# Discussion of Burnthrough Test Method for Aircraft Thermal Acoustic Insulation Blankets

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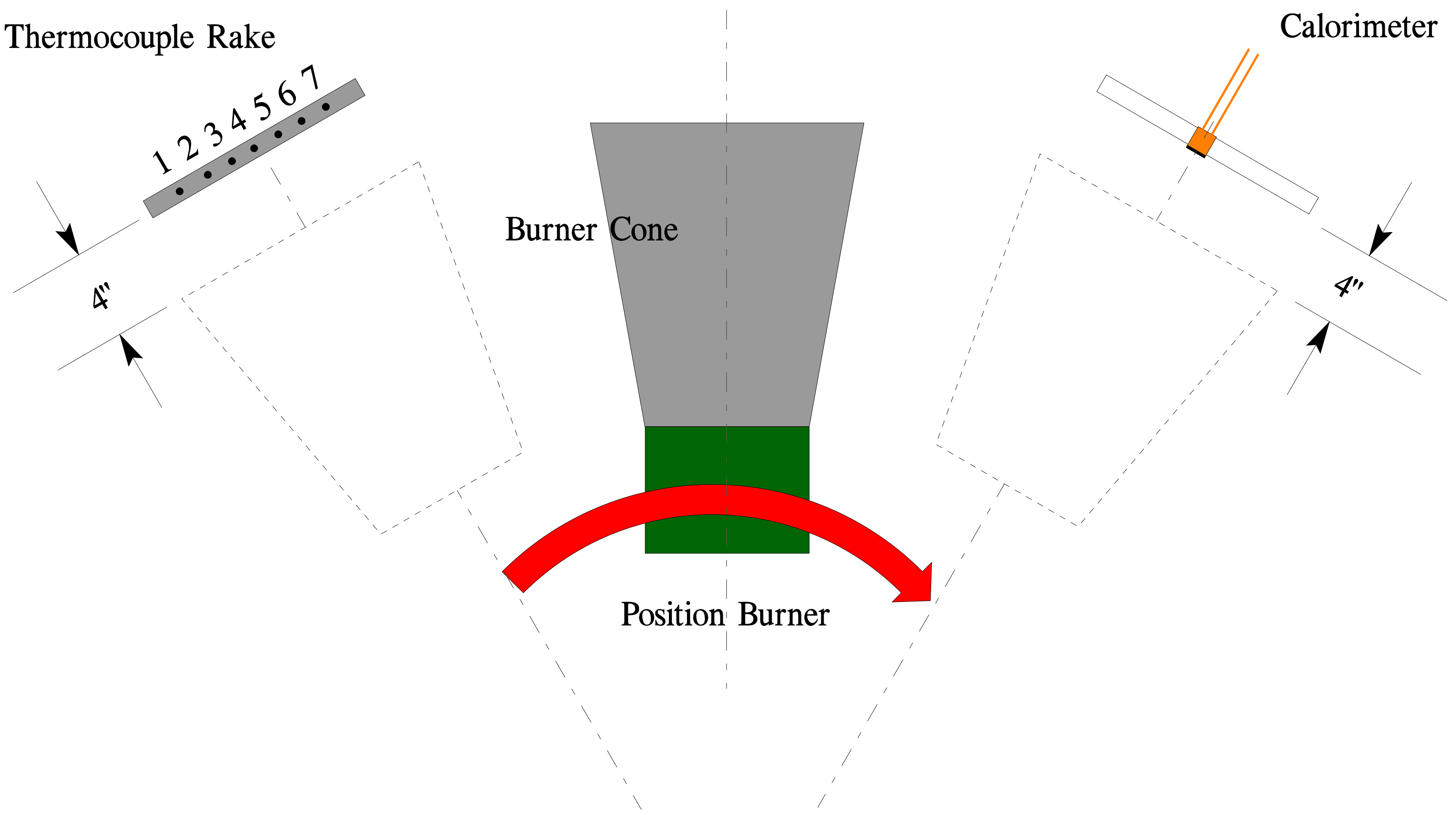
# Flanged vs. Socket Type Housing

# Flanged vs. Socket Type Draft Tube

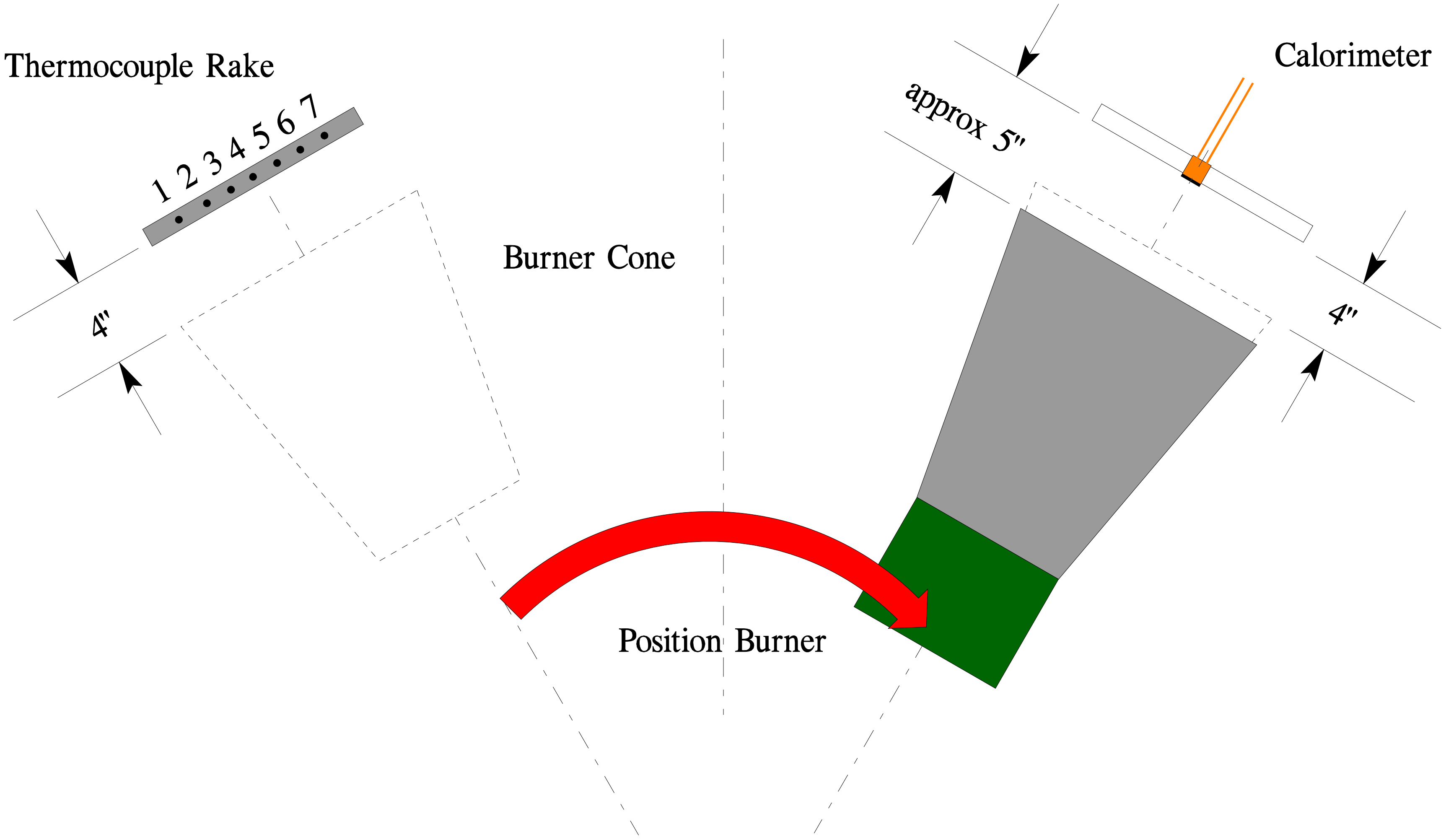
# Assortment of Draft Tube Types Used on Park Burners


## DRAFT TUBES

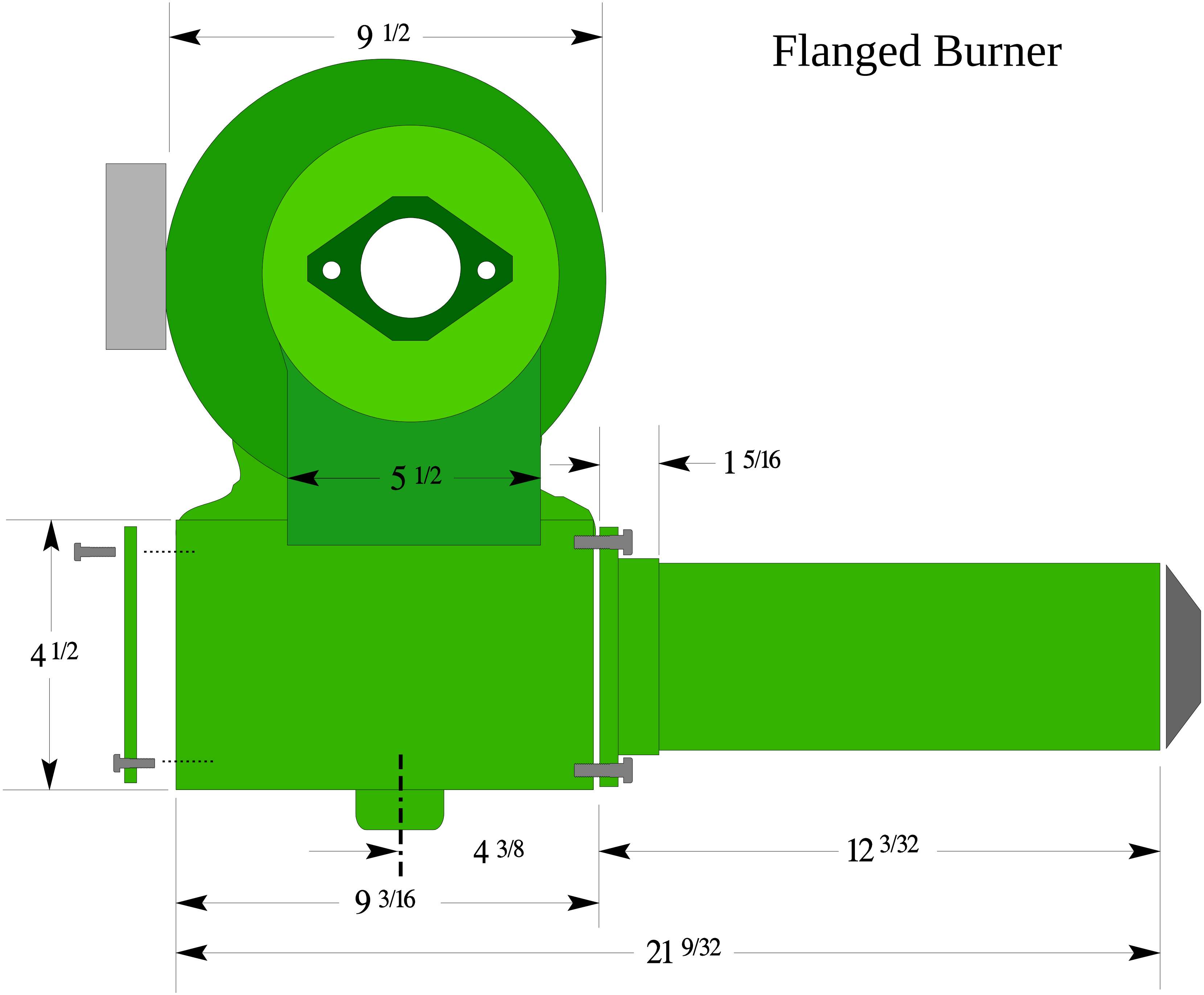
# Socket Burner at FAA Lab

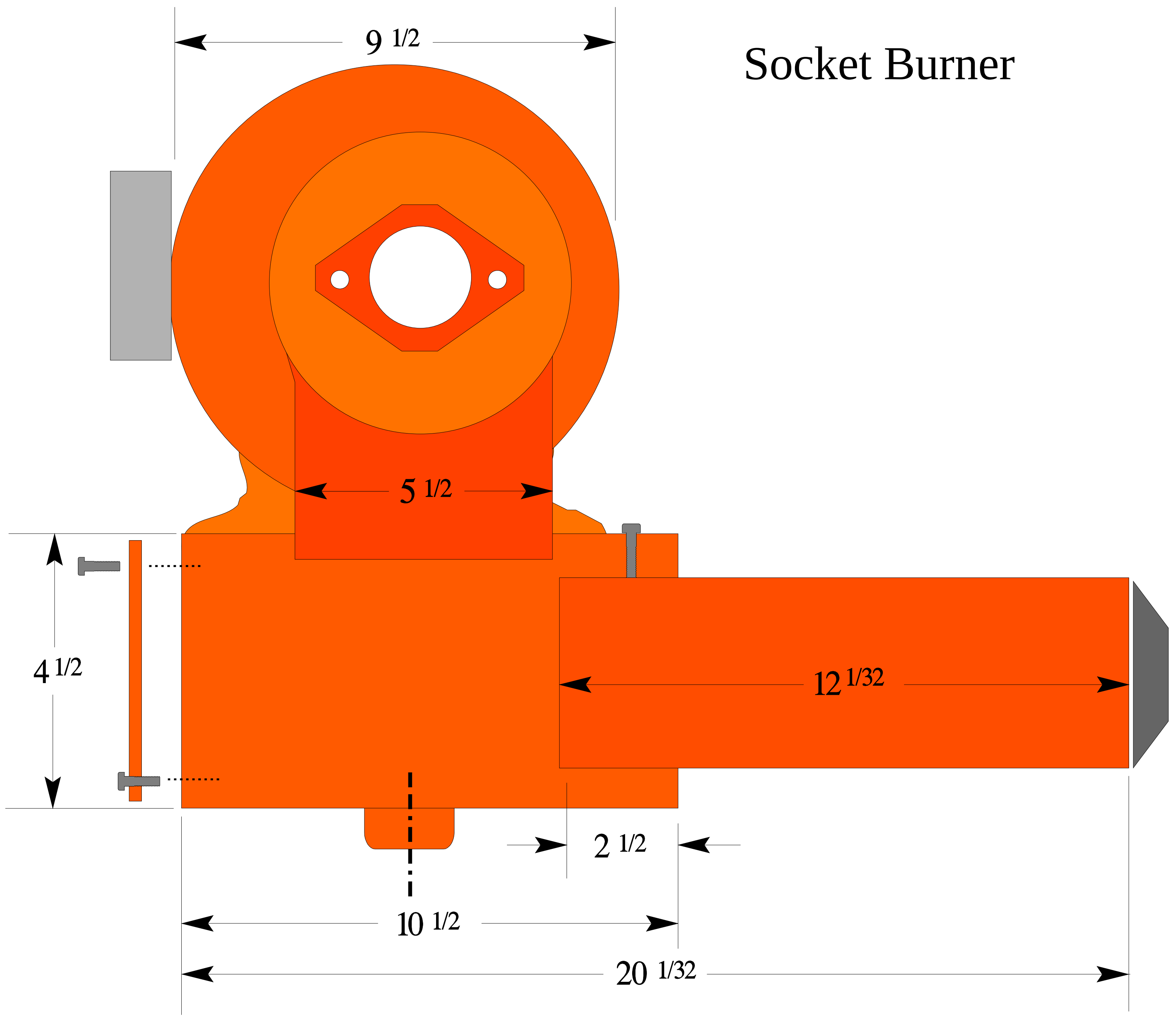


# Socket Burner at FAA Lab



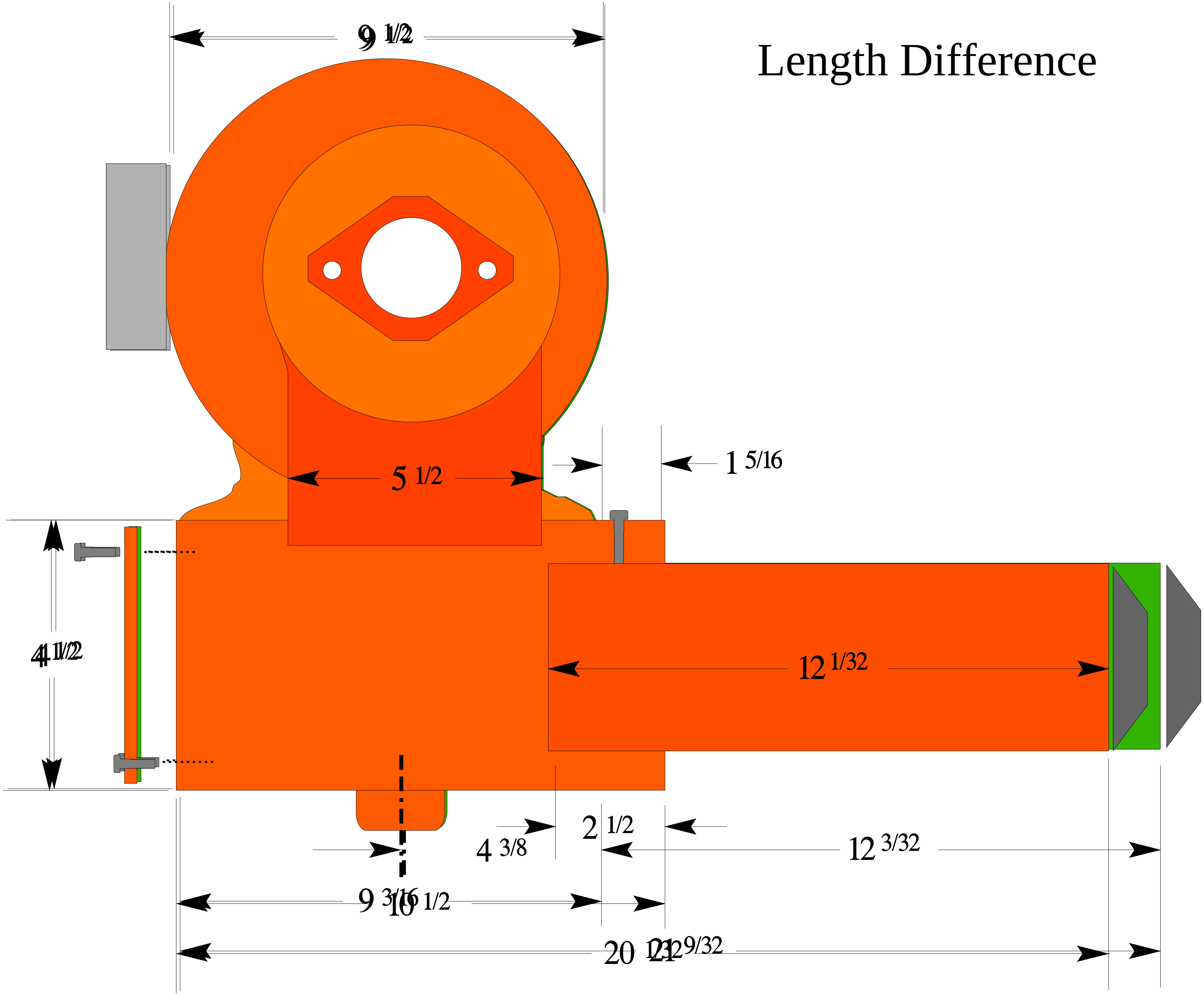
# Flanged Burner





Socket Burner
9 1/2
5 1/2
4 1/2
12 1/32
2 1/2
10 1/2
20 1/32

# Length Difference



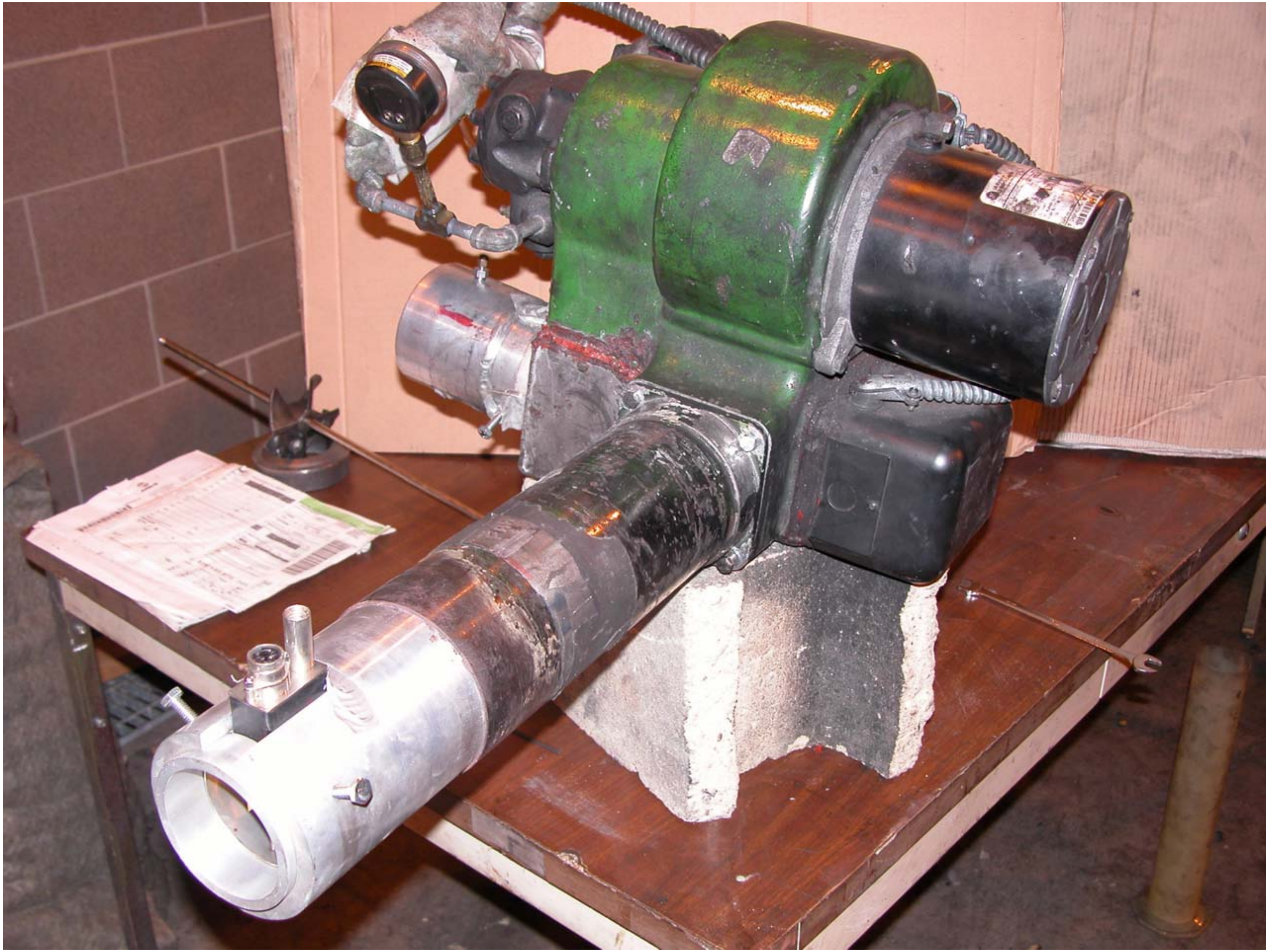
# Extended Draft Tube for Socket Burner

# Test Results, Socket Burner with Extended Draft Tube

**Finding 1**: During calibration, the measured heat flux was still low and not within specification (low 14's)

**Finding 2**: During burnthrough test using TexTech 8 oz/yd$^2$ felt, the failure time was still early (2 ½ min) when compared to results using FAA flanged burner (typically 3 to 3 ½ minutes).

# Measurement of Exit Air Velocity



# Measurement of Exit Air Velocity

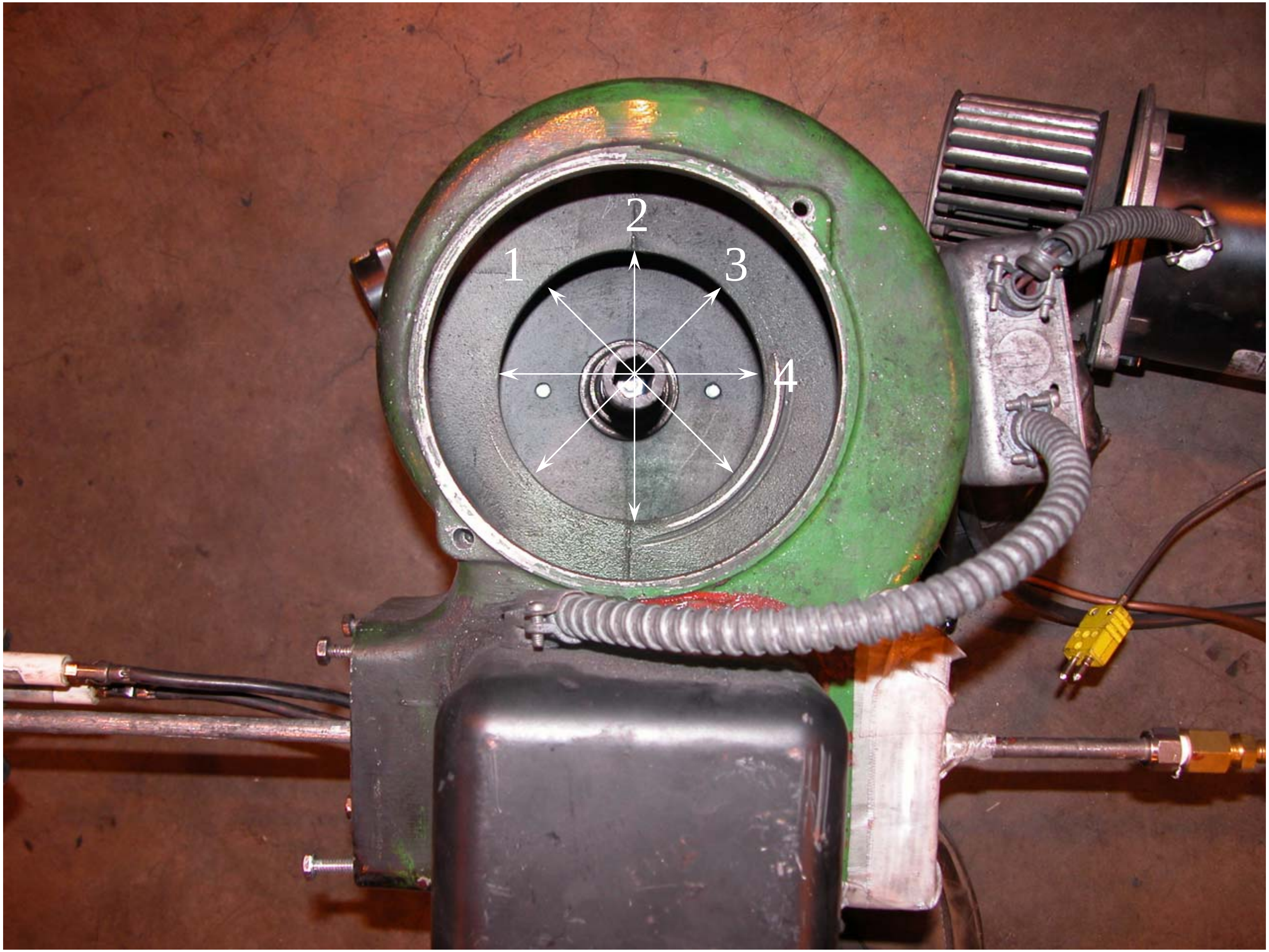
# Measurement of Intake Velocity Through Straightening Device

# Comparison of Exit Air Velocity, Flanged vs. Socket

| | Inlet Velocity Through Stream Straightening Device (ft/min) | Exit Velocity Through Sleeve Containing Annemometer (ft/min) |
|---|---|---|
| Flanged Burner | 2000 | 1300 |
| Socket Burner | 2000 | 1350 |

Results indicate higher exit velocity with socket burner.  However, air velocity device could be sensing a higher "stream", and not necessarily the true average velocity of the exit area.

# Housing Inner Diameter Measurement



# Housing Inner Diameter Measurement

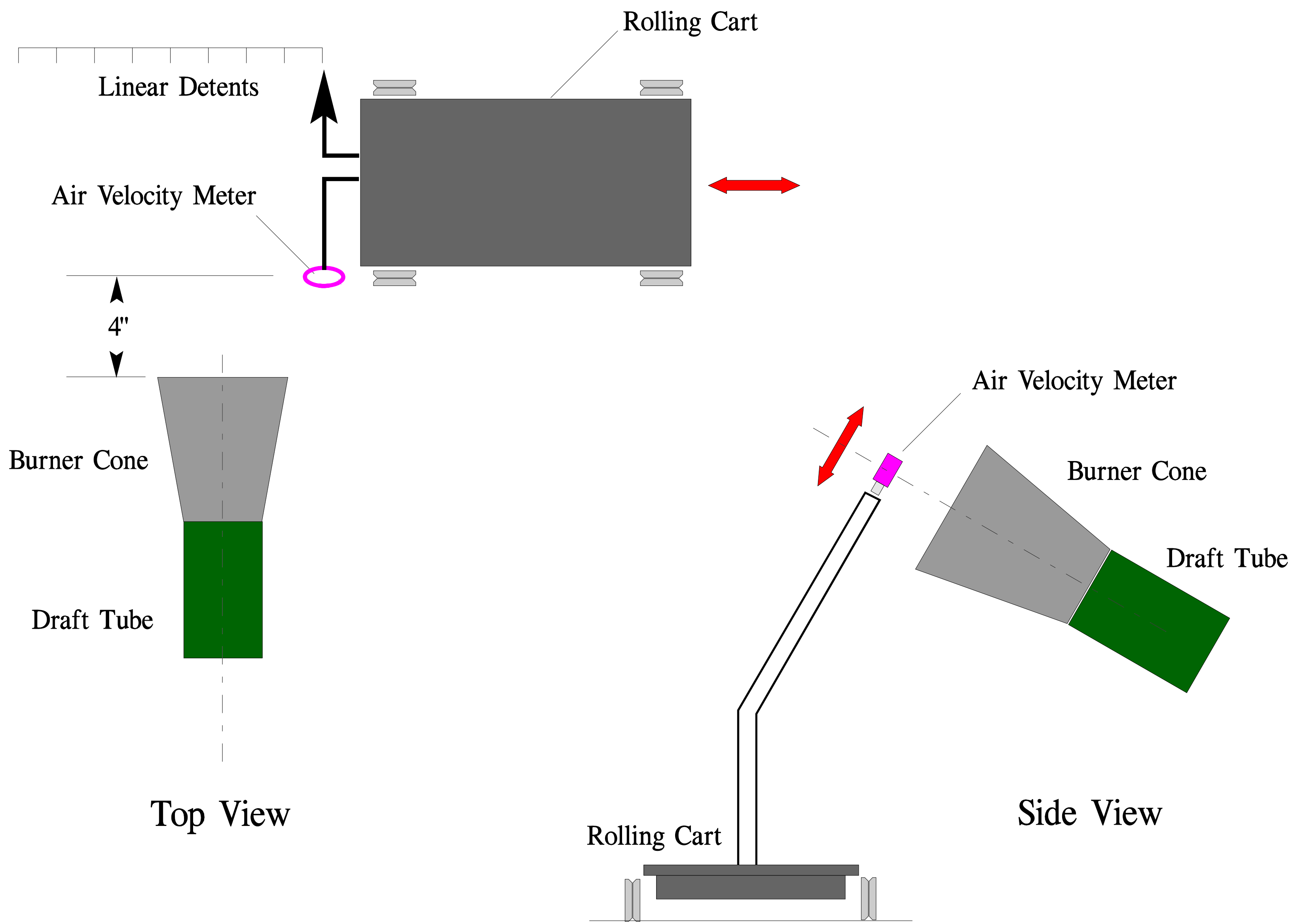
| | Flanged | Socket |
|---|---|---|
| Diameter 1 | 4.94 | 4.84 |
| Diameter 2 | 5.03 | 5.01 |
| Diameter 3 | 4.98 | 4.93 |
| Diameter 4 | 4.96 | 4.88 |
| Diameter Average | 4.9775 | 4.915 |
| Area | 19.46 | 18.97 |

# Mapping Exit Area Air Velocity

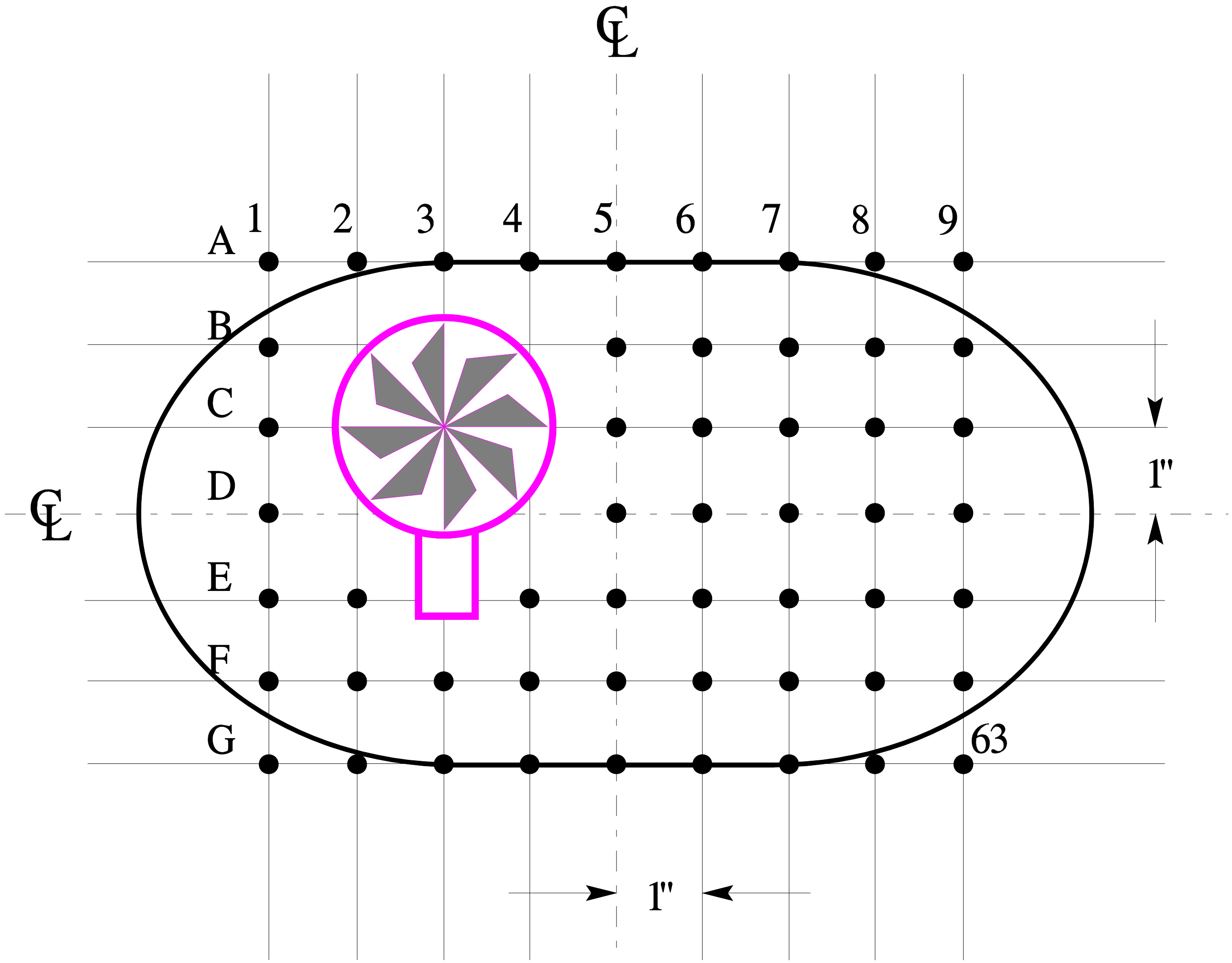
**Objective**: To determine cause of differences in calibration heat flux and test results between flanged style burner and socket style burner when both units are identically-prepared.

**Methodology**: Map exit area air velocity of each burner to determine if there is a correlation between “shape” of exit air and heat flux/test results.

# Mapping Exit Area Air Velocity



# Exit Area Air Velocity Mapping



# Exit Velocity Comparison

## FAA Flanged Burner

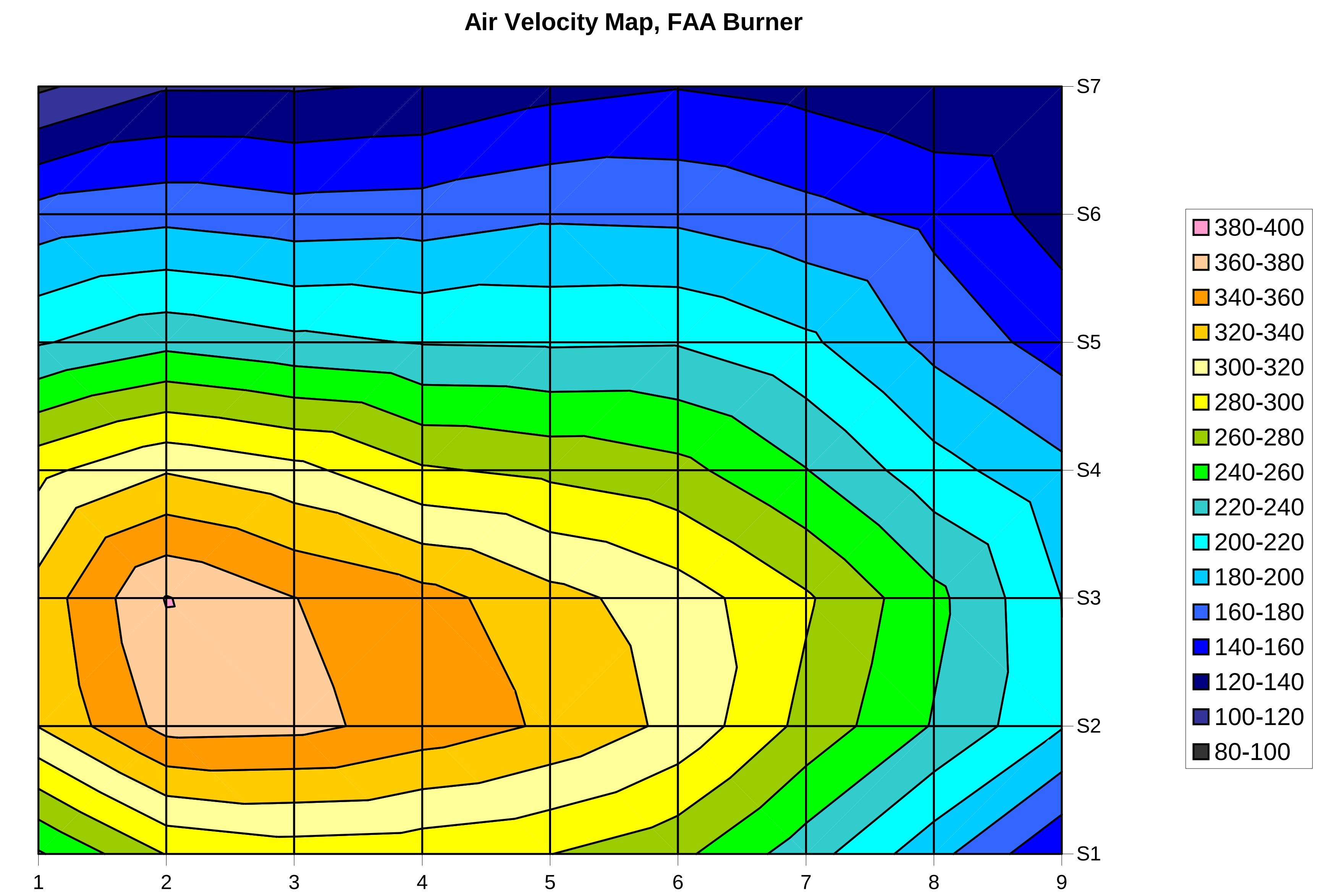
averaged air velocities

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | 96 | 118 | 118 | 122 | 134 | 139 | 134 | 125 | 123 |
| B | 168 | 174 | 168 | 170 | 177 | 175 | 165 | 154 | 131 |
| C | 218 | 234 | 225 | 219 | 218 | 219 | 204 | 174 | 151 |
| D | 295 | 318 | 306 | 282 | 275 | 266 | 241 | 208 | 185 |
| E | 328 | **381** | 360 | 348 | 327 | 310 | 283 | 246 | 200 |
| F | 321 | 367 | 365 | 352 | 337 | 315 | 274 | 238 | 201 |
| G | 238 | 281 | 290 | 287 | 280 | 265 | 229 | 187 | 142 |

## Socket Burner

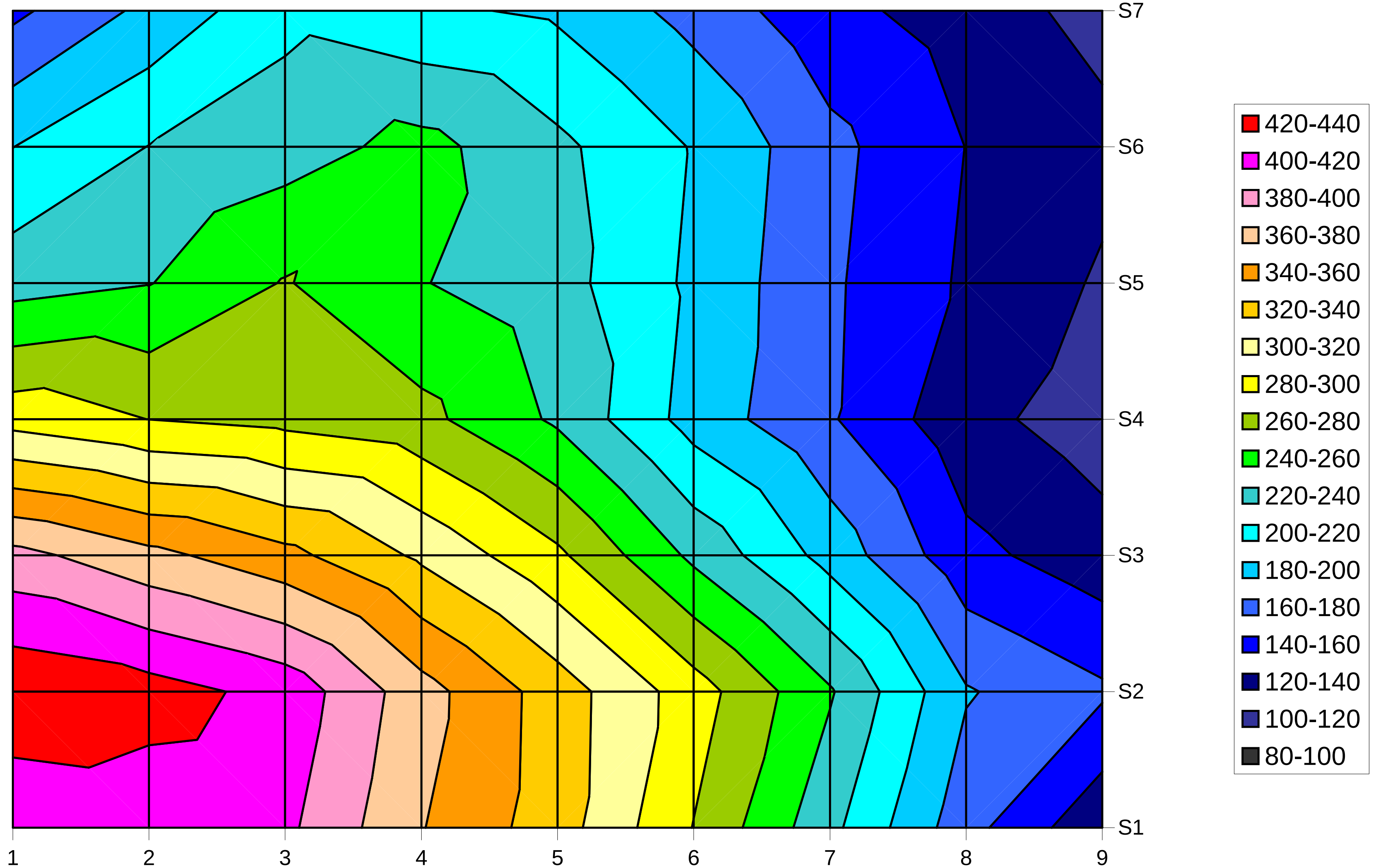
averaged air velocities

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | 155 | 185 | 214 | 203 | 197 | 173 | 146 | 130 | 113 |
| B | 200 | 220 | 231 | 246 | 224 | 199 | 166 | 140 | 126 |
| C | 232 | 239 | 261 | 241 | 228 | 196 | 163 | 137 | 118 |
| D | 292 | 280 | 274 | 266 | 237 | 192 | 162 | 126 | 110 |
| E | 387 | 366 | 346 | 316 | 284 | 236 | 193 | 146 | 128 |
| F | **437** | 429 | 413 | 368 | 330 | 290 | 242 | 182 | 163 |
| G | 402 | 407 | 404 | 361 | 329 | 279 | 226 | 167 | 124 |



Air Velocity Map, FAA Burner
S7
S6
S5
S4
S3
S2
S1
1
2
3
4
5
6
7
8
9
380-400
360-380
340-360
320-340
300-320
280-300
260-280
240-260
220-240
200-220
180-200
160-180
140-160
120-140
100-120
80-100

**Air Velocity Map, Round Burner A**



# Analysis of Exit Air Velocity Measurement

averaged air velocities

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | 96 | 118 | 118 | 122 | 134 | 139 | 134 | 125 | 123 |
| B | 168 | 174 | 168 | 170 | 177 | 175 | 165 | 154 | 131 |
| C | 218 | 234 | 225 | 219 | 218 | 219 | 204 | 174 | 151 |
| D | 295 | 318 | 306 | 282 | 275 | 266 | 241 | 208 | 185 |
| E | 328 | **381** | 360 | 348 | 327 | 310 | 283 | 246 | 200 |
| F | 321 | 367 | 365 | 352 | 337 | 315 | 274 | 238 | 201 |
| G | 238 | 281 | 290 | 287 | 280 | 265 | 229 | 187 | 142 |

Flanged Burner Total Average = 231 ft/min

averaged air velocities

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| A | 155 | 185 | 214 | 203 | 197 | 173 | 146 | 130 | 113 |
| B | 200 | 220 | 231 | 246 | 224 | 199 | 166 | 140 | 126 |
| C | 232 | 239 | 261 | 241 | 228 | 196 | 163 | 137 | 118 |
| D | 292 | 280 | 274 | 266 | 237 | 192 | 162 | 126 | 110 |
| E | 387 | 366 | 346 | 316 | 284 | 236 | 193 | 146 | 128 |
| F | **437** | 429 | 413 | 368 | 330 | 290 | 242 | 182 | 163 |
| G | 402 | 407 | 404 | 361 | 329 | 279 | 226 | 167 | 124 |

Socket Burner Total Average = 238 ft/min

# Analysis of Exit Air Velocity Measurement

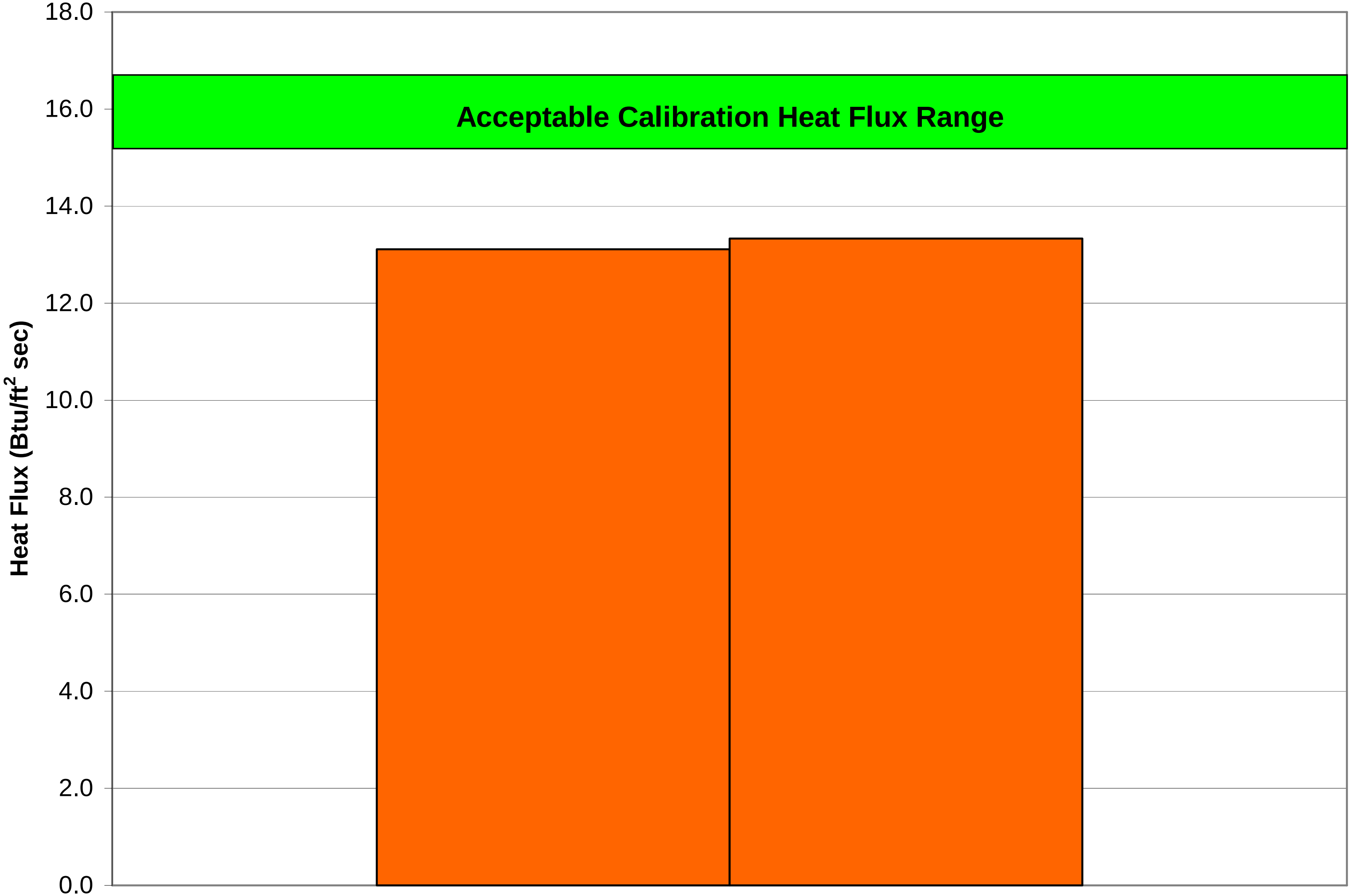
Peak Exit Velocity of Flanged Burner = 381 ft/min

Peak Exit Velocity of Socket Burner = 437 ft/min

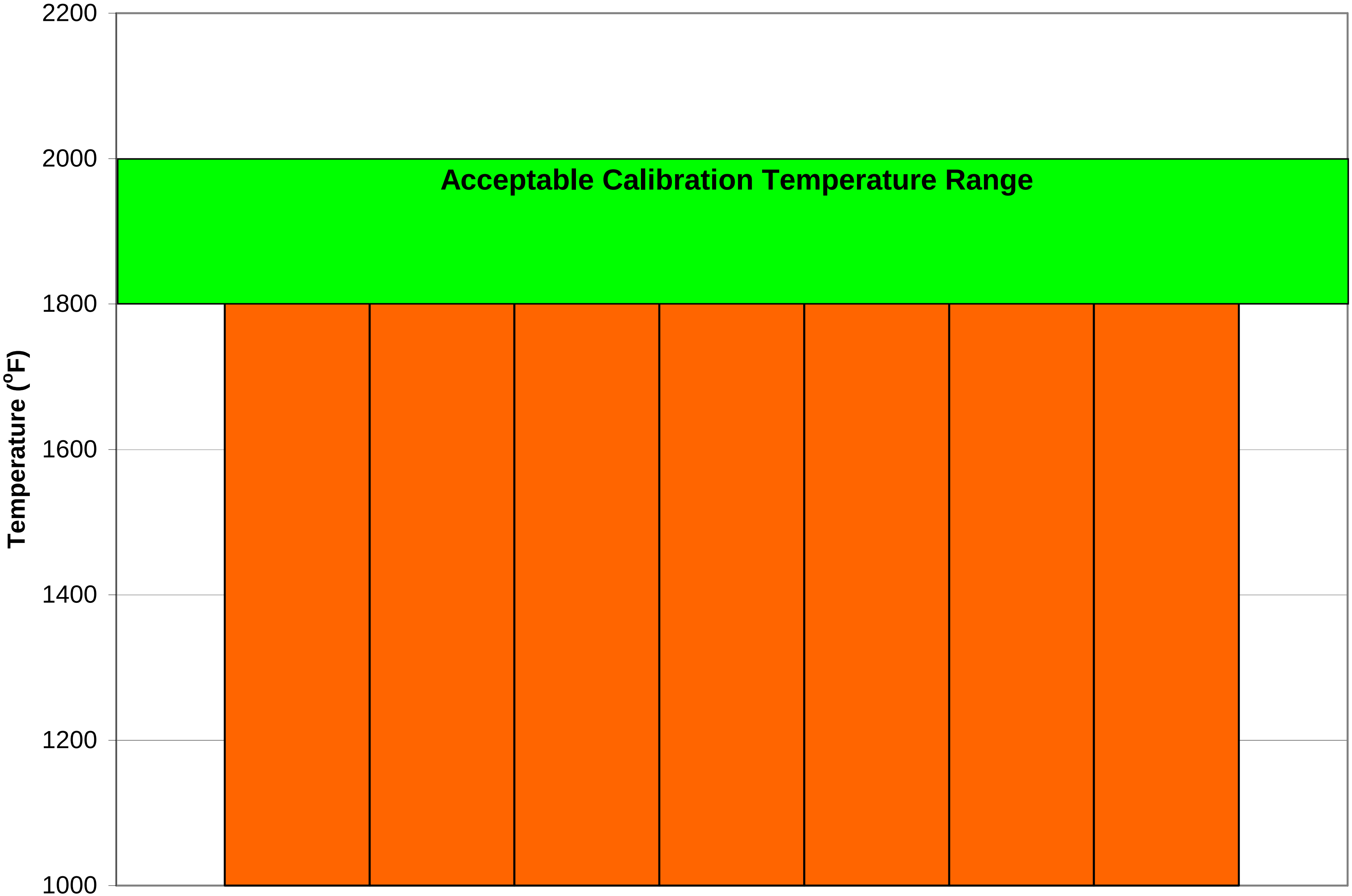
381/437 = 87% and 87% of 2150 = 1874 ft/min

Adjust intake velocity to approx 1874 ft/min, determine effect

# Socket Burner with Adjusted Intake Velocity of 1900 ft/min



# Socket Burner with Adjusted Intake Velocity of 1900 ft/min



# Socket Burner with Adjusted Intake Velocity of 1900 ft/min

**Burnthrough of TexTech 8 oz/yd$^2$ at 3 min 59 sec**

**Interim Conclusion 1**: calibration heat flux and temperature profile not impacted by reduced exit air velocity.

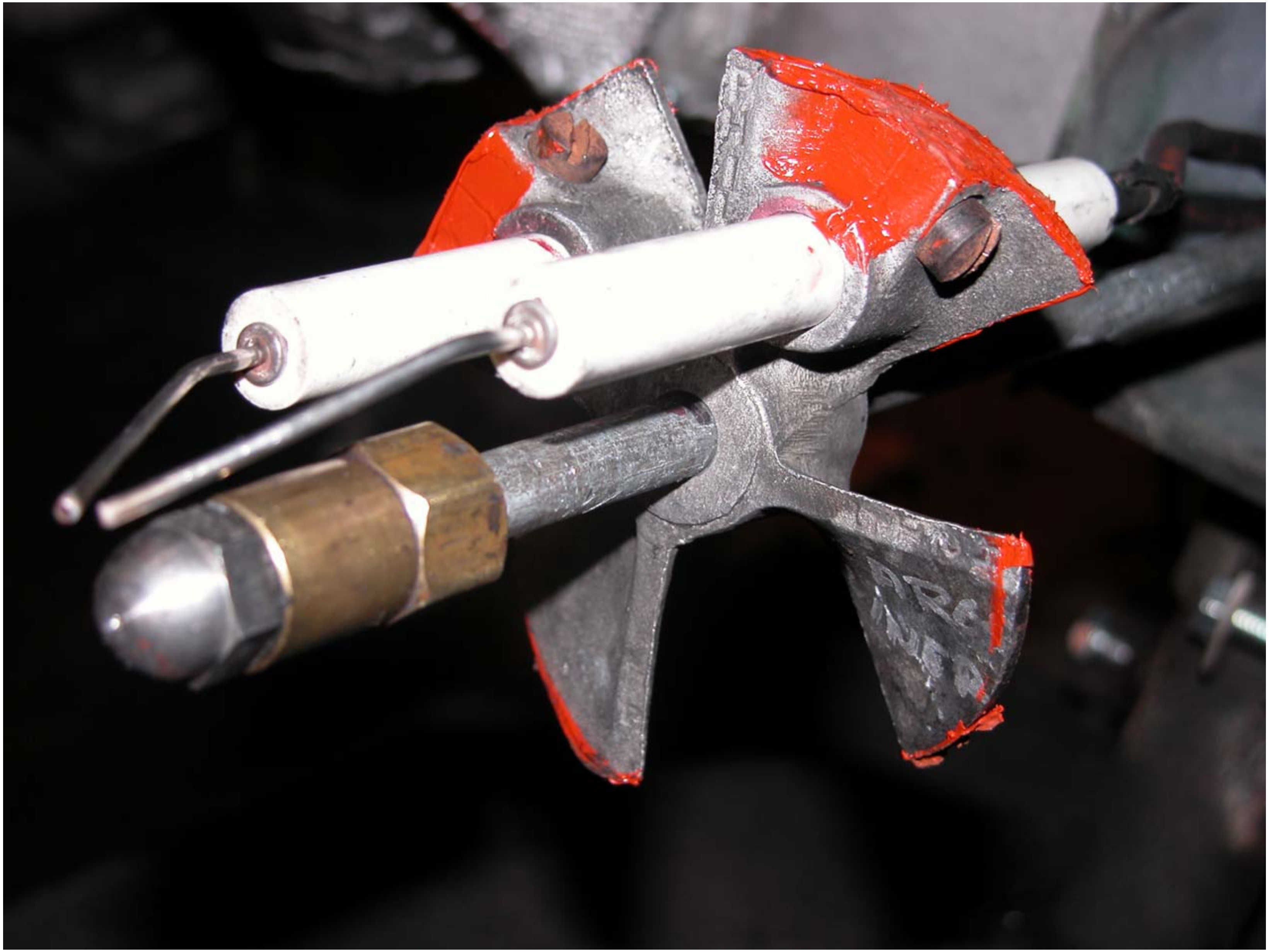
**Interim Conclusion 2**: burnthrough test results are highly dependent on reduced exit air velocity.

# Possible Simple Modifications to Socket Burner

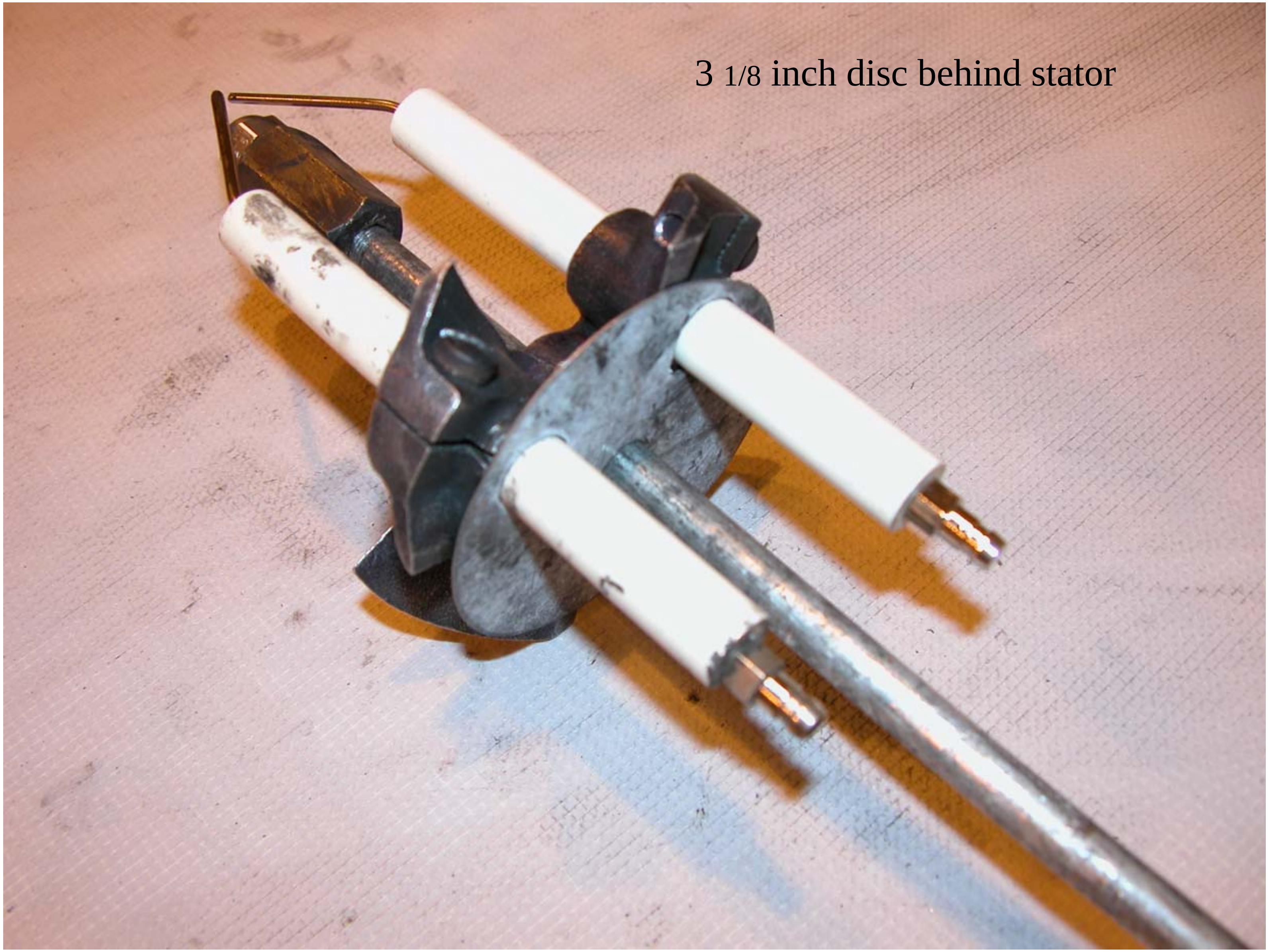
**Objective**: To develop a simple modification to the socket burner that would result in equivalent performance to the flanged burner (i.e., reduced exit air velocity while maintaining specified 2150 ft/min intake velocity).

**Methodology**: Alter the flow of air in the draft tube using various deflectors, discs, and stators in order to reduce the output velocity.

# RTV Sealant Added to Blade Edge



# Possible Simple Modifications to Socket Burner



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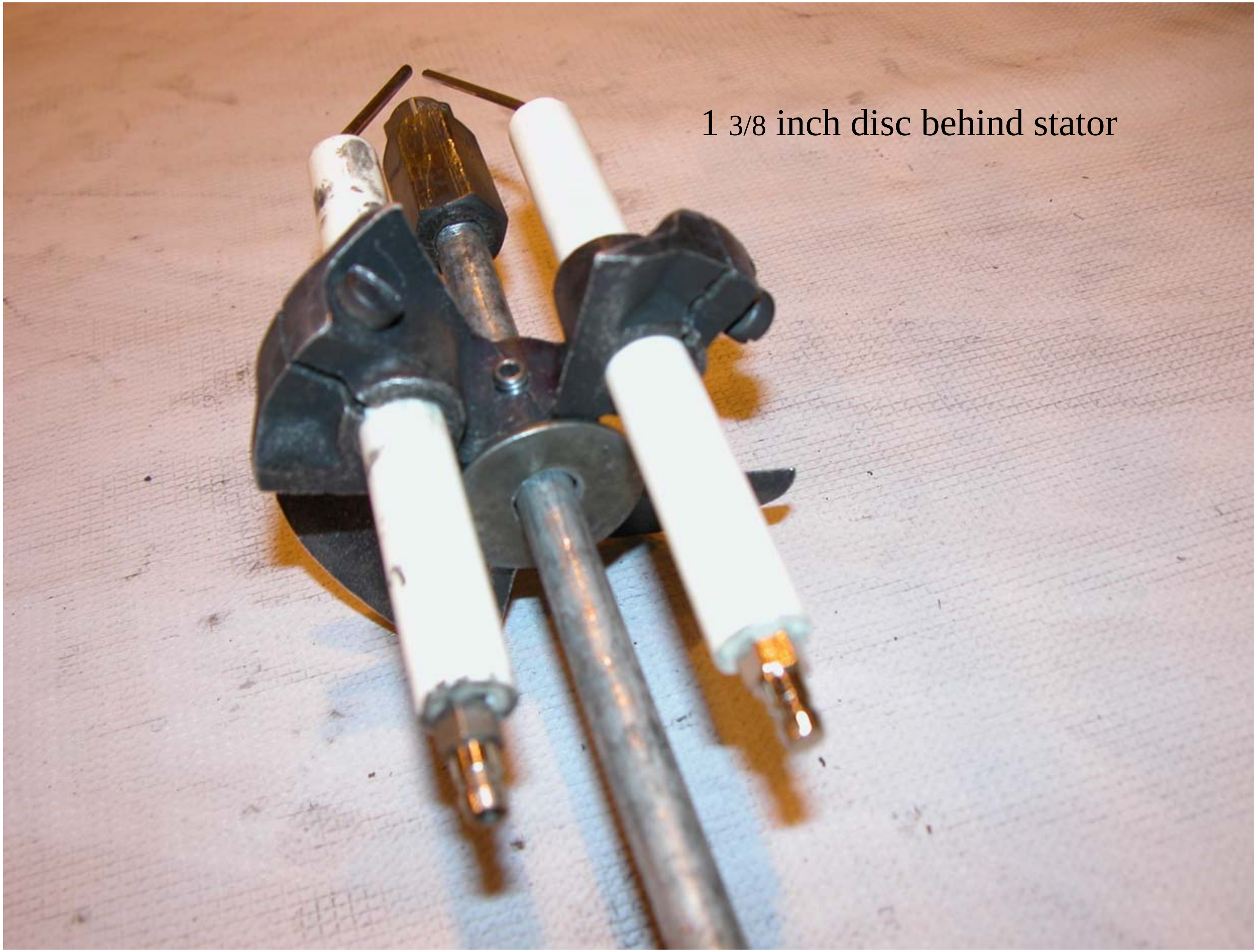

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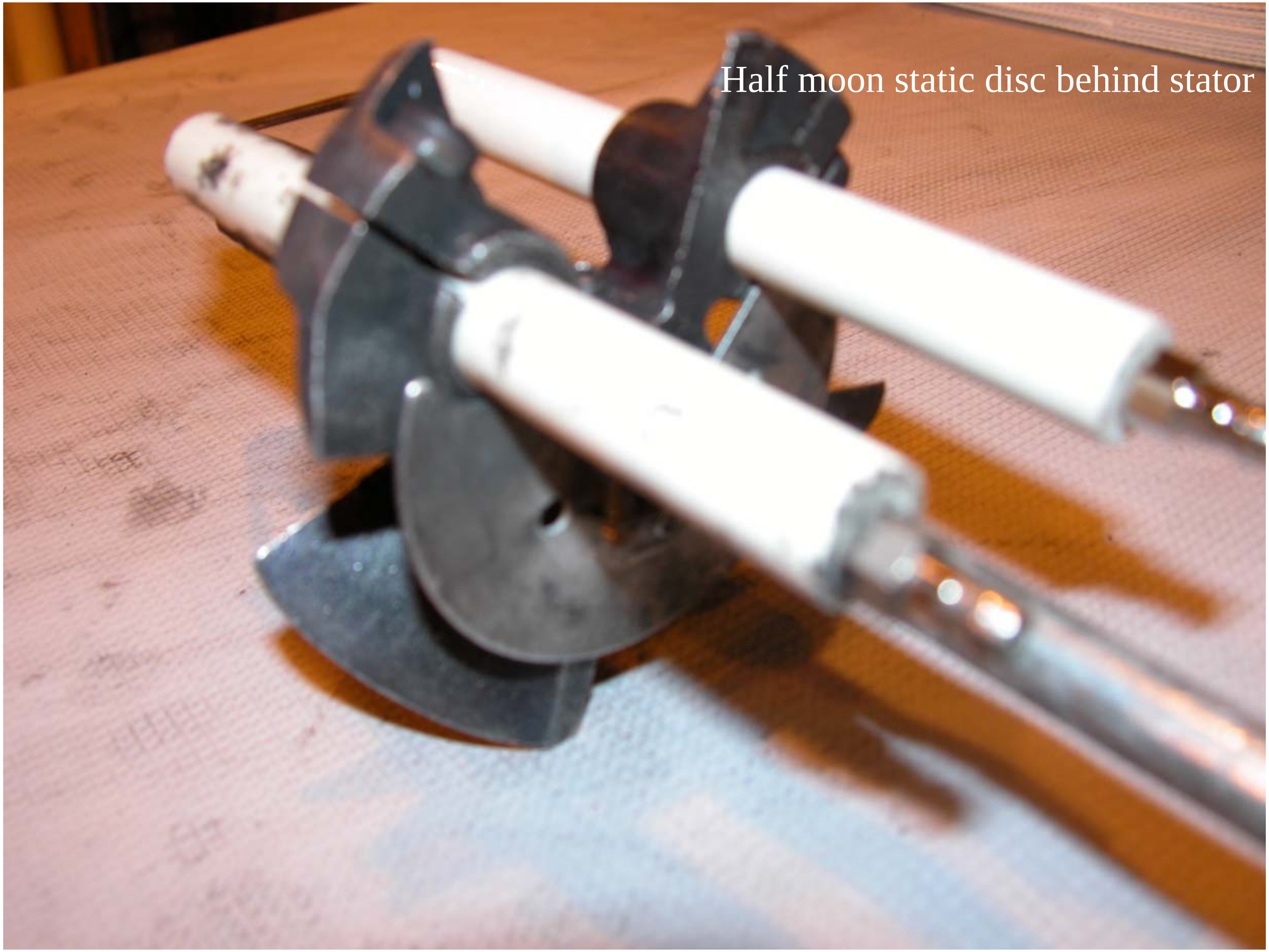

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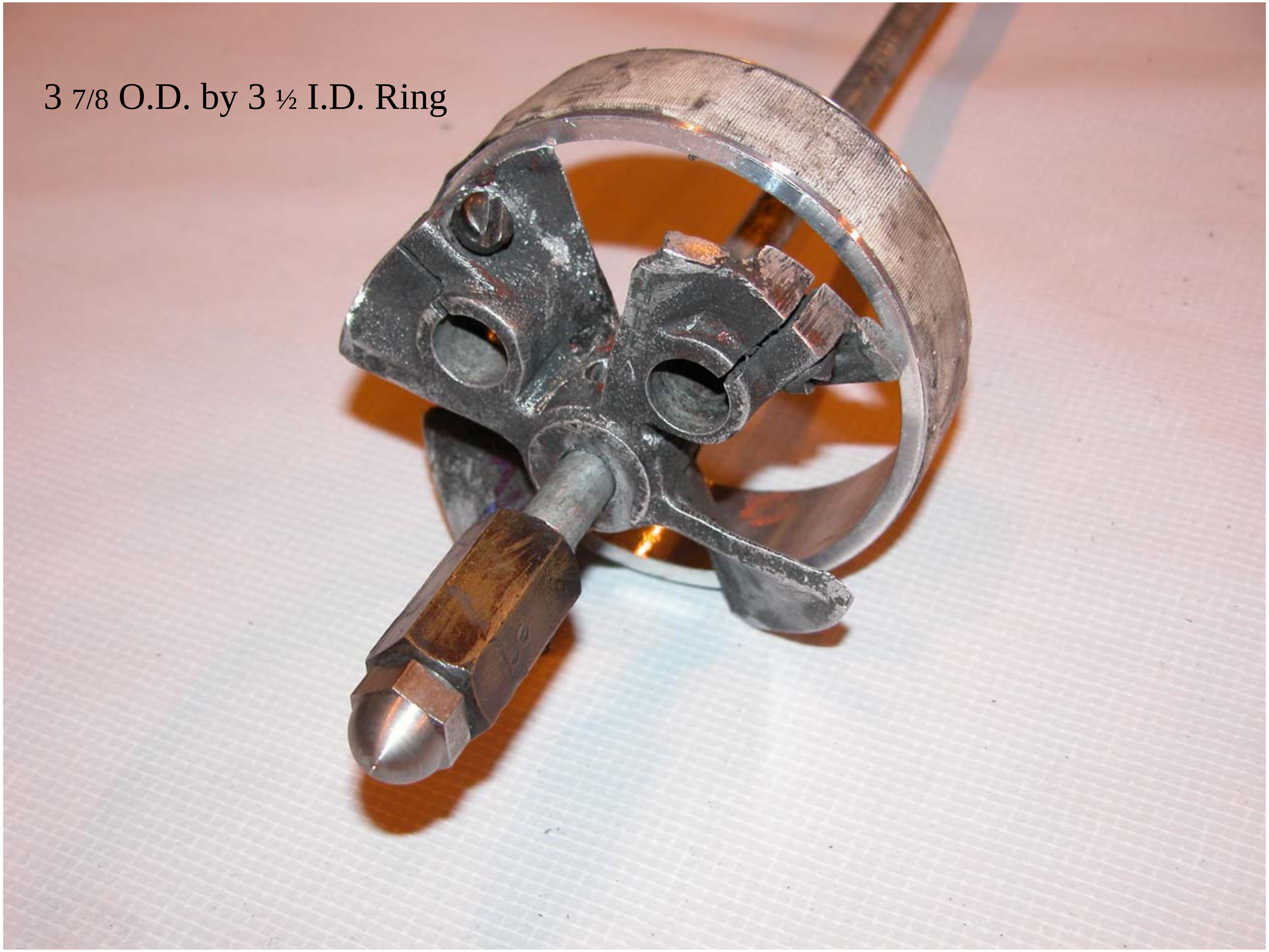
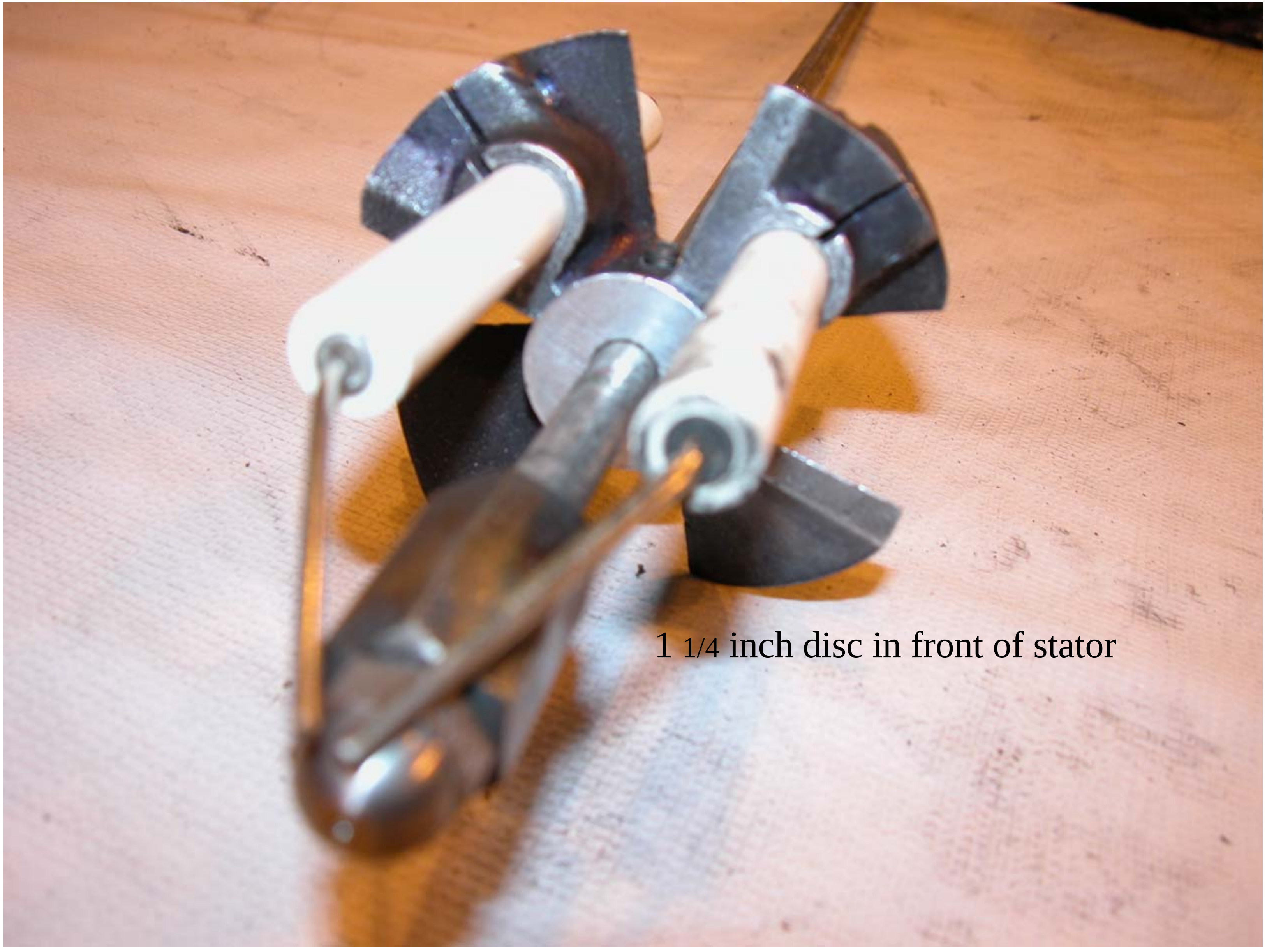
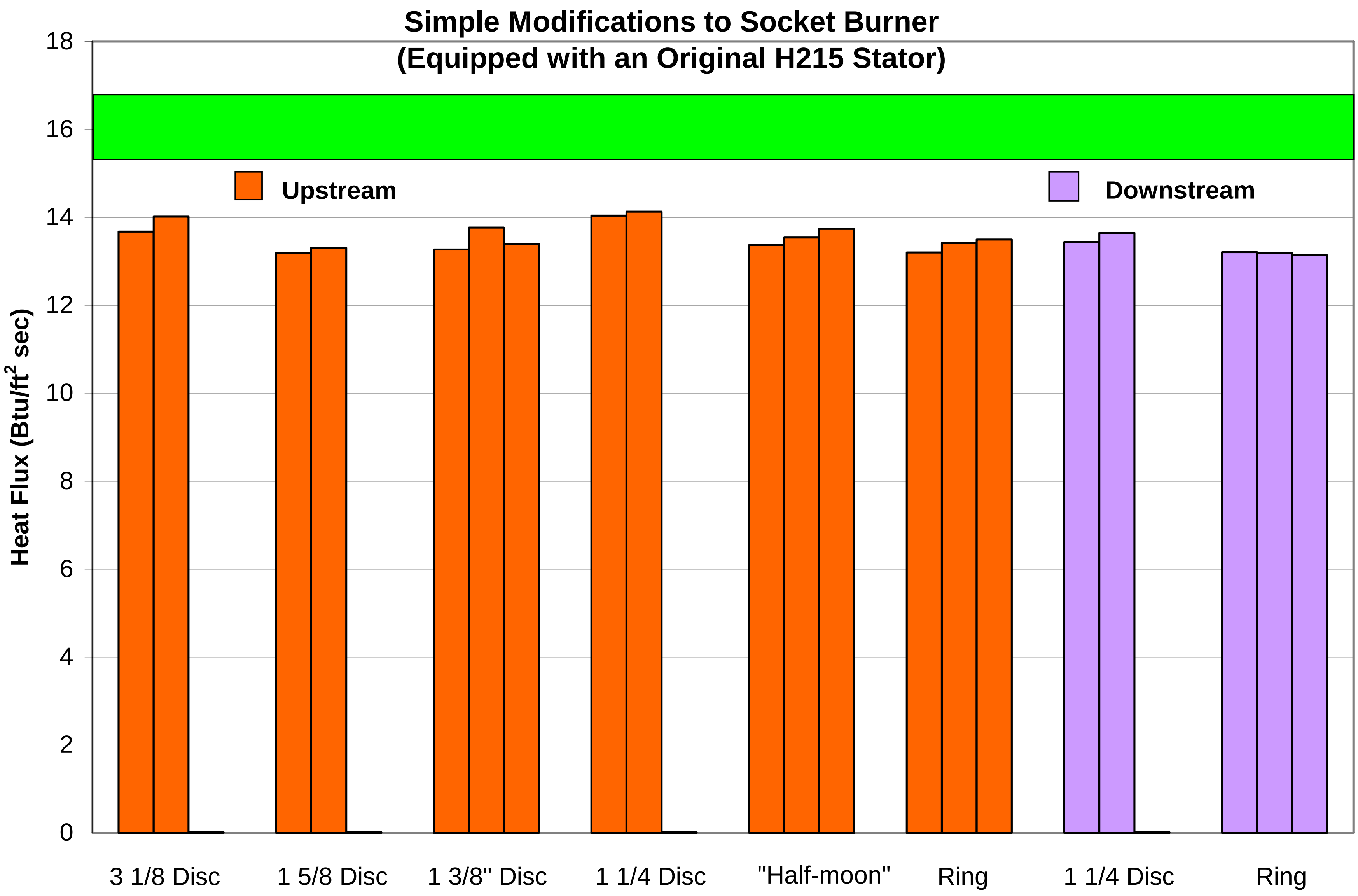



1 1/4 inch disc in front of stator

# Possible Simple Modifications to Socket Burner

# Socket Burner Testing



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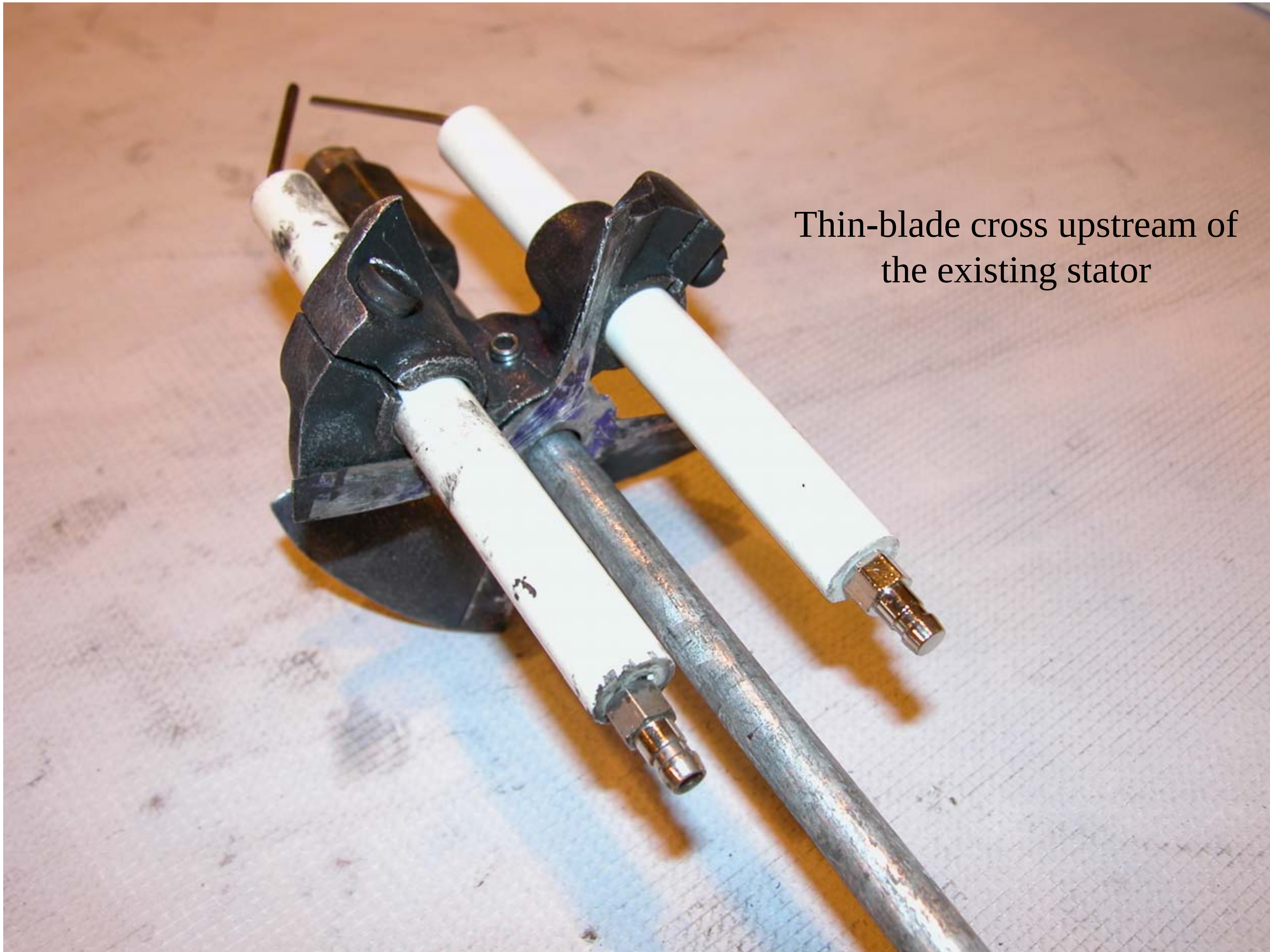

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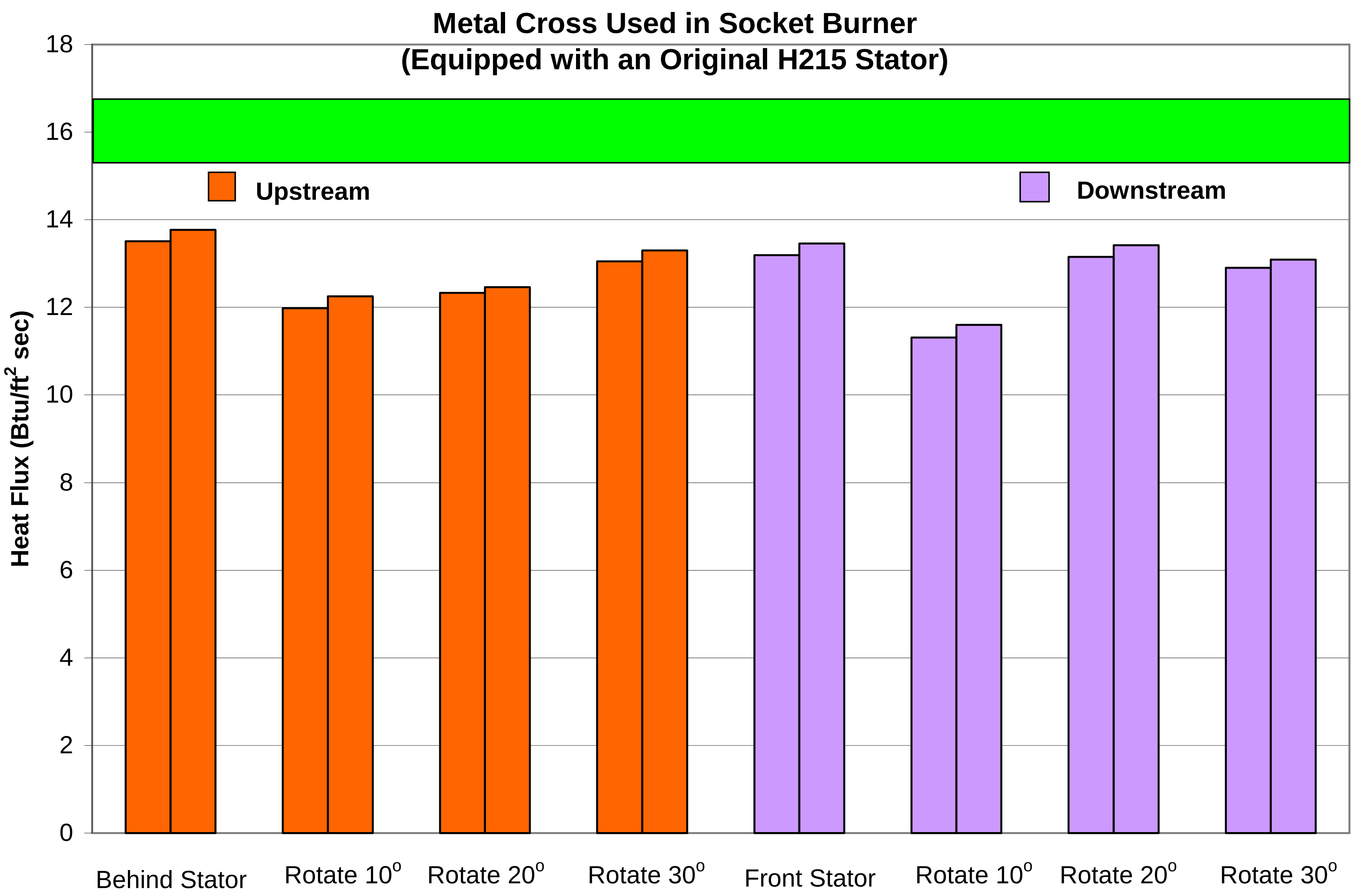
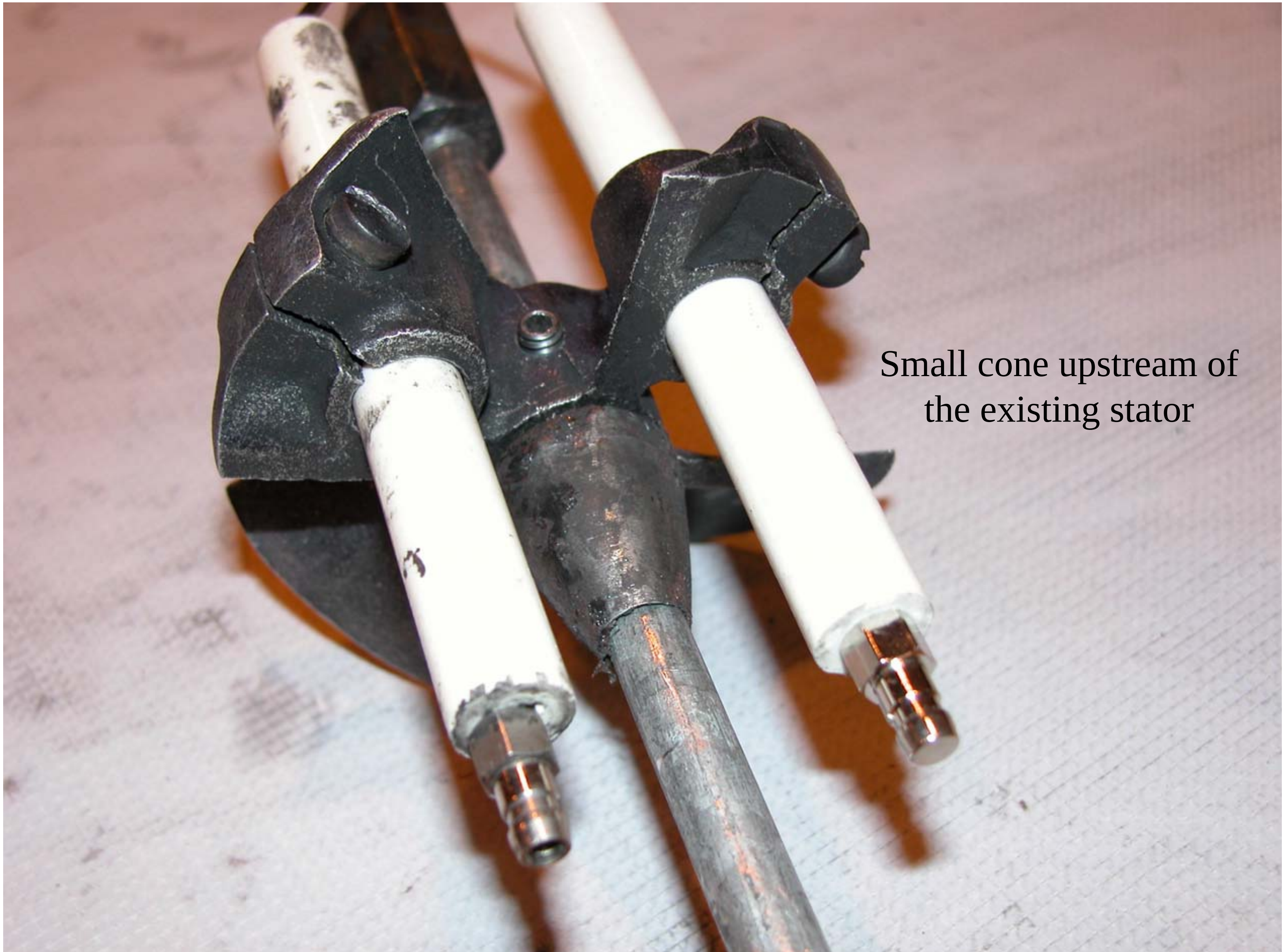
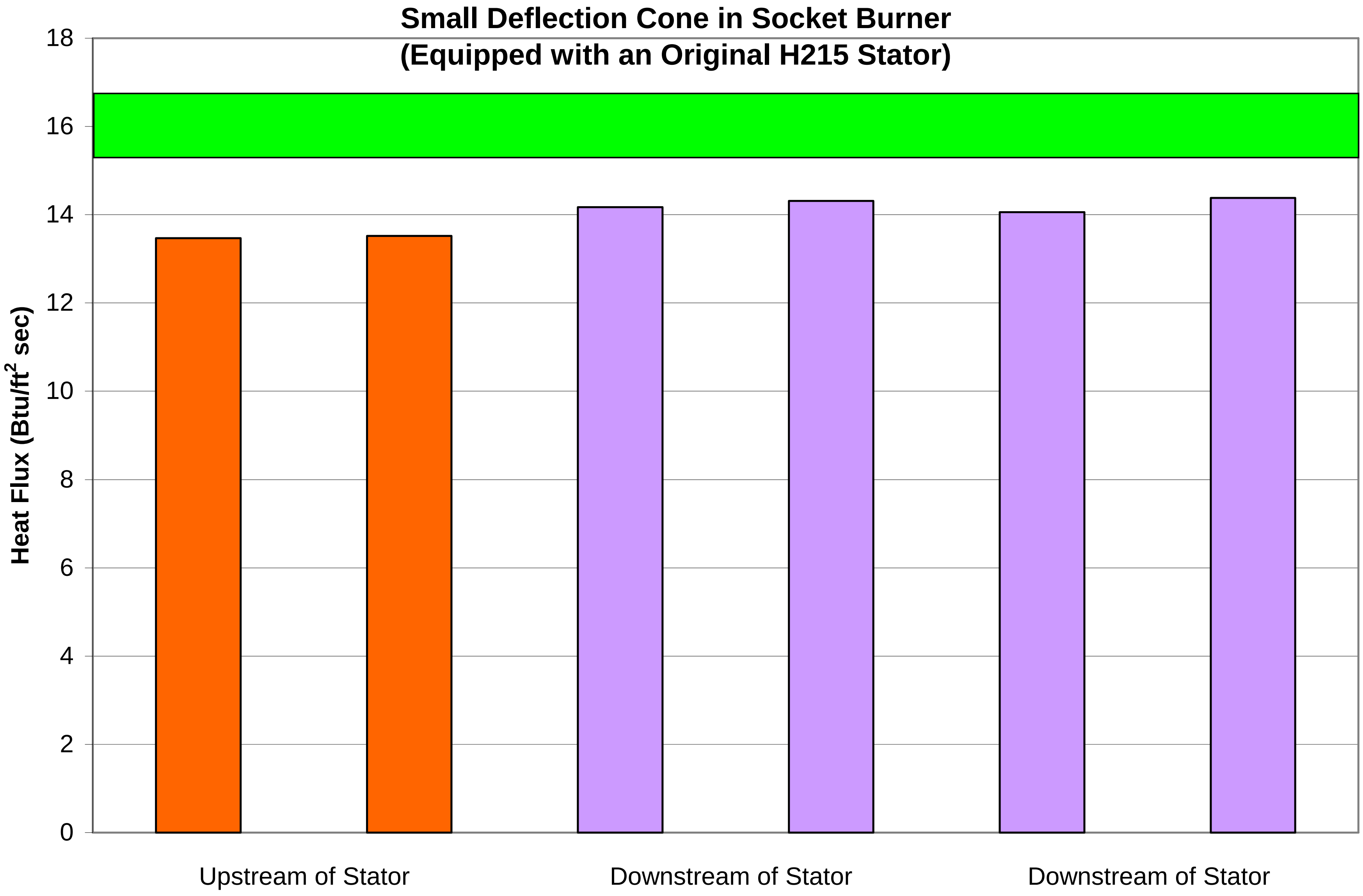


# Assorted Components Used in Socket Burner

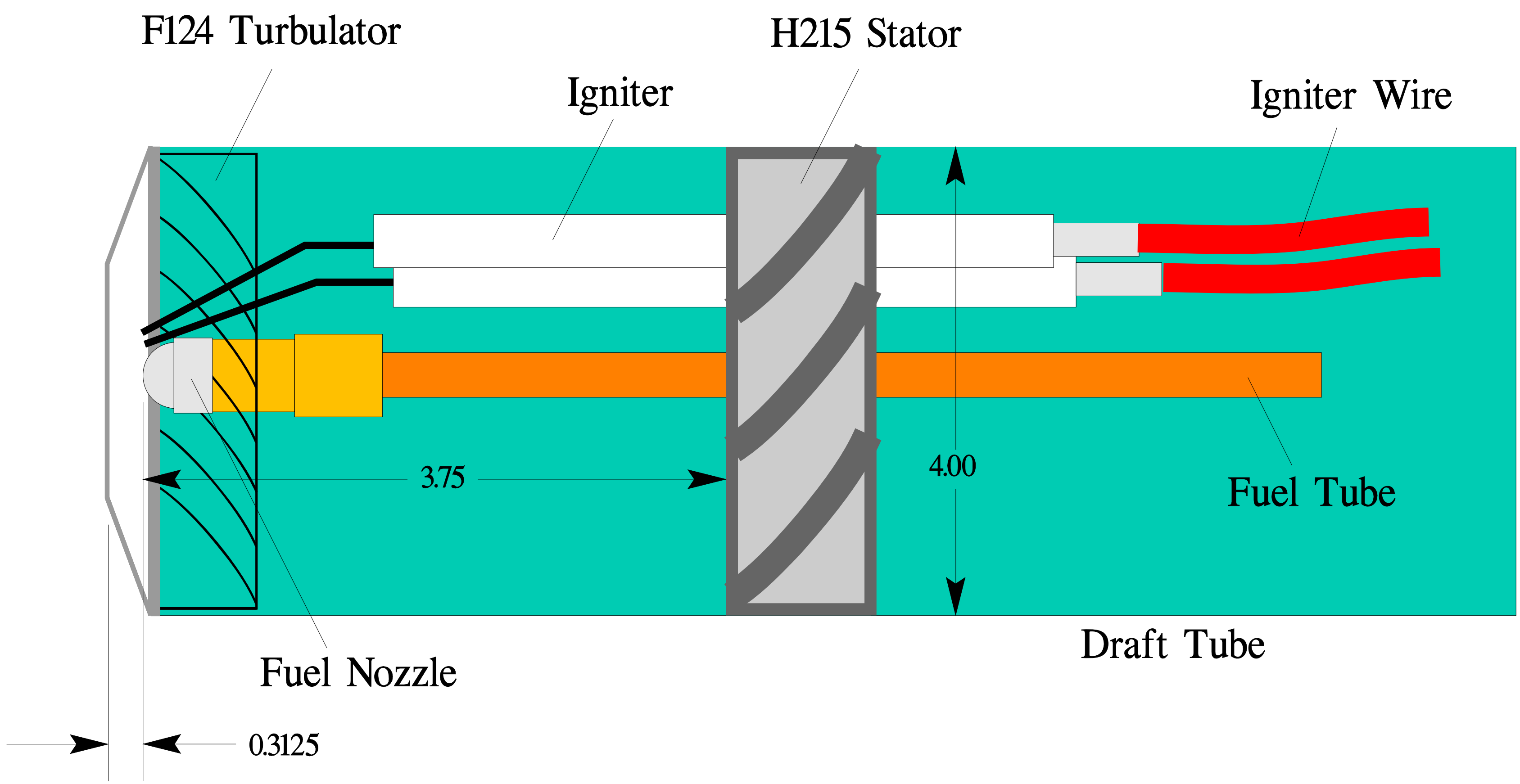
# Possible Simple Modifications to Socket Burner



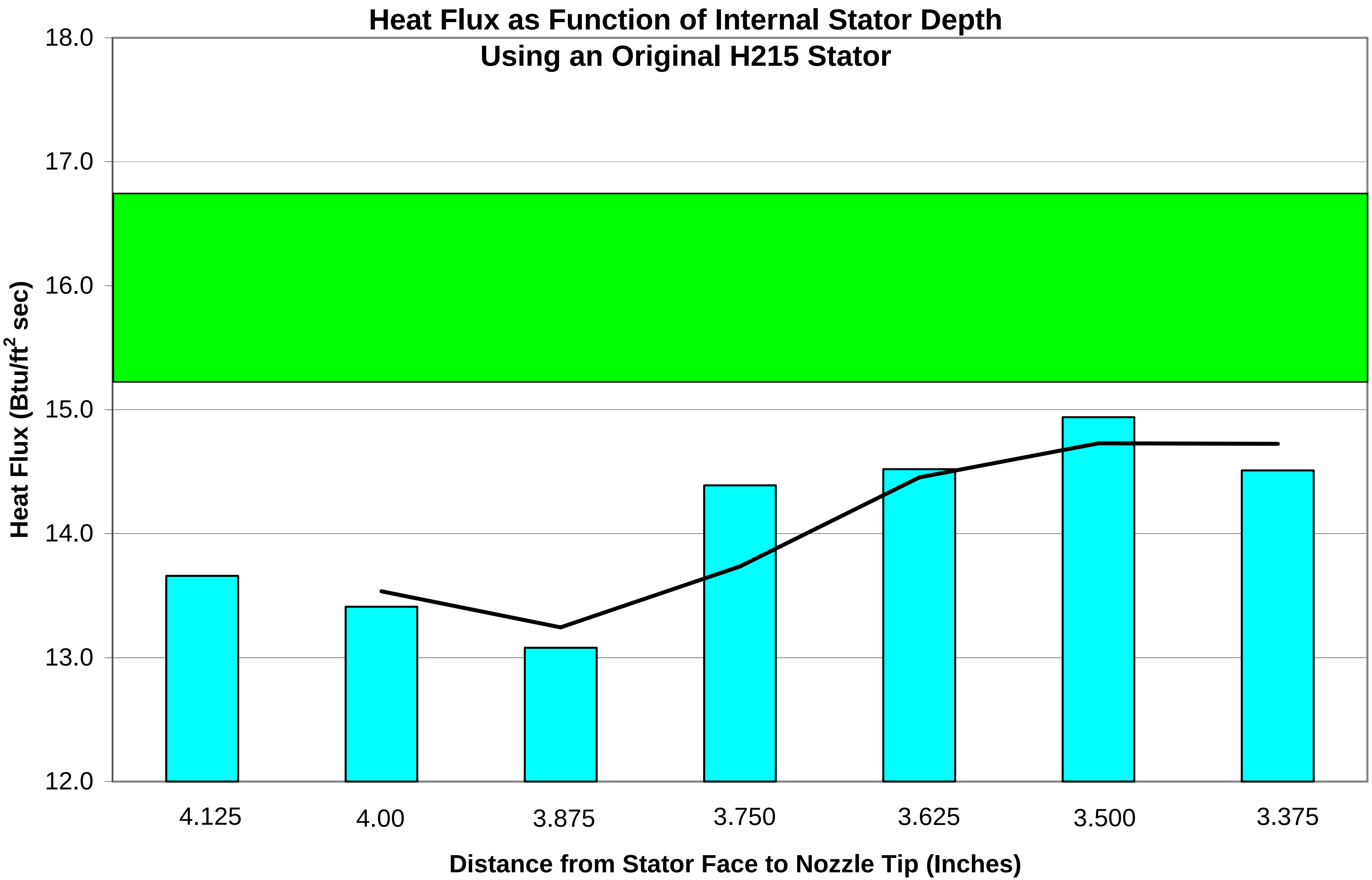
# Possible Simple Modifications to Socket Burner


Small Deflection Cone in Socket Burner
(Equipped with an Original H215 Stator)
Heat Flux (Btu/ft2 sec)
0
2
4
6
8
10
12
14
16
18
Upstream of Stator
Downstream of Stator
Downstream of Stator

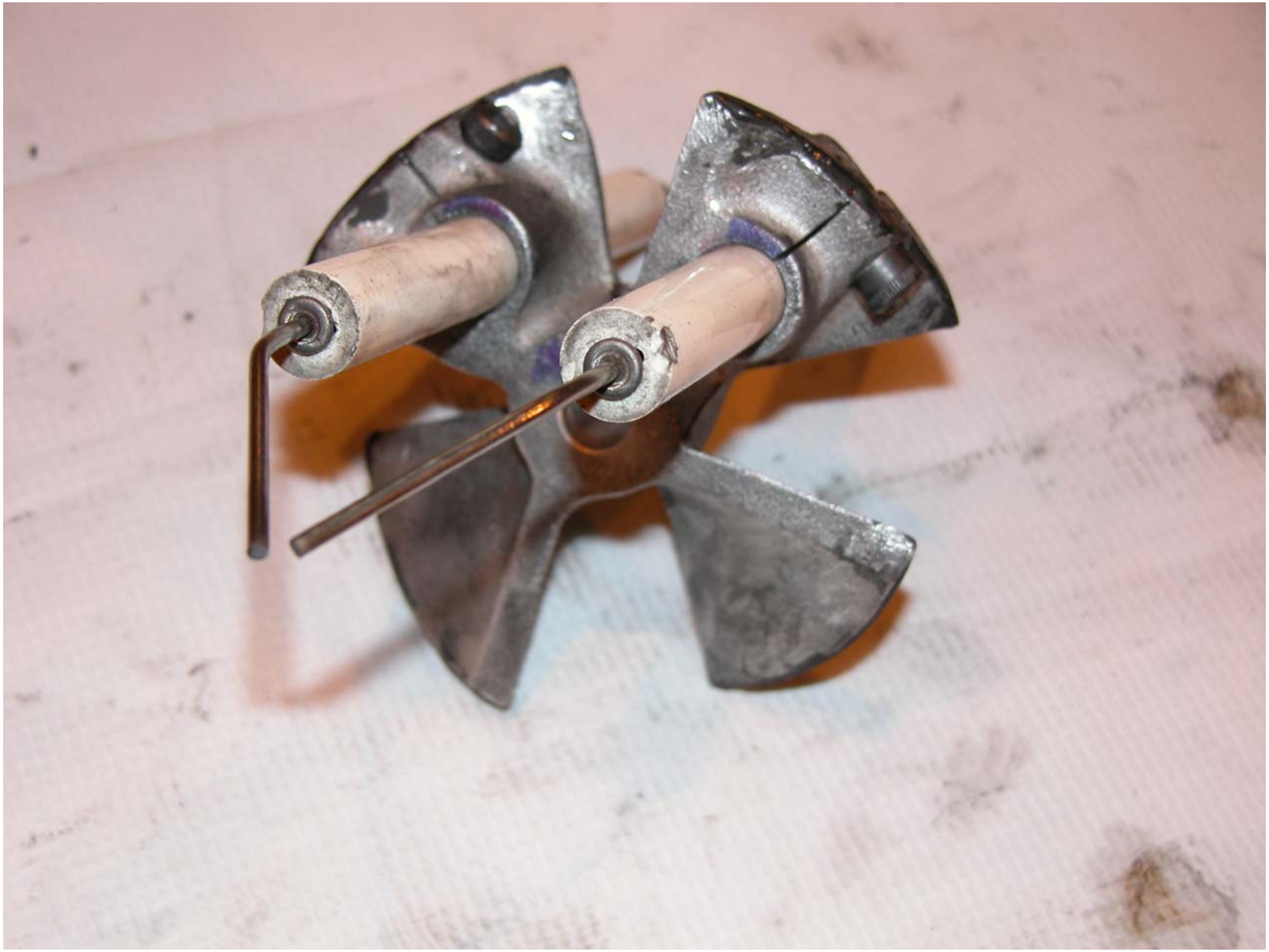
# Current Specification for Stator Position



# Socket Burner Testing

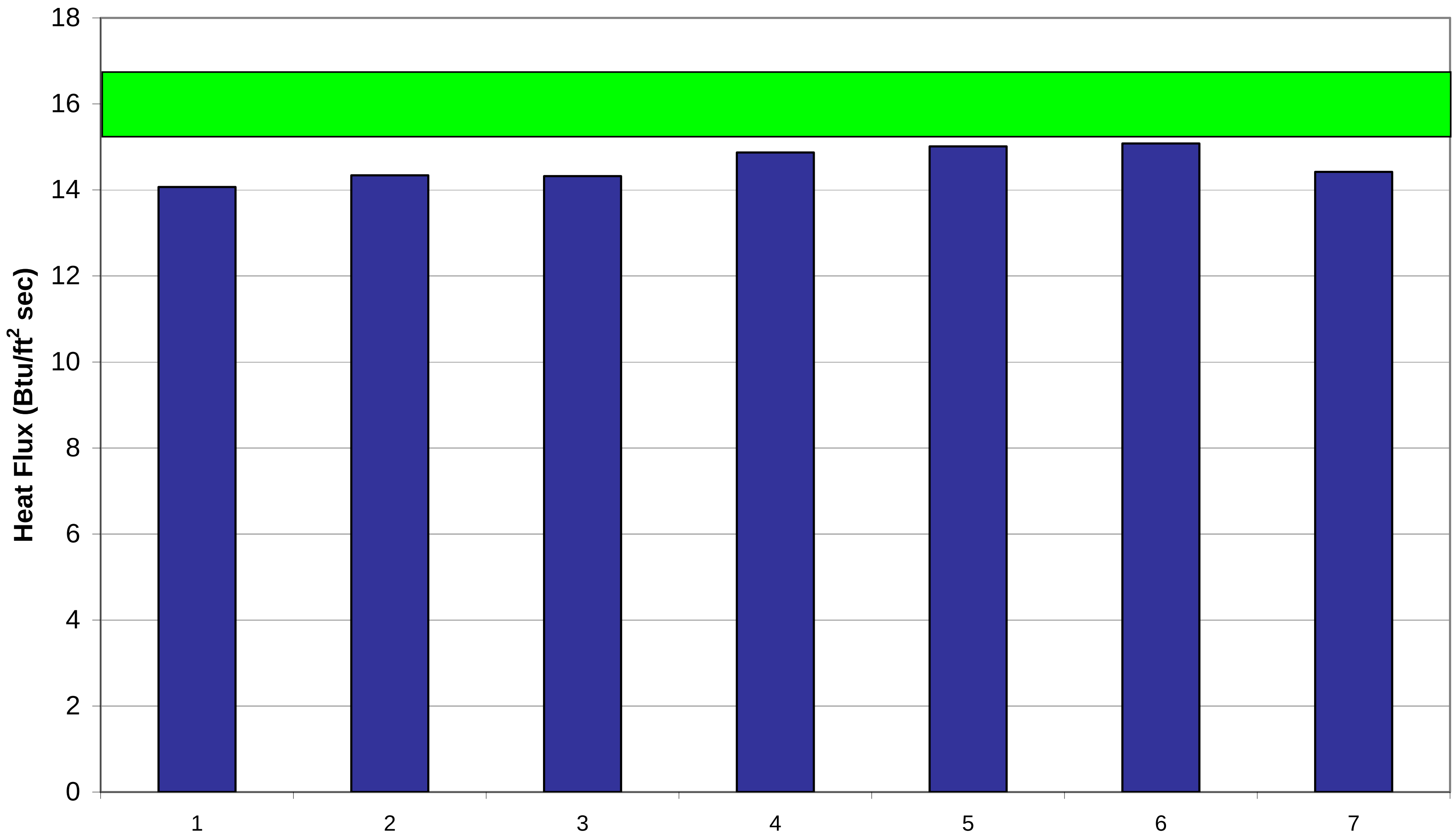


# Reproduction Stator, Modified at Edges of Blades



# Socket Burner Testing

**Reproduction Stator Modified at Edges**
**Using Epoxy Filler (Initial Modification)**



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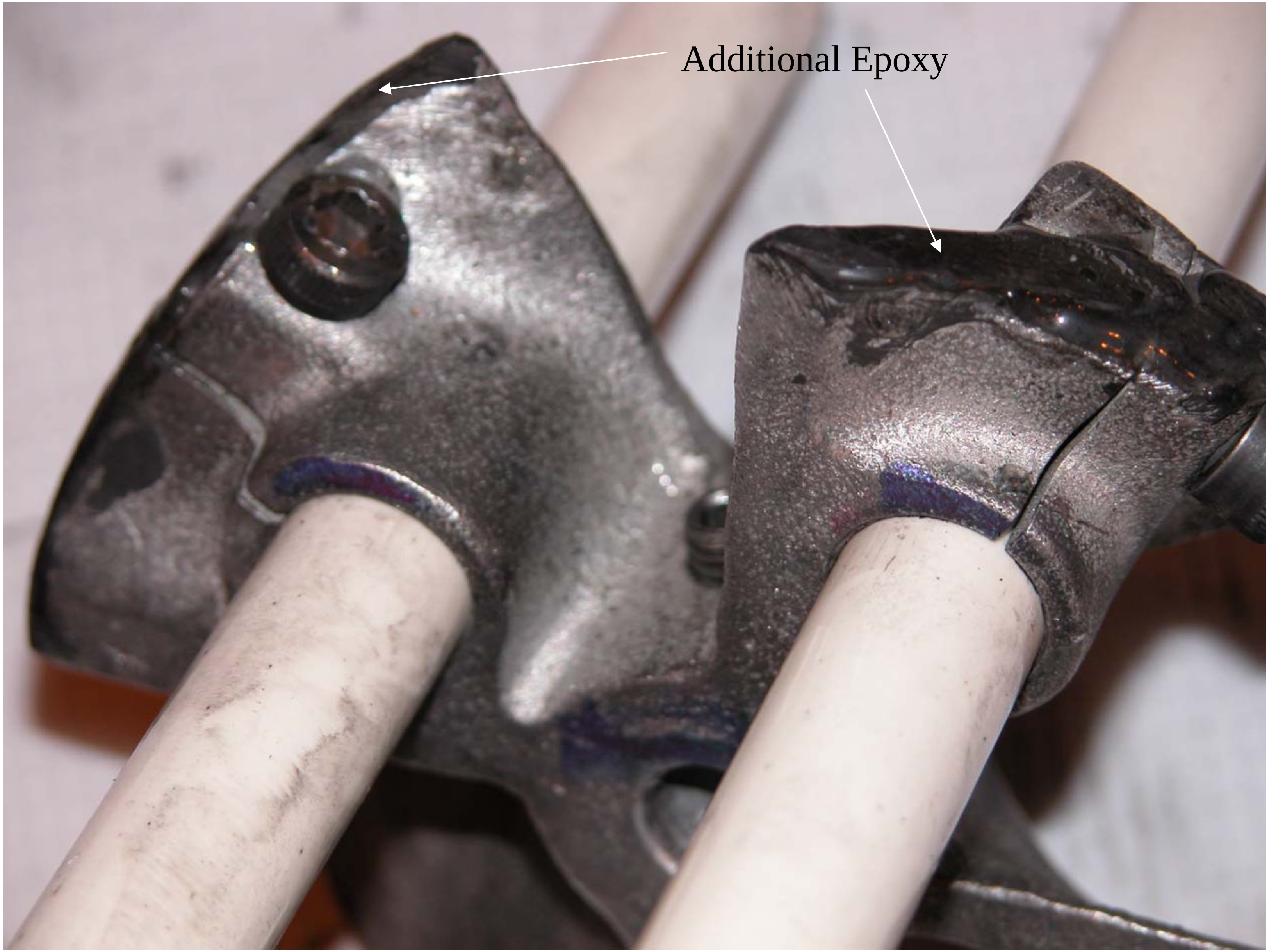

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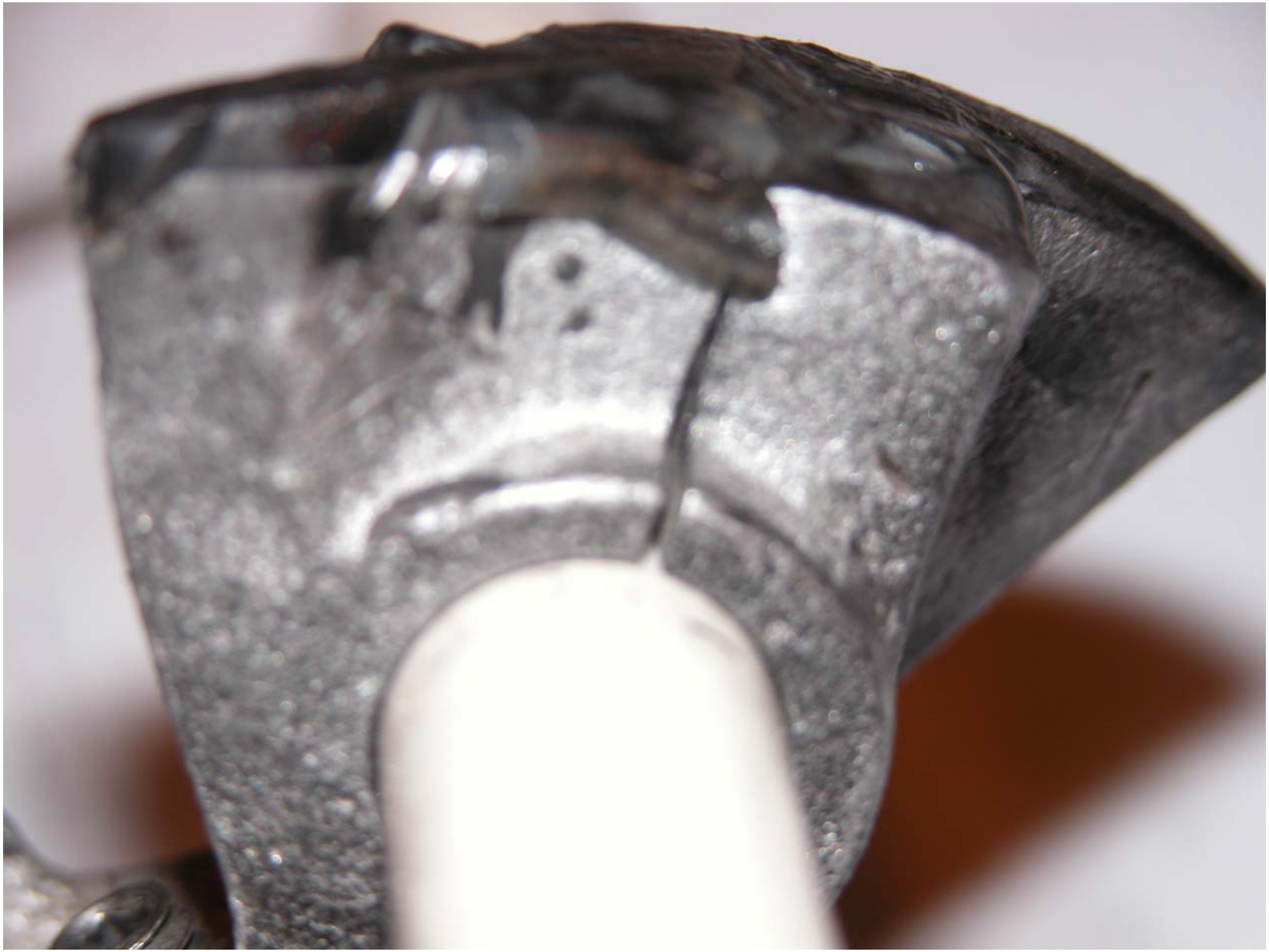

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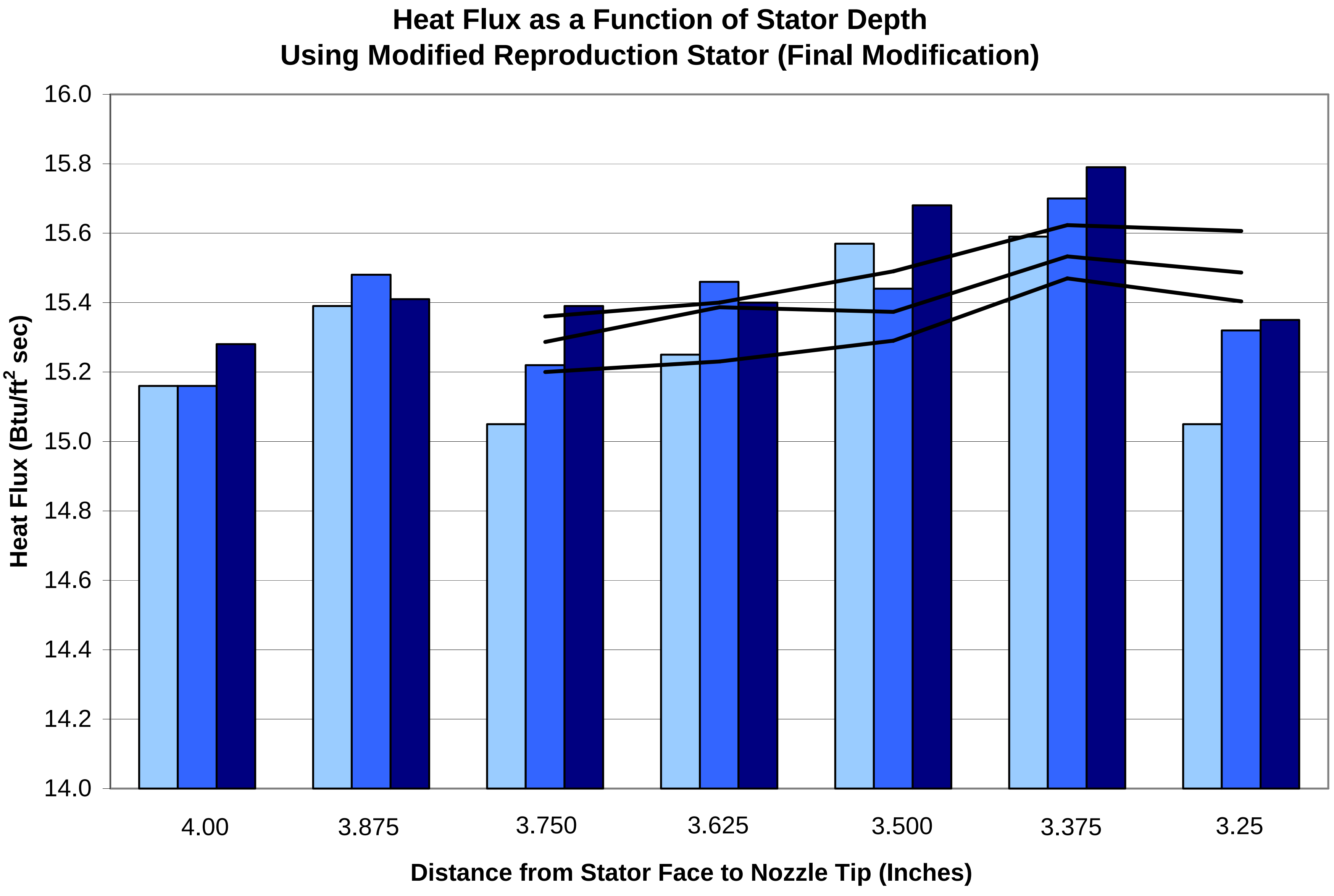

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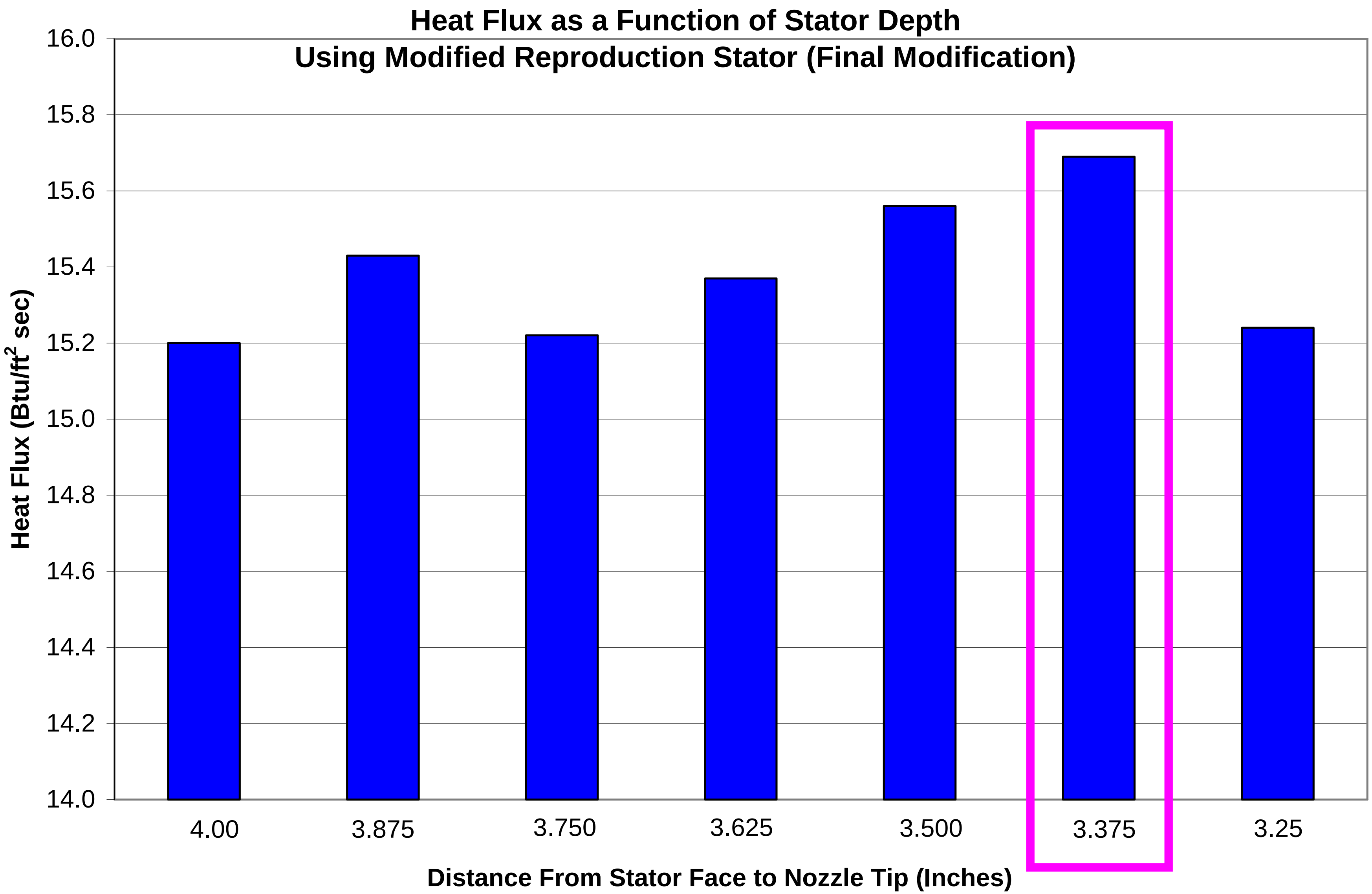
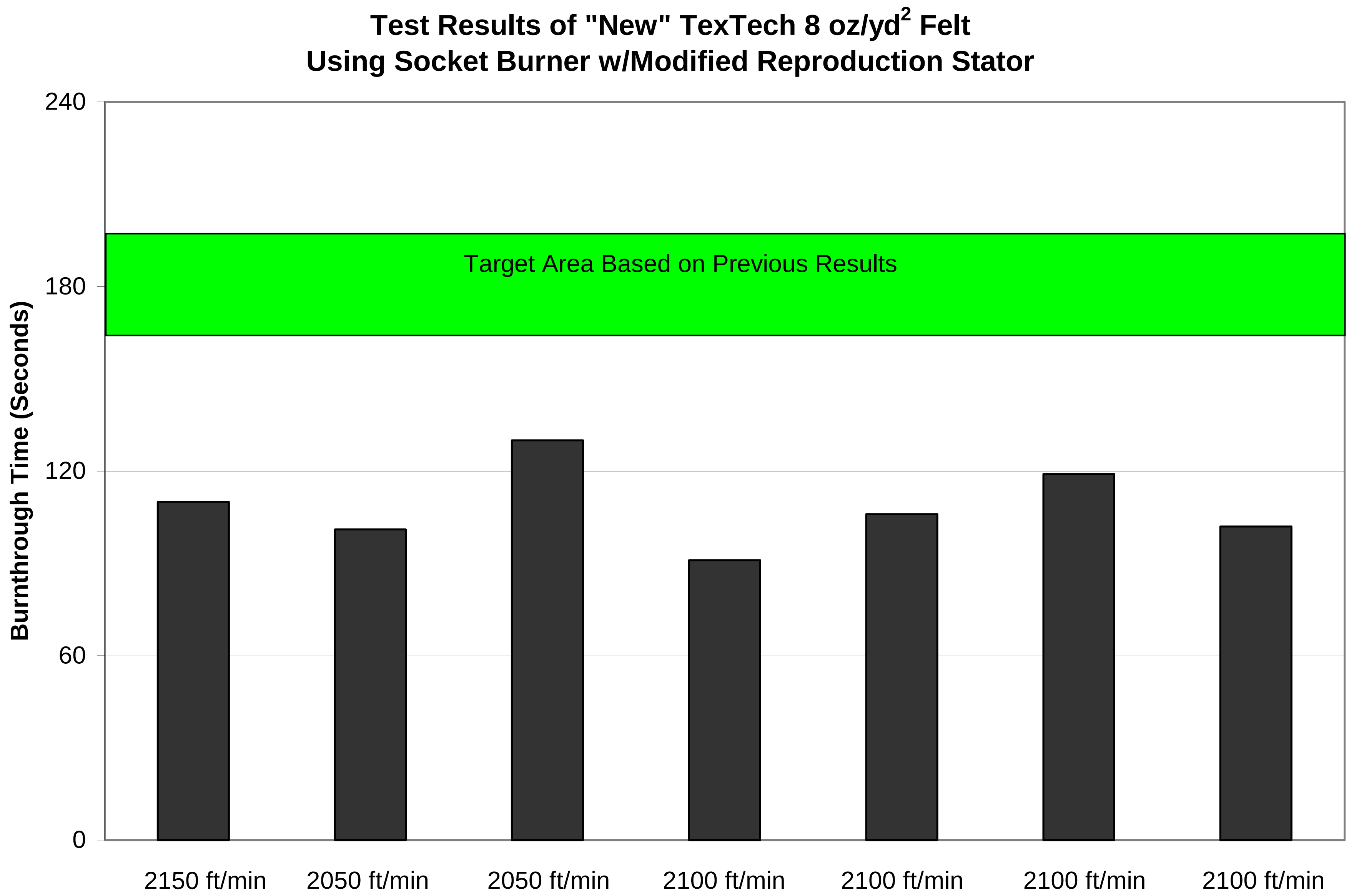
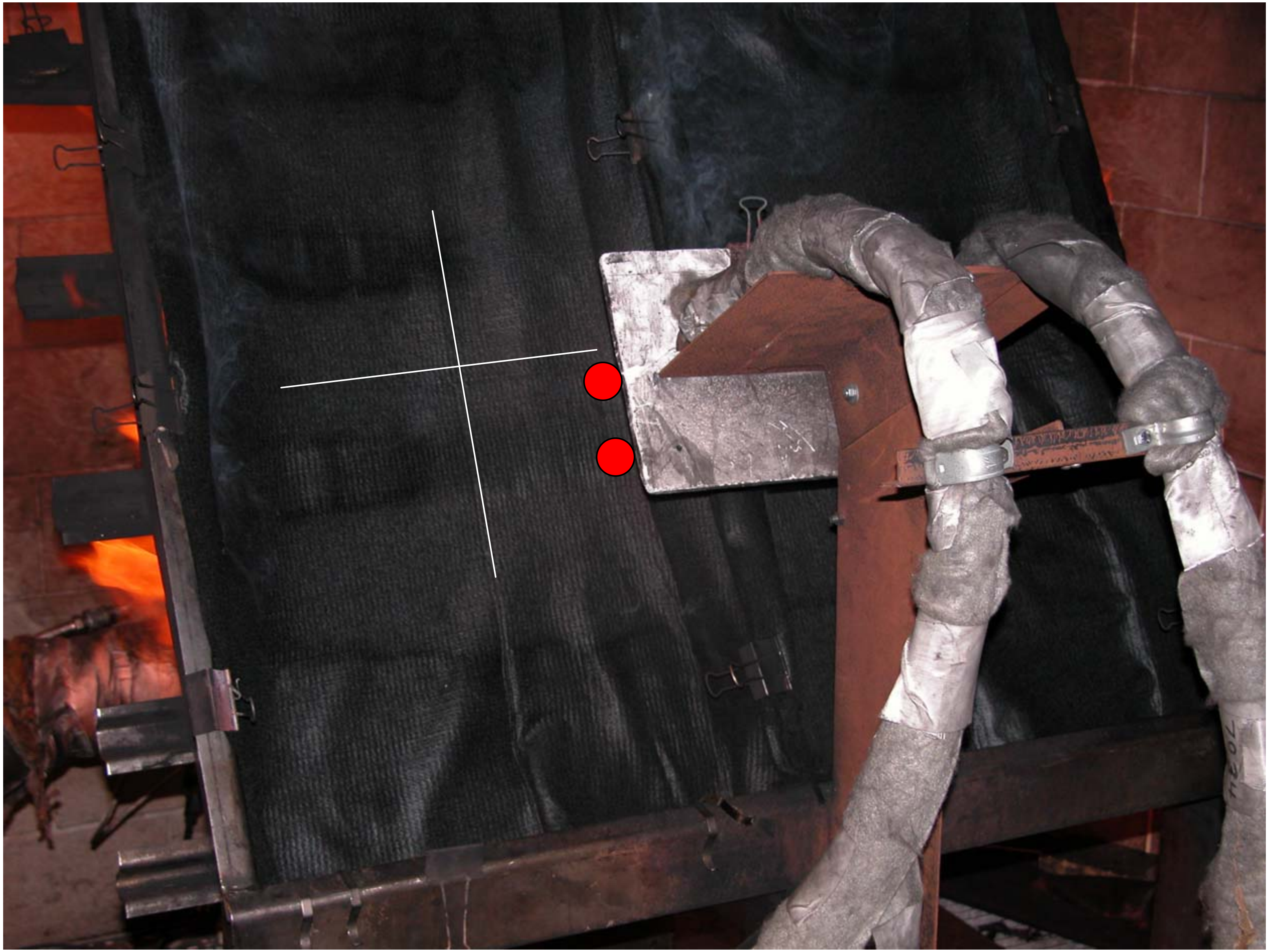


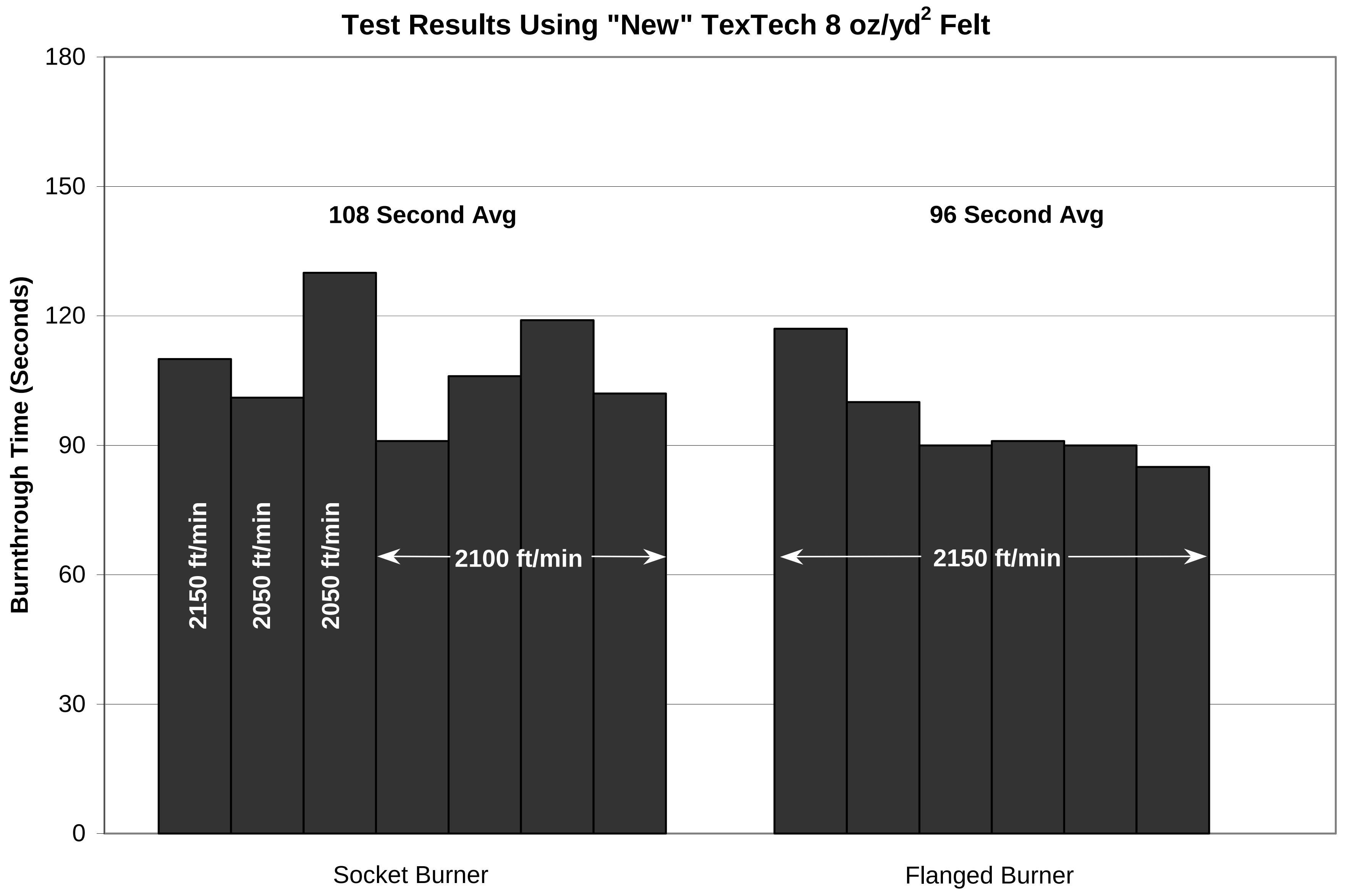

Test Results of "New" TexTech 8 oz/yd$^2$ Felt
Using Socket Burner w/Modified Reproduction Stator
Burnthrough Time (Seconds)
240
180
120
60
0
Target Area Based on Previous Results
2150 ft/min
2050 ft/min
2050 ft/min
2100 ft/min
2100 ft/min
2100 ft/min
2100 ft/min

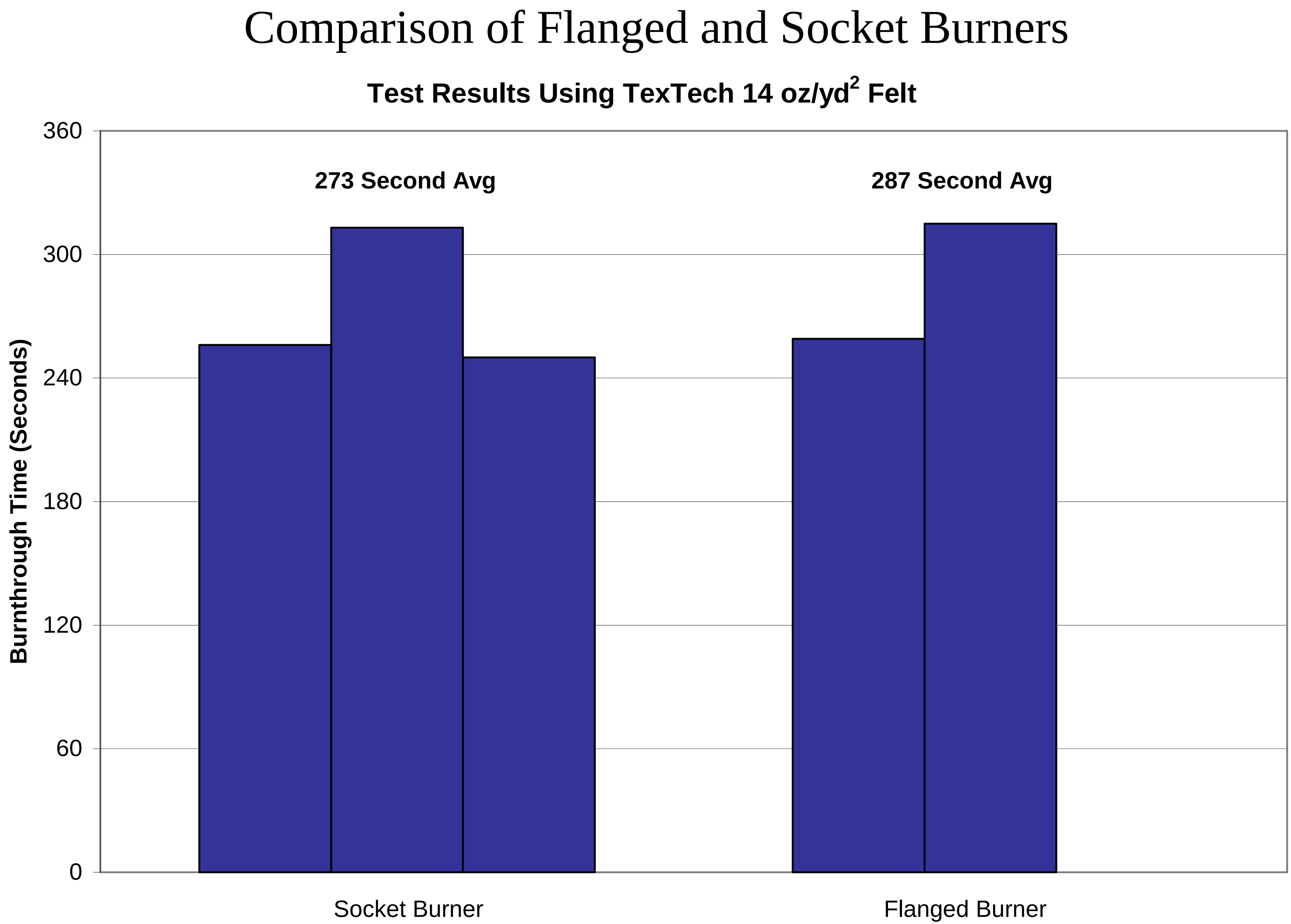
# New TexTech Material Showing Creased Areas

# Burnthrough Location of New TexTech Material



# Comparison of Flanged and Socket Burners





Comparison of Flanged and Socket Burners
Test Results Using TexTech 14 oz/yd2 Felt
273 Second Avg
287 Second Avg
Burnthrough Time (Seconds)
0
60
120
180
240
300
360
Socket Burner
Flanged Burner

# Summary of Testing

•Slight differences in burner housings/draft tube result in higher exit air velocity when using the socket-style burner.

•Lowering the intake velocity of the socket burner to 1900 ft/min resulted in good correlation to flanged burner, but heat flux still low (when using un-modified stator).

•An assortment of modifications were tested in an attempt to reduce the exit air velocity, and ultimately replicate the flanged burner performance. Modifications placed upstream and downstream of the stator appeared to have very little impact on the measured heat flux.

# Summary of Testing (con't)

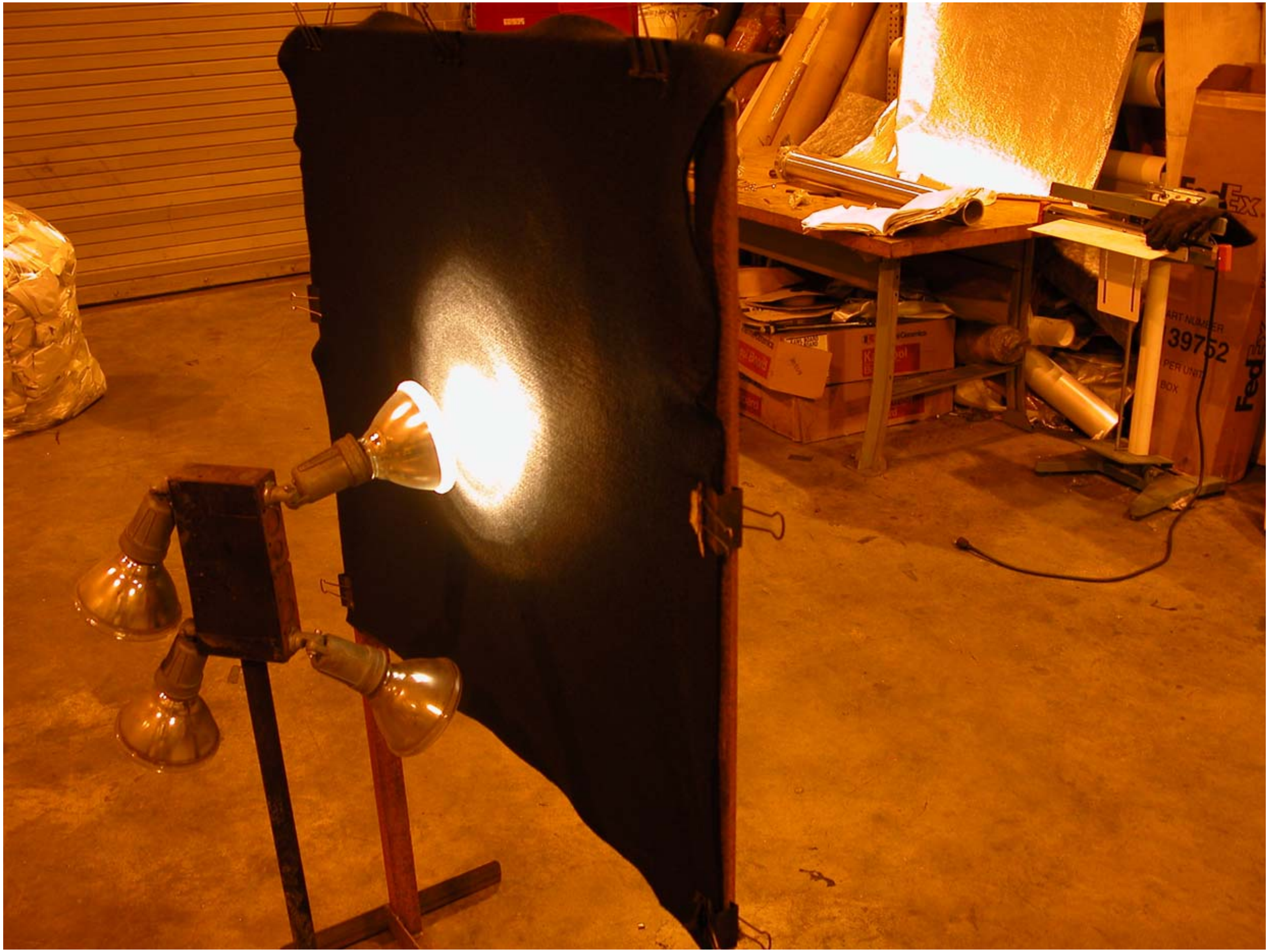
•Enlargement of stator diameter, resulting in a tighter fit within the draft tube bore, produced higher heat flux in socket burner.

•Positioning of the stator within the draft tube was critical in maximizing the heat flux for the socket burner.

•Final results using modified stator at maximized depth indicate good correlation between socket and flanged burners.

# Influence of Material on Test Method Results

# Consistency of Test Data Using TexTech Blanket Material



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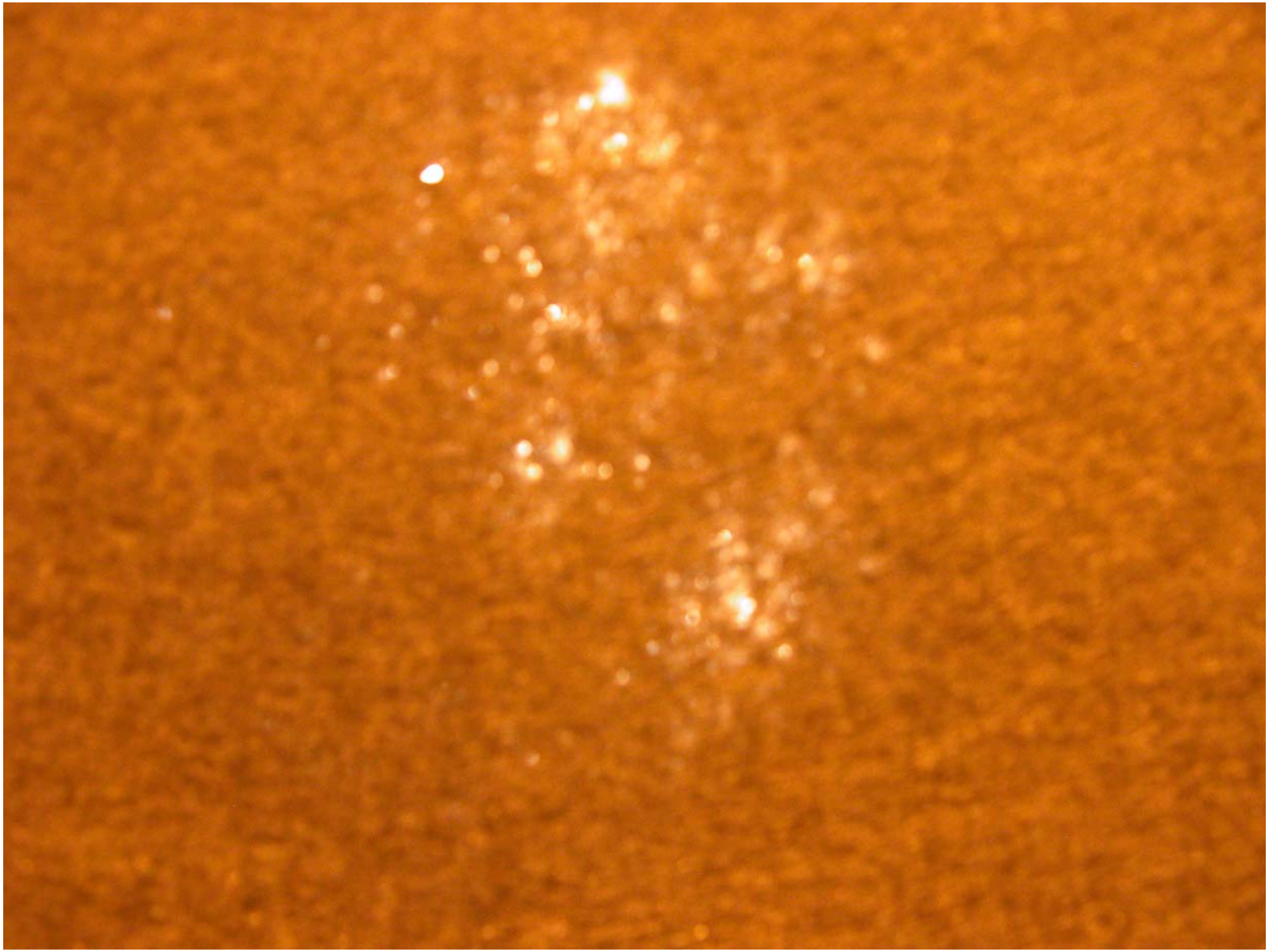

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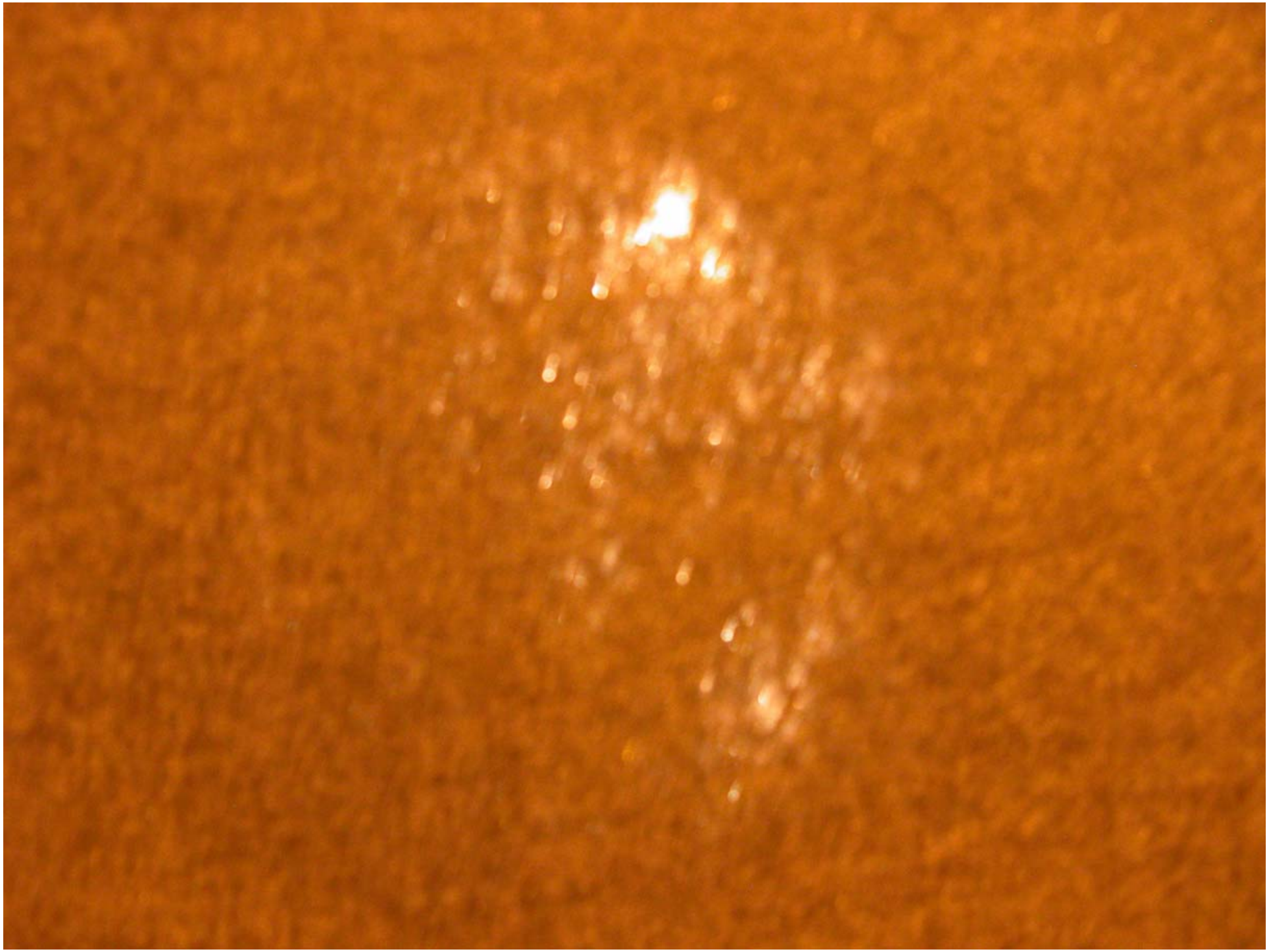
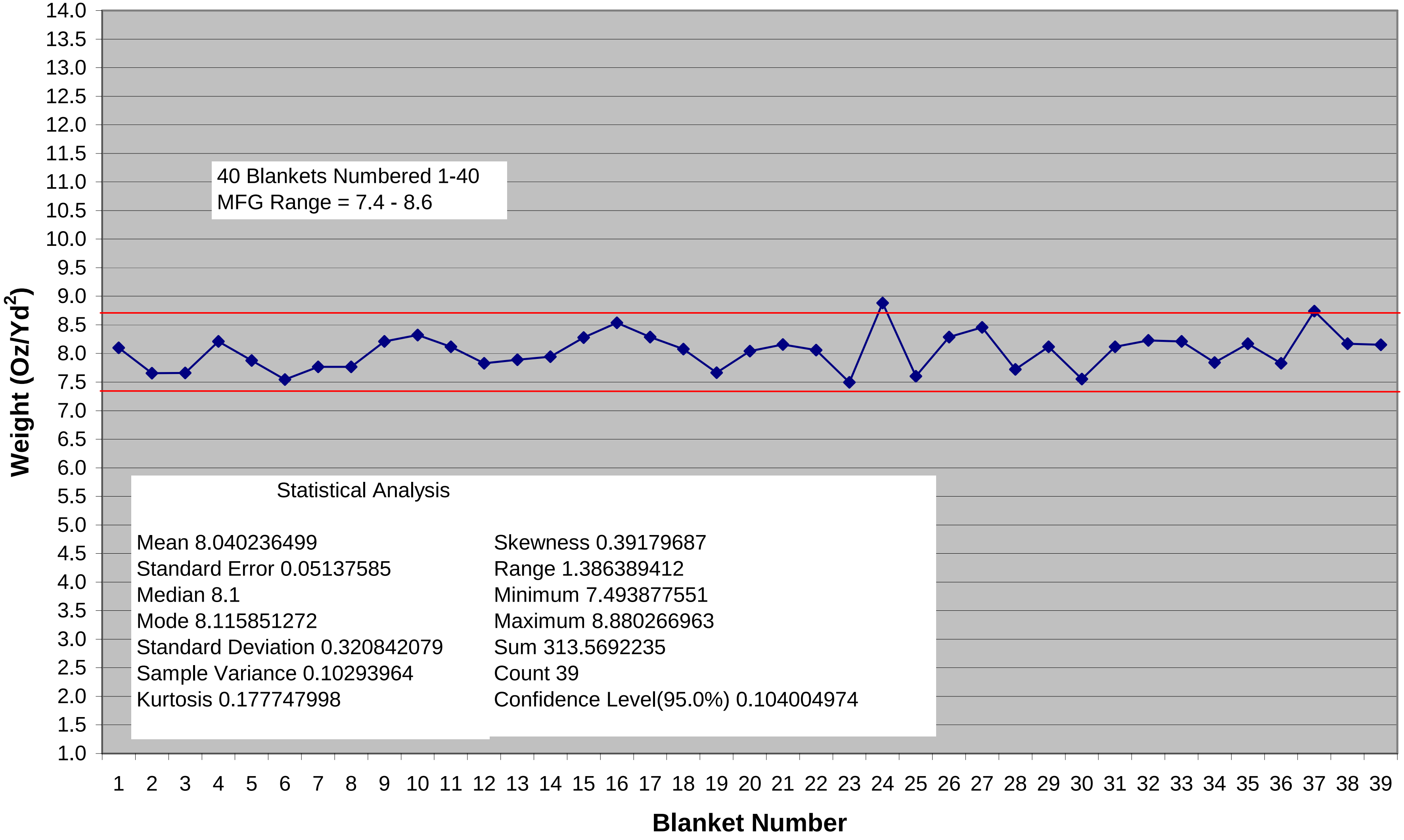


## Tex Tech Style 362
## (8.0 Oz/Yd$^2$ PAN Blanket)



# Planned Activities

Confirm stator modifications are repeatable in socket burner.

Supply modified stators to participating labs that currently use the socket style burner.

Conduct socket-burner round robin, with original FAA burner as a control.

Consider blueprinting optimal stator, reproduce via machining (no casting!).

Develop a new stator for future use, which can be produced via machining.