out approx 1 inch
5	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.12	X	Boeing burner @ FAA lab using FAA settings
6	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Boeing burner with FAA air velocity meter
7	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 0.4-inch wide draft tube restriction ring
8	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 1-inch wide draft tube restriction ring
9	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install smaller I.D. restriction ring in draft tube
10	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Increase air velocity to 2400 fpm
11	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.60	X	Increase air velocity to 2600 fpm
12	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 3:00	premature burnthrough
13	Socket	H215 replicate	F124	1/4	Monarch PL (Boeing)	13.30	X	Install FAA motor on Boeing burner
14	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.30	X	Re-install FAA burner using FAA settings
15	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	SampleX B/T @ 1:45	Same as previous result
16	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:00	Blankets horizontal
17	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG no B/T	Blankets Vertical
18	Flange	H215 original	F124	1/3	Monarch PL (FAA)	15.63	X	Install Pat's Flanged burner using FAA settings
19	Flange	H215 original	F124	1/3	Monarch PL (FAA)	16.27	X	Install Pat's Flanged burner using FAA settings
20	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner
21	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 2:00	Same result as FAA burner
22	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.23	X	Pat's burner w/Boeing stator and ignitors
23	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.12	X	Pat's burner w/Boeing fuel nozzle
24	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.33	X	Pat's burner w/Boeing fuel nozzle
25	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.21	X	Pat's burner w/Boeing fuel nozzle
26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

	Housing	Stator	Turb	Motor (HP)	Fuel Nozzle	Heat Flux	Test Result	Comments
1	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.74	X	Boeing burner @ FAA lab using Boeing settings
2	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:00	Boeing burner @ FAA lab using Boeing settings
3	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.23	X	Move Boeing draft tube out approx 1 inch
4	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:15	Move Boeing draft tube out approx 1 inch
5	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.12	X	Boeing burner @ FAA lab using FAA settings
6	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Boeing burner with FAA air velocity meter
7	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 0.4-inch wide draft tube restriction ring
8	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 1-inch wide draft tube restriction ring
9	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install smaller I.D. restriction ring in draft tube
10	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Increase air velocity to 2400 fpm
11	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.60	X	Increase air velocity to 2600 fpm
12	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 3:00	premature burnthrough
13	Socket	H215 replicate	F124	1/4	Monarch PL (Boeing)	13.30	X	Install FAA motor on Boeing burner
14	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.30	X	Re-install FAA burner using FAA settings
15	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	SampleX B/T @ 1:45	Same as previous result
16	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:00	Blankets horizontal
17	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG no B/T	Blankets Vertical
18	Flange	H215 original	F124	1/3	Monarch PL (FAA)	15.63	X	Install Pat's Flanged burner using FAA settings
19	Flange	H215 original	F124	1/3	Monarch PL (FAA)	16.27	X	Install Pat's Flanged burner using FAA settings
20	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner
21	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 2:00	Same result as FAA burner
22	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.23	X	Pat's burner w/Boeing stator and ignitors
23	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.12	X	Pat's burner w/Boeing fuel nozzle
24	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.33	X	Pat's burner w/Boeing fuel nozzle
25	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.21	X	Pat's burner w/Boeing fuel nozzle
26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

	Housing	Stator	Turb	Motor (HP)	Fuel Nozzle	Heat Flux	Test Result	Comments
1	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.74	X	Boeing burner @ FAA lab using Boeing settings
2	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:00	Boeing burner @ FAA lab using Boeing settings
3	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.23	X	Move Boeing draft tube out approx 1 inch
4	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:15	Move Boeing draft tube out approx 1 inch
5	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.12	X	Boeing burner @ FAA lab using FAA settings
6	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Boeing burner with FAA air velocity meter
7	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 0.4-inch wide draft tube restriction ring
8	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 1-inch wide draft tube restriction ring
9	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install smaller I.D. restriction ring in draft tube
10	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Increase air velocity to 2400 fpm
11	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.60	X	Increase air velocity to 2600 fpm
12	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 3:00	premature burnthrough
13	Socket	H215 replicate	F124	1/4	Monarch PL (Boeing)	13.30	X	Install FAA motor on Boeing burner
14	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.30	X	Re-install FAA burner using FAA settings
15	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	SampleX B/T @ 1:45	Same as previous result
16	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:00	Blankets horizontal
17	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG no B/T	Blankets Vertical
18	Flange	H215 original	F124	1/3	Monarch PL (FAA)	15.63	X	Install Pat's Flanged burner using FAA settings
19	Flange	H215 original	F124	1/3	Monarch PL (FAA)	16.27	X	Install Pat's Flanged burner using FAA settings
20	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner
21	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 2:00	Same result as FAA burner
22	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.23	X	Pat's burner w/Boeing stator and ignitors
23	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.12	X	Pat's burner w/Boeing fuel nozzle
24	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.33	X	Pat's burner w/Boeing fuel nozzle
25	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.21	X	Pat's burner w/Boeing fuel nozzle
26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

	Housing	Stator	Turb	Motor (HP)	Fuel Nozzle	Heat Flux	Test Result	Comments
1	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.74	X	Boeing burner @ FAA lab using Boeing settings
2	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:00	Boeing burner @ FAA lab using Boeing settings
3	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.23	X	Move Boeing draft tube out approx 1 inch
4	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 4:15	Move Boeing draft tube out approx 1 inch
5	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.12	X	Boeing burner @ FAA lab using FAA settings
6	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Boeing burner with FAA air velocity meter
7	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 0.4-inch wide draft tube restriction ring
8	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install 1-inch wide draft tube restriction ring
9	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.30	X	Install smaller I.D. restriction ring in draft tube
10	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.50	X	Increase air velocity to 2400 fpm
11	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	13.60	X	Increase air velocity to 2600 fpm
12	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	X	TTFG B/T @ 3:00	premature burnthrough
13	Socket	H215 replicate	F124	1/4	Monarch PL (Boeing)	13.30	X	Install FAA motor on Boeing burner
14	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.30	X	Re-install FAA burner using FAA settings
15	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	SampleX B/T @ 1:45	Same as previous result
16	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:00	Blankets horizontal
17	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG no B/T	Blankets Vertical
18	Flange	H215 original	F124	1/3	Monarch PL (FAA)	15.63	X	Install Pat's Flanged burner using FAA settings
19	Flange	H215 original	F124	1/3	Monarch PL (FAA)	16.27	X	Install Pat's Flanged burner using FAA settings
20	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner
21	Flange	H215 original	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 2:00	Same result as FAA burner
22	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.23	X	Pat's burner w/Boeing stator and ignitors
23	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.12	X	Pat's burner w/Boeing fuel nozzle
24	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.33	X	Pat's burner w/Boeing fuel nozzle
25	Flange	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.21	X	Pat's burner w/Boeing fuel nozzle
26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

Boeing PL Nozzle



FAA PL Nozzle



Boeing PL Nozzle



FAA PL Nozzle



Boeing PL Nozzle



FAA PL Nozzle



26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

29	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.77	X	Boeing burner w/Boeing fuel nozzle*
30	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.79	X	Boeing burner w/Boeing fuel nozzle*
31	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.96	X	Boeing burner w/Boeing fuel nozzle*

32	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.17	X	Boeing burner w/FAA fuel nozzle
33	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.30	X	Boeing burner w/FAA fuel nozzle
34	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.45	X	Boeing burner w/FAA fuel nozzle

1 week later...

35	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	15.61	X	Boeing burner w/FAA fuel nozzle
36	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.14	X	Boeing burner w/FAA fuel nozzle
37	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 1:00	Quicker burnthrough than FAA burner
38	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 1:00	Quicker burnthrough than FAA burner
39	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner

40	Socket	H215 replicate	F124	1/3	Monarch PLP	13.99	X	Boeing burner w/PLP fuel nozzle
41	Socket	H215 replicate	F124	1/3	Monarch PLP	14.15	X	Boeing burner w/PLP fuel nozzle
42	Socket	H215 replicate	F124	1/3	Monarch PLP	14.27	X	Boeing burner w/PLP fuel nozzle

new batch of blankets...

43	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG B/T @ 4:45	Quicker burnthrough than previous
44	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG B/T @ 5:40	Quicker burnthrough than previous

reinstall original FAA burner...

45	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.60	X	Re-install FAA burner using FAA settings
46	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:55	Same result as Boeing burner
47	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 5:50	Same result as Boeing burner

* FAA burner cone, FAA air velocity meter, fuel nozzle cleaned, ignitor box sealed

26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

29	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.77	X	Boeing burner w/Boeing fuel nozzle*
30	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.79	X	Boeing burner w/Boeing fuel nozzle*
31	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.96	X	Boeing burner w/Boeing fuel nozzle*

32	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.17	X	Boeing burner w/FAA fuel nozzle
33	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.30	X	Boeing burner w/FAA fuel nozzle
34	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.45	X	Boeing burner w/FAA fuel nozzle

1 week later...

35	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	15.61	X	Boeing burner w/FAA fuel nozzle
36	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.14	X	Boeing burner w/FAA fuel nozzle
37	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 1:00	Quicker burnthrough than FAA burner
38	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 1:00	Quicker burnthrough than FAA burner
39	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner

40	Socket	H215 replicate	F124	1/3	Monarch PLP	13.99	X	Boeing burner w/PLP fuel nozzle
41	Socket	H215 replicate	F124	1/3	Monarch PLP	14.15	X	Boeing burner w/PLP fuel nozzle
42	Socket	H215 replicate	F124	1/3	Monarch PLP	14.27	X	Boeing burner w/PLP fuel nozzle

new batch of blankets...

43	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG B/T @ 4:45	Quicker burnthrough than previous
44	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG B/T @ 5:40	Quicker burnthrough than previous

reinstall original FAA burner...

45	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.60	X	Re-install FAA burner using FAA settings
46	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:55	Same result as Boeing burner
47	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 5:50	Same result as Boeing burner

* FAA burner cone, FAA air velocity meter, fuel nozzle cleaned, ignitor box sealed

26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

29	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.77	X	Boeing burner w/Boeing fuel nozzle*
30	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.79	X	Boeing burner w/Boeing fuel nozzle*
31	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.96	X	Boeing burner w/Boeing fuel nozzle*

32	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.17	X	Boeing burner w/FAA fuel nozzle
33	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.30	X	Boeing burner w/FAA fuel nozzle
34	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.45	X	Boeing burner w/FAA fuel nozzle

1 week later...

35	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	15.61	X	Boeing burner w/FAA fuel nozzle
36	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	16.14	X	Boeing burner w/FAA fuel nozzle
37	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 1:00	Quicker burnthrough than FAA burner
38	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	SampleX B/T @ 1:00	Quicker burnthrough than FAA burner
39	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG no B/T	Same result as FAA burner

40	Socket	H215 replicate	F124	1/3	Monarch PLP	13.99	X	Boeing burner w/PLP fuel nozzle
41	Socket	H215 replicate	F124	1/3	Monarch PLP	14.15	X	Boeing burner w/PLP fuel nozzle
42	Socket	H215 replicate	F124	1/3	Monarch PLP	14.27	X	Boeing burner w/PLP fuel nozzle

new batch of blankets...

43	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG B/T @ 4:45	Quicker burnthrough than previous
44	Socket	H215 replicate	F124	1/3	Monarch PL (FAA)	X	TTFG B/T @ 5:40	Quicker burnthrough than previous

reinstall original FAA burner...

45	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.60	X	Re-install FAA burner using FAA settings
46	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 4:55	Same result as Boeing burner
47	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 5:50	Same result as Boeing burner

* FAA burner cone, FAA air velocity meter, fuel nozzle cleaned, ignitor box sealed

Boeing PL



FAA PL



PLP Nozzle



Boeing PL



FAA PL



PLP Nozzle



26	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	15.81	X	Pat's burner w/FAA fuel nozzle
27	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.06	X	Pat's burner w/FAA fuel nozzle
28	Flange	H215 replicate	F124	1/3	Monarch PL (FAA)	16.22	X	Pat's burner w/FAA fuel nozzle

29	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.77	X	Boeing burner w/Boeing fuel nozzle*
30	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.79	X	Boeing burner w/Boeing fuel nozzle*
31	Socket	H215 replicate	F124	1/3	Monarch PL (Boeing)	14.96	X	Boeing burner w/Boeing fuel nozzle*

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new batch of blankets...

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reinstall original FAA burner...

45	Flange	H215 original	F124	1/4	Monarch PL (FAA)	15.60	X	Re-install FAA burner using FAA settings
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47	Flange	H215 original	F124	1/4	Monarch PL (FAA)	X	TTFG B/T @ 5:50	Same result as Boeing burner

* FAA burner cone, FAA air velocity meter, fuel nozzle cleaned, ignitor box sealed

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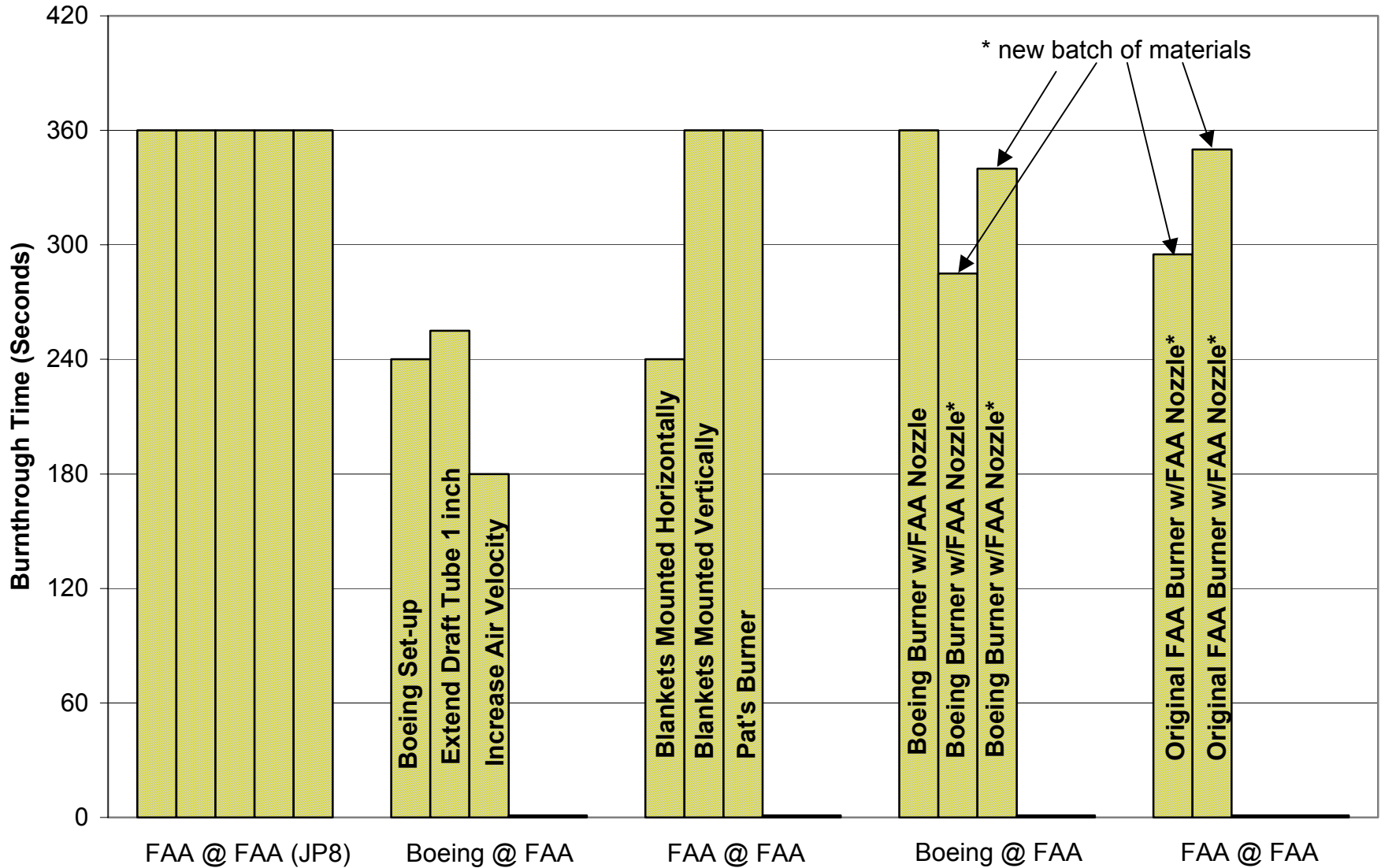
reinstall original FAA burner...

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* FAA burner cone, FAA air velocity meter, fuel nozzle cleaned, ignitor box sealed

Summary of Tests

Testing at FAATC Using TexTech/Fiberglass Blankets





Conclusions

Various types of motors do not impact heat flux or burnthrough times.

Replicate stator does not impact heat flux or burnthrough times.

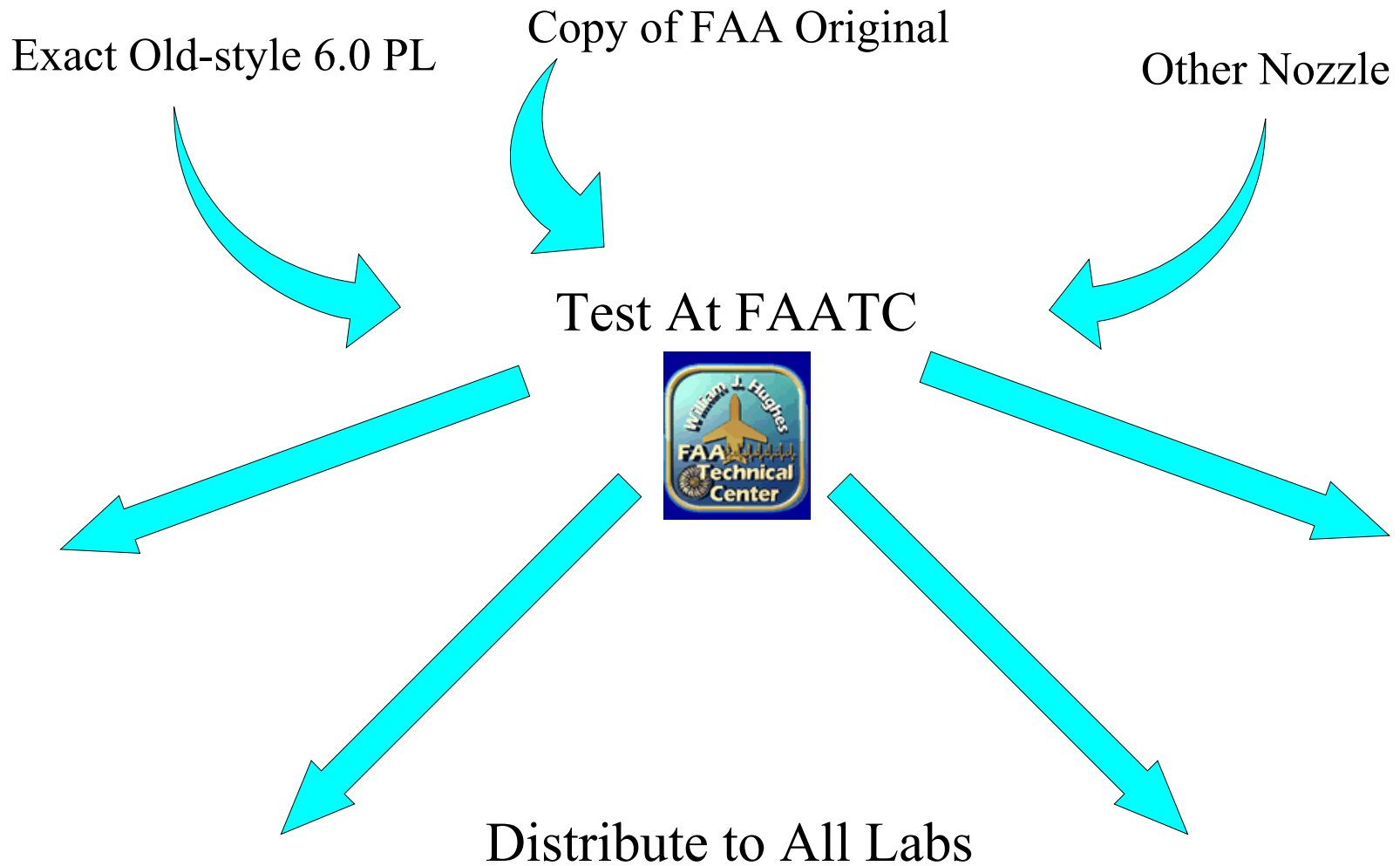
Difference in housing/draft tube does not impact temperature or heat flux.

Difference in fuel nozzle impacts both heat flux and burnthrough times.

More testing needed to determine impact of housing on burnthrough time.



Obtain “Appropriate” Nozzles



Discussion with Monarch

Early nozzles inscribed with “F-80” (generic drawing description)

Internal swirl disc
stamped into shape



Original FAA Nozzle

Discussion with Monarch

Late 1980's, change from "F-80" to "MTD-92" (material tolerance description)



Discussion with Monarch

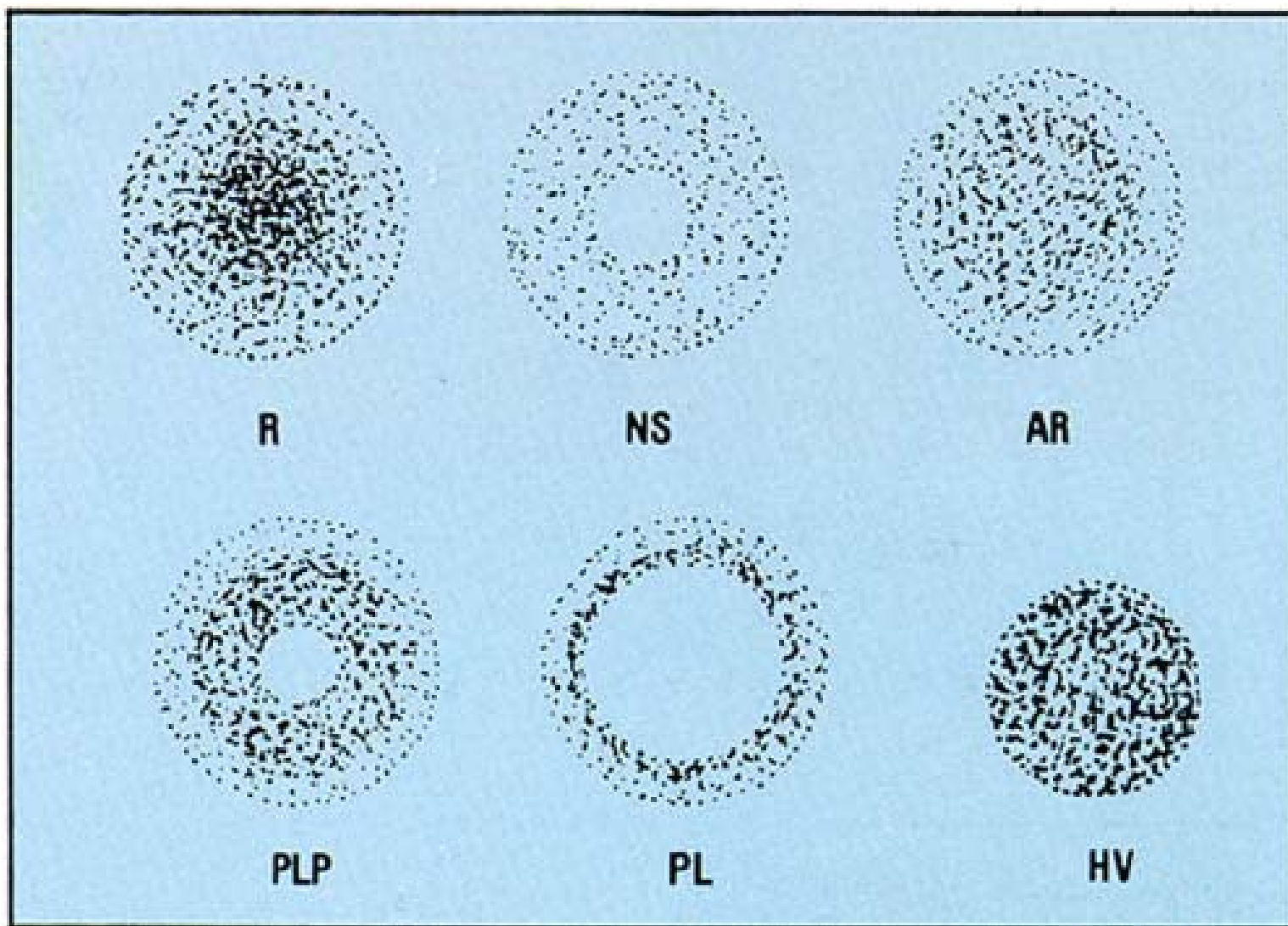
Early 1990's no inscription, but rather a production number (for example "9 7")

Late Production Nozzle
distributed to ALL labs
in September 2000



Internal swirl disc
machined into shape
using precision cutters

Monarch Nozzle Spray Patterns

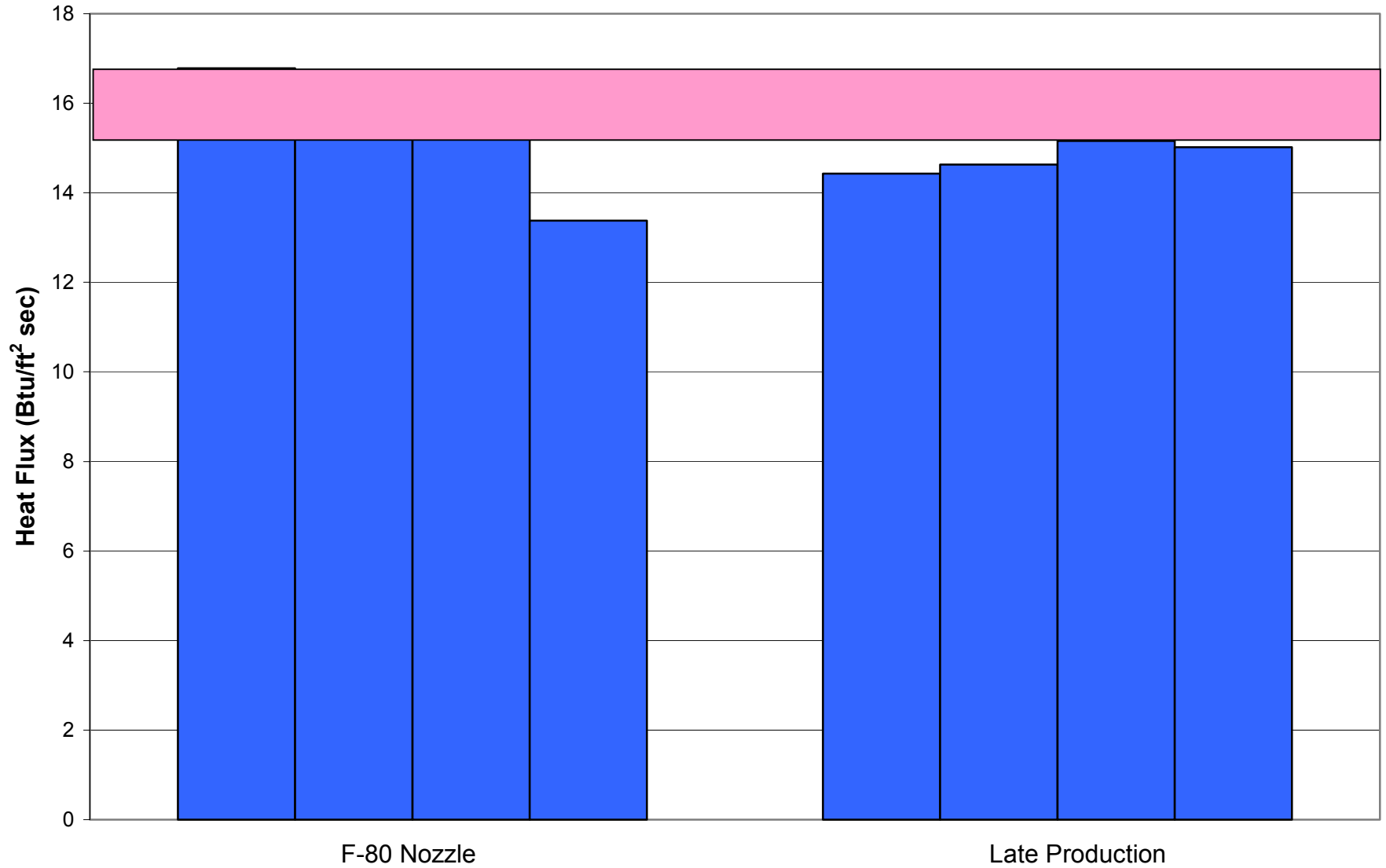


Nozzle Rotation Tests

Test #	Nozzle Type	Monarch Letter Orientation	Heat Flux (Btu/ft ² sec)	Heat Flux Average
1	F-80	3 o'clock	16.56	16.78
2	F-80	3 o'clock	16.62	
3	F-80	3 o'clock	17.16	
4	F-80	6 o'clock	15.52	15.71
5	F-80	6 o'clock	15.88	
6	F-80	6 o'clock	15.74	
7	F-80	9 o'clock	15.08	15.47
8	F-80	9 o'clock	15.55	
9	F-80	9 o'clock	15.79	
10	F-80	12 o'clock	13.37	13.38
11	F-80	12 o'clock	13.51	
12	F-80	12 o'clock	13.26	

Test #	Nozzle Type	Monarch Letter Orientation	Heat Flux (Btu/ft ² sec)	Heat Flux Average
13	Late Production	3 o'clock	14.17	14.43
14	Late Production	3 o'clock	14.43	
15	Late Production	3 o'clock	14.69	
16	Late Production	6 o'clock	14.29	14.63
17	Late Production	6 o'clock	14.69	
18	Late Production	6 o'clock	14.92	
19	Late Production	9 o'clock	14.80	15.16
20	Late Production	9 o'clock	15.35	
21	Late Production	9 o'clock	15.34	
22	Late Production	12 o'clock	14.77	15.02
23	Late Production	12 o'clock	15.05	
24	Late Production	12 o'clock	15.23	

Nozzle Rotation Testing



Prototype Nozzle Developed by Monarch

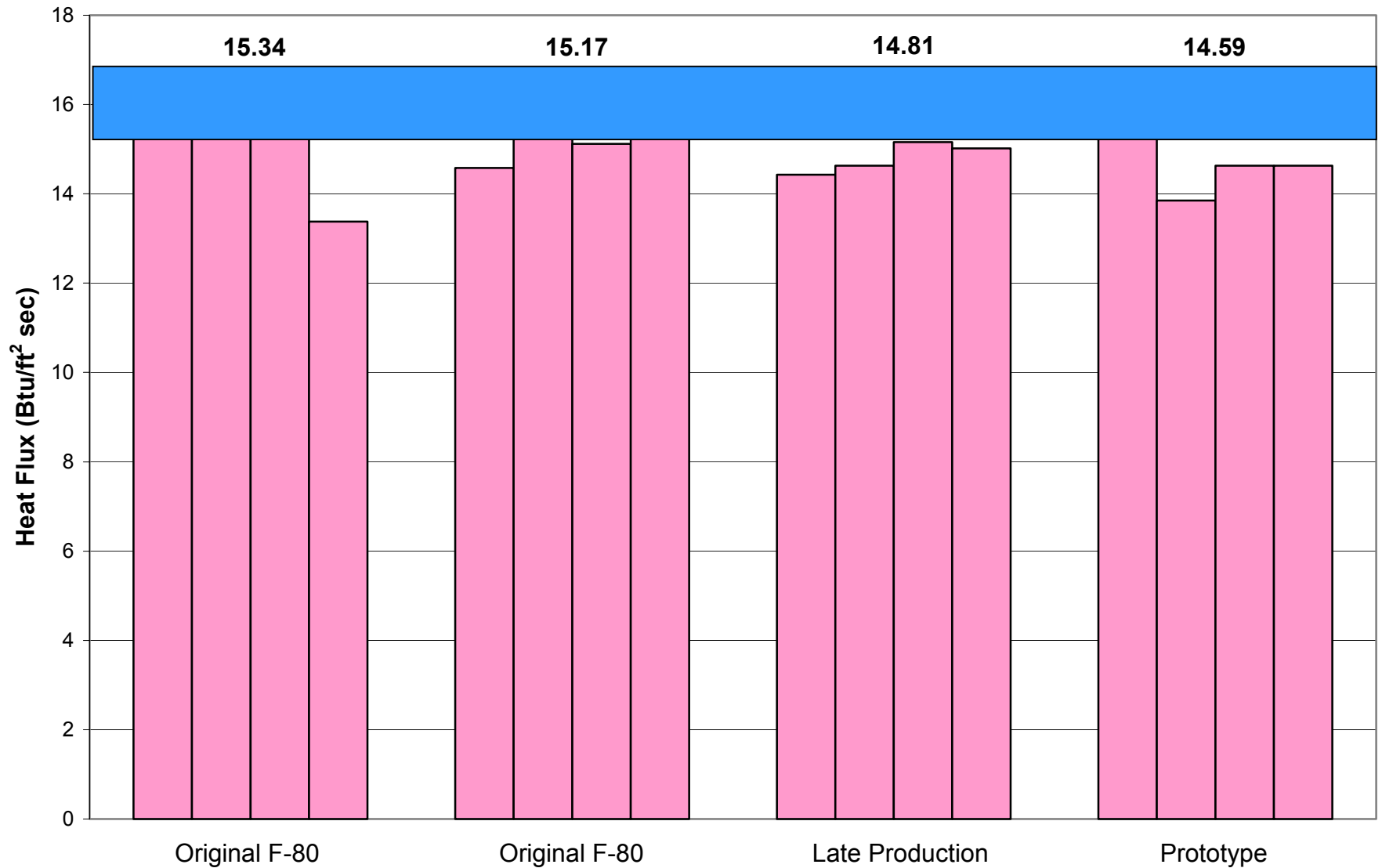


Swirl disc copied from
original FAA nozzle



Heat Flux Comparison of Nozzles

Nozzle Comparison



Additional Testing of Prototype Nozzles

Test #	Nozzle Type	Heat Flux (Btu/ft² sec)	Heat Flux Average
1	Prototype 1	14.27	14.46
2	Prototype 1	14.61	
3	Prototype 1	14.51	
4	Prototype 2	14.77	14.88
5	Prototype 2	14.83	
6	Prototype 2	15.03	
7	Prototype 3	14.35	14.42
8	Prototype 3	14.41	
9	Prototype 3	14.49	
10	Prototype 4	14.34	14.49
11	Prototype 4	14.54	
12	Prototype 4	14.59	

6.5 GPH 80° PL “old style” F-80



Evaluation of Monarch 6.5 GPH 80° PL

Nozzle	Std Flowrate @ 100 psi	Fuel Pressure	Adjusted Flowrate	Heat Flux (Btu/ft ² sec)
6.0 80° PL	6.0	107	6.02	15.60
6.5 80° PL	6.5	107	6.52	16.03
6.5 80° PL	6.5	97	6.04	15.26
6.5 80° PL	6.5	97	6.04	15.59

Evaluation of Monarch 6.5 GPH 80° PL

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Evaluation of Monarch 6.5 GPH 80° PL

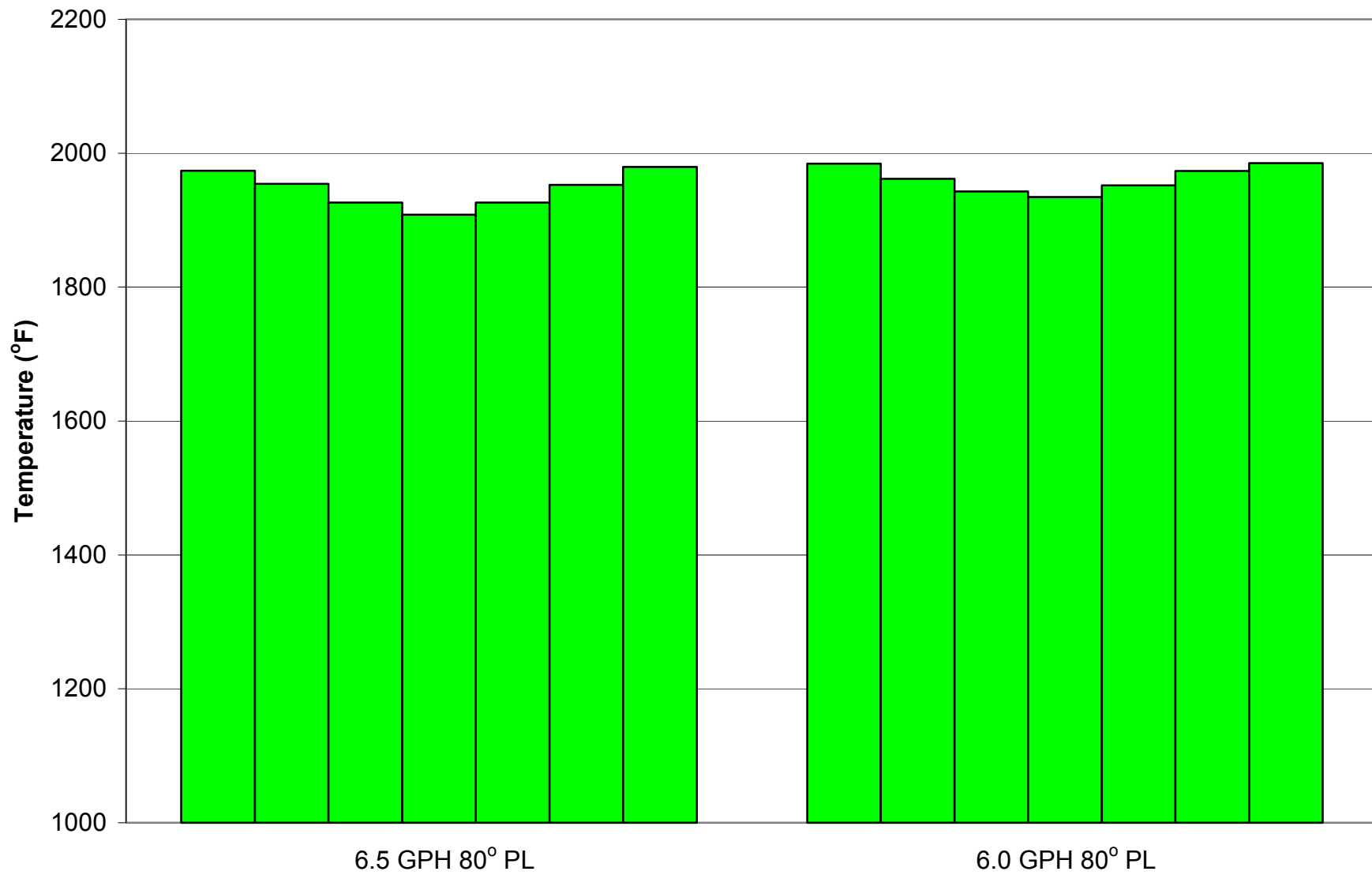
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Evaluation of Monarch 6.5 GPH 80° PL

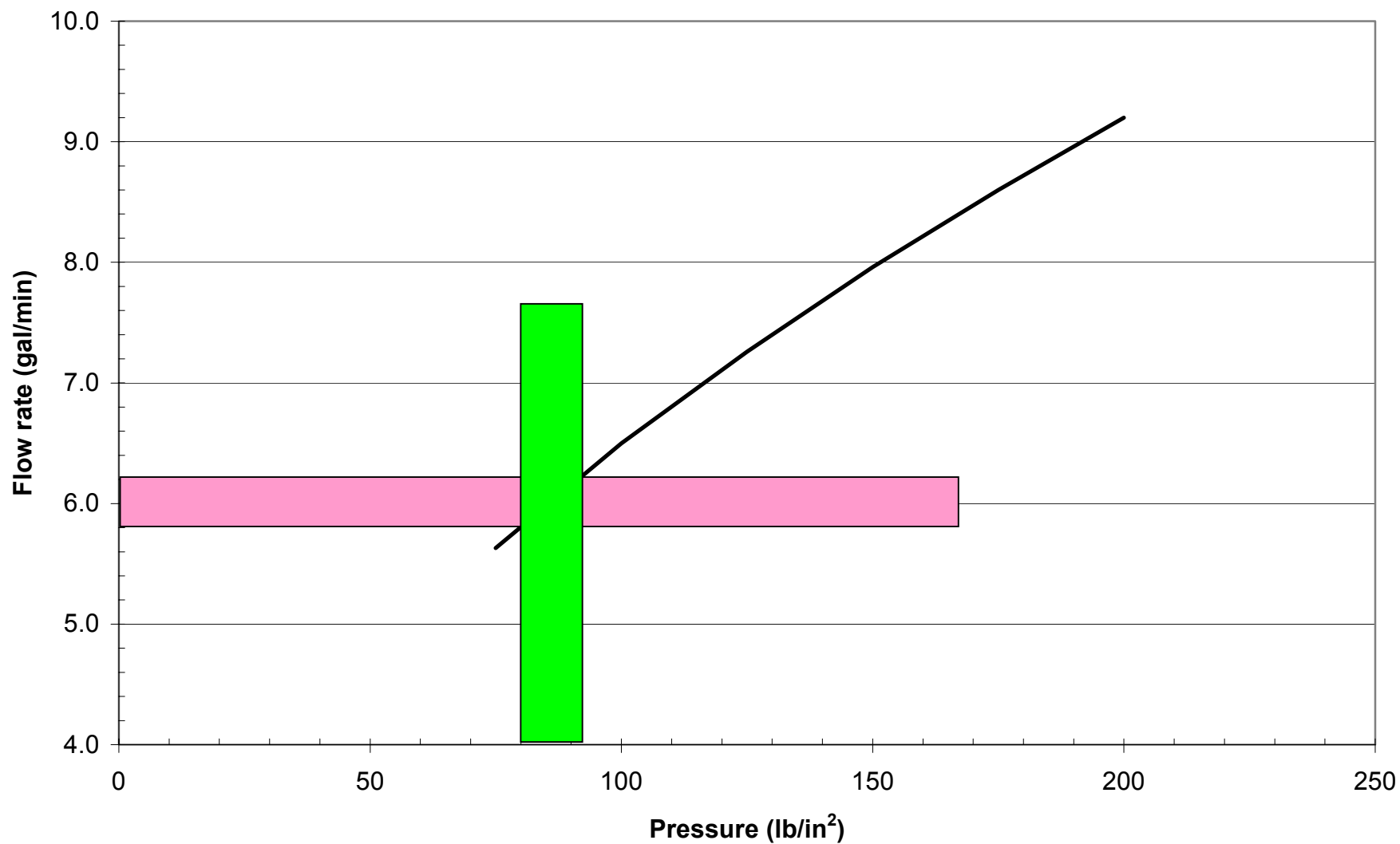
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1941 1981 1958 1958 1974 1992 1999 Avg 1972

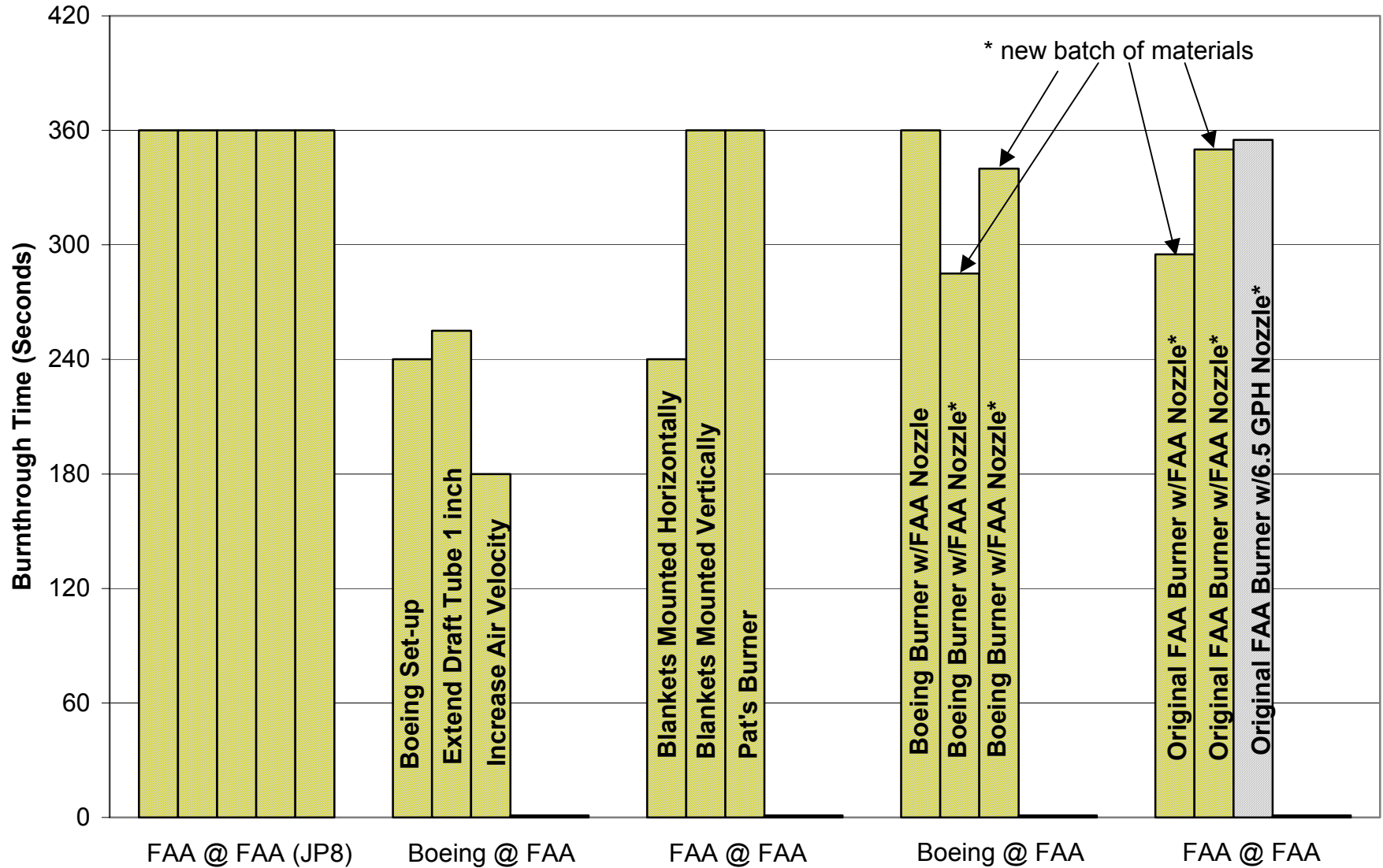
Monarch F-80 Nozzle Comparison



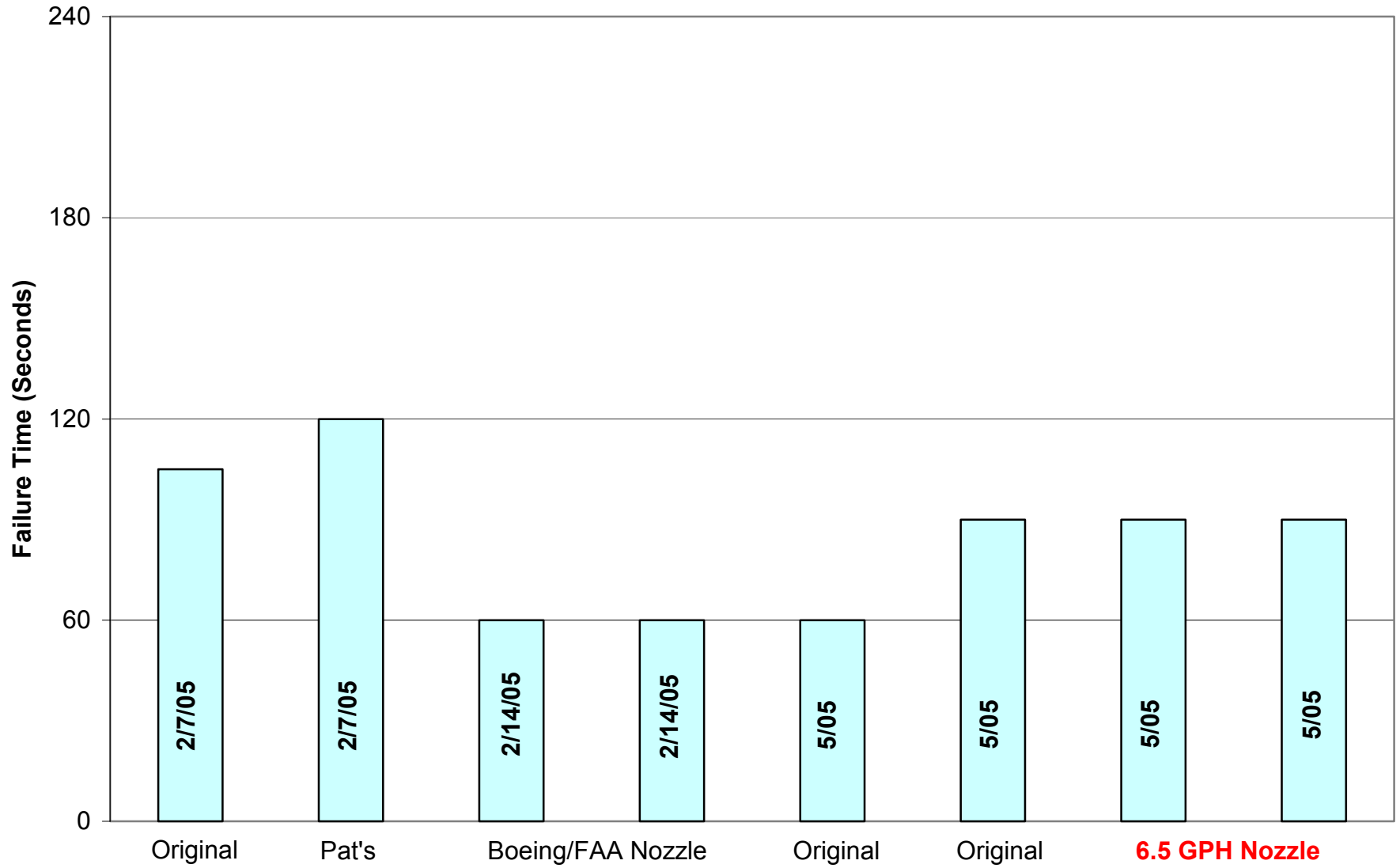
6.5 GPH nozzle flow chart



Testing at FAATC Using TexTech/Fiberglass Blankets



Material X Testing at FAATC



June 2005 Mini Round Robin

TexTech 8 oz/yd² felt used as standard material

4 sets of blankets and new nozzle sent to:

Boeing

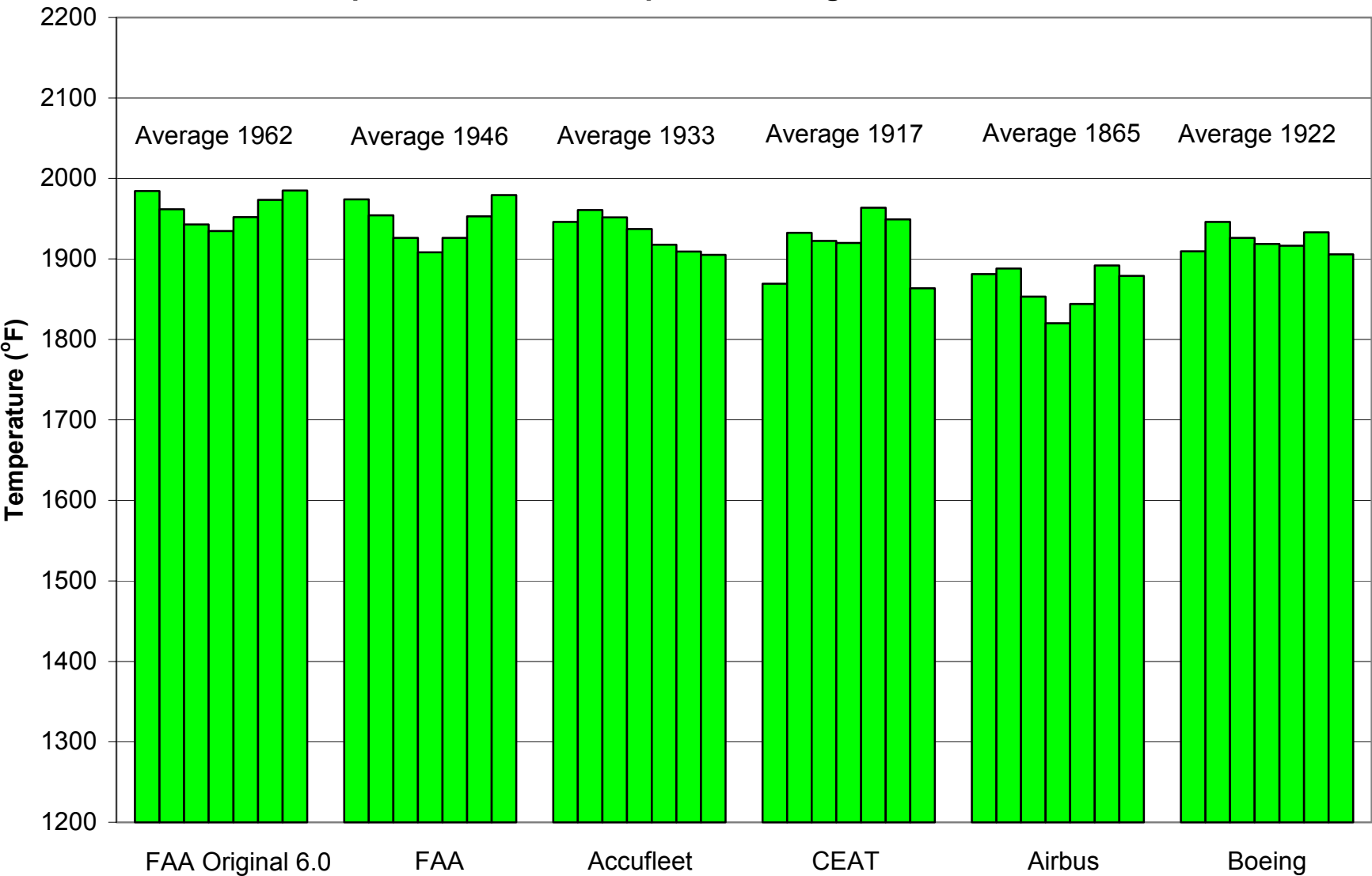
Airbus

Accufleet

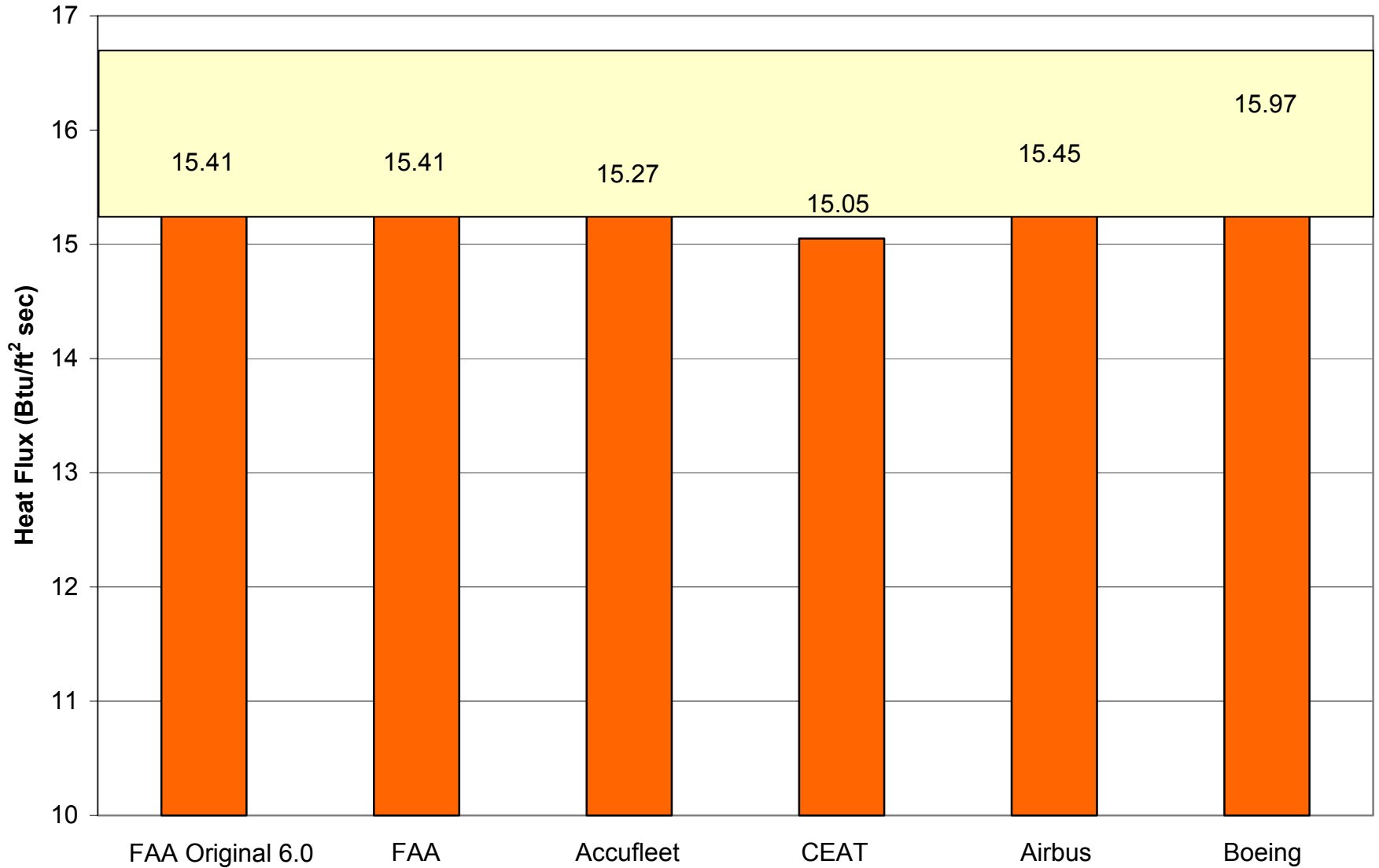
CEAT

FAATC

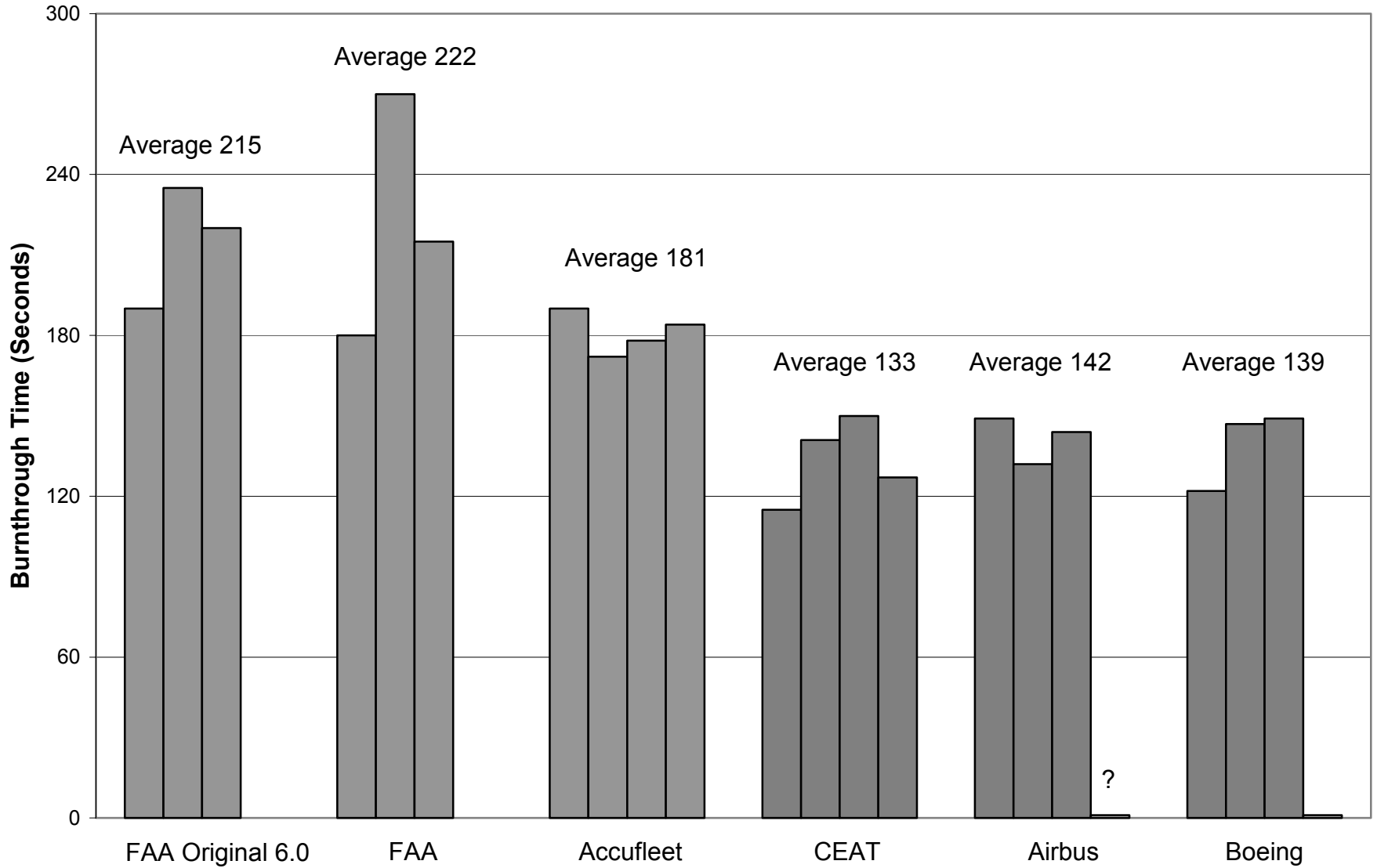
Temperature Profile Comparison Using 6.5 GPH 80° PL



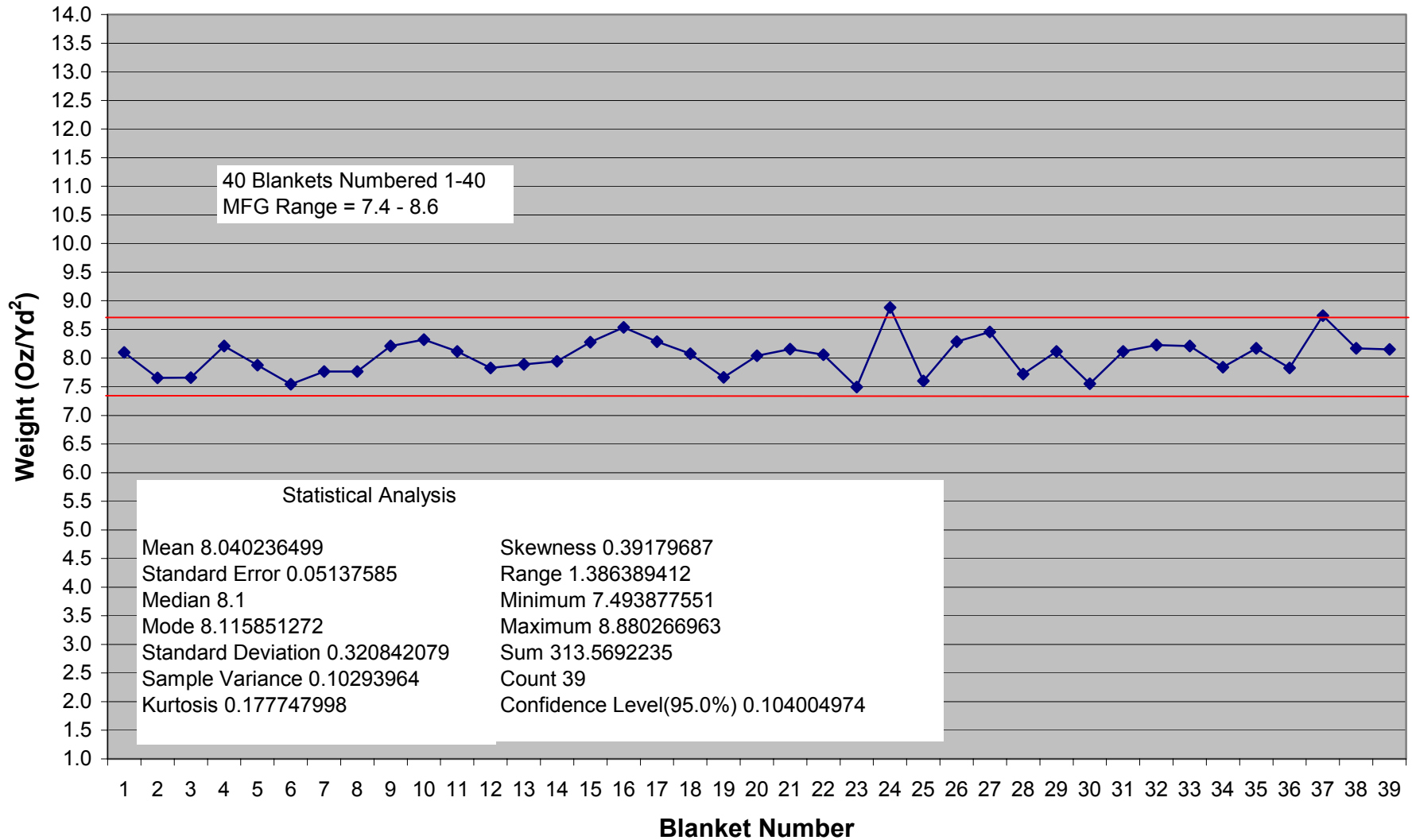
Heat Flux Comparison Using 6.5 GPH 80° PL



Material A Comparison Using 6.5 GPH 80° PL



Tex Tech Style 362 (8.0 Oz/Yd² PAN Blanket)





June 2005 Mini Round Robin Summary

Material analysis indicates weight/area consistency, no impact on results.

All labs reporting were capable of obtaining correct temperature profile.

4 of 5 labs reporting were capable of obtaining correct heat flux.

3 of 5 labs still indicate a more severe test than FAA lab; quicker burnthrough times by approximately 1 minute.

The 3 labs with a more severe result use the socket-style burner.



Planned Activities

FAATC/Accufleet: Continue investigation of rotational effects of nozzle.

FAATC: Continue visiting labs to assist in calibration of burner.

All Labs: Conduct RR testing using 8 oz/yd² and 14 oz/yd² material and paper.

FAATC: Investigate correlation between premature failure and socket-style burner.

FAATC: Complete fabrication of additional flanged burners for comparison testing.

FAATC: Explore possibility of different, standard nozzle (lower fuel flowrate).

New FAATC Test Apparatus





Oil Burner Nozzles

III Technology

MONARCH utilizes state-of-the-art, CNC controlled test equipment with digital flow measuring devices, insuring precise performance of every nozzle.

A new generation of CNC manufacturing equipment provides our customers with the necessary uniformity of every part. This results in accurate and consistent flow and spray angles. In addition, micro-finishing and process control monitoring, applied exclusively by **MONARCH**, assure smooth and consistent oil flow and spray.

WARNING!

We strongly advise you not to disassemble the nozzle. The high performance characteristics of the nozzle will not be reclaimed!