



**Federal Aviation
Administration**

International Aircraft Materials Fire Test Working Group Meeting

Task Group Session on New Flammability Test for Magnesium-Alloy Seat Structure

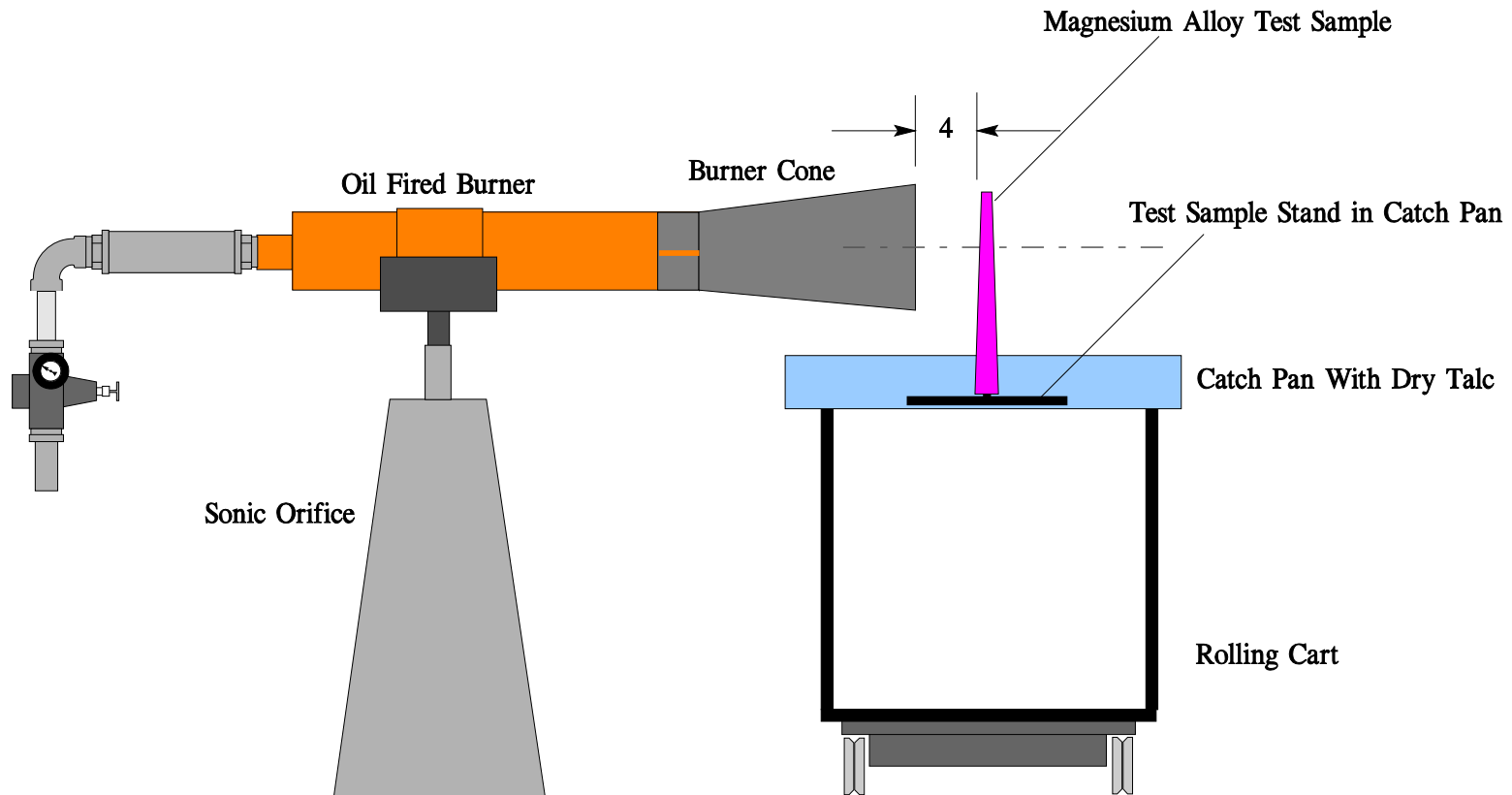
Presented to: International Aircraft Materials Fire
Test Working Group, Atlantic City

By: Tim Marker, FAA Technical Center

Date: October 19-20, 2011



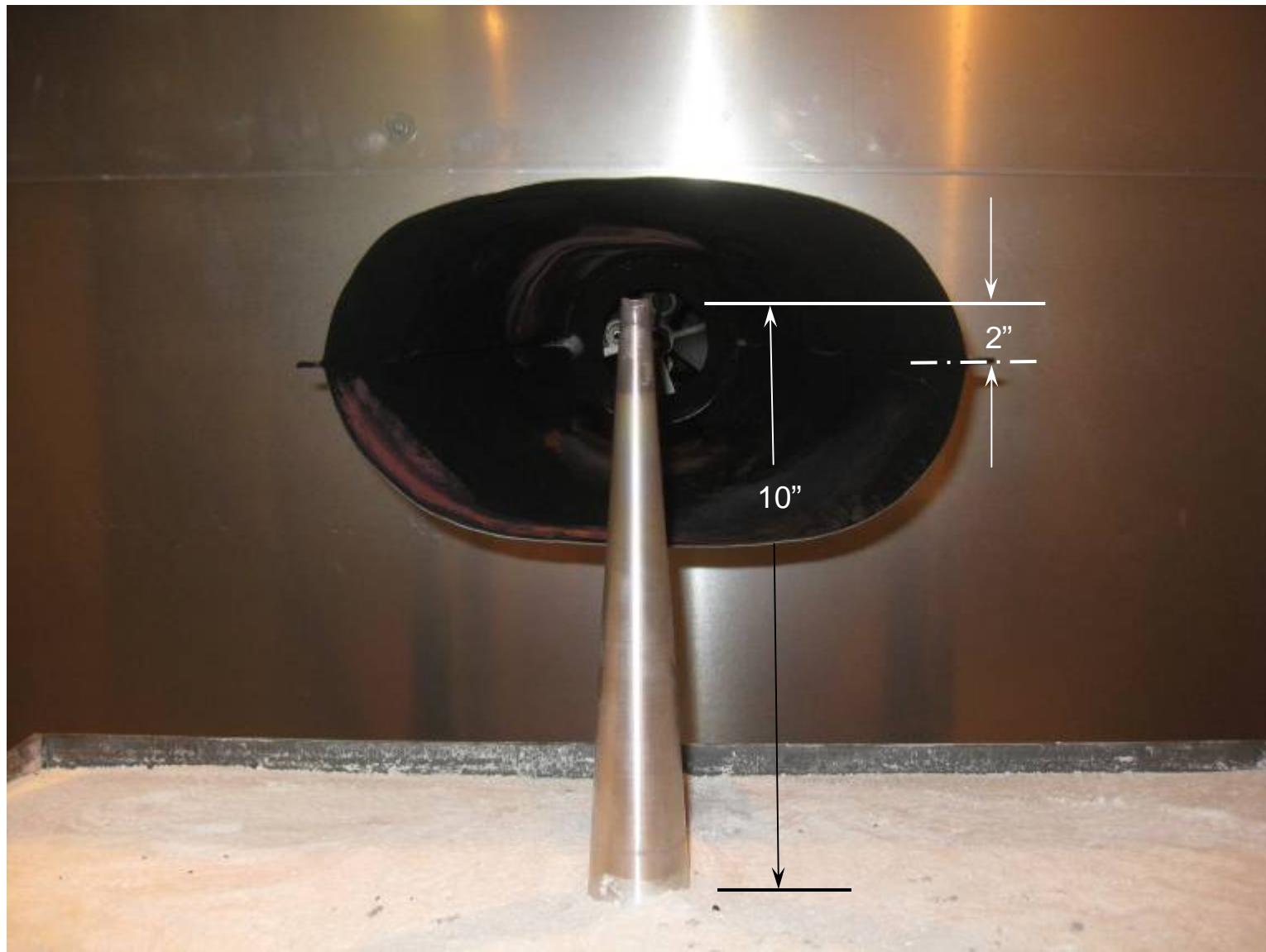
Proposed Magnesium Alloy Flammability Test



Objective: reproduce results obtained in full-scale tests

WE-43: After several minutes of exposure, remove burner, sample burns for approx 1 minute

Truncated Cone Test Sample of Magnesium Alloy



Planned Activities for Summer 2011

...from previous meeting in Bremen

Continue testing of various magnesium alloys, how do they react compared to WE-43 and AZ-31

- AZ91E
- AZ80
- ZK60
- ZE41
- Elektron 21
- Elektron 675

Problems Encountered with Truncated Cone

Repeatability

Molten section of cone falls down into pan, no ignition

Molten alloy creates thin shape which is ignited; ignition stops after short period

Molten alloy creates shape that ignites; ignition of remaining cone occurs, resulting in extended ignition

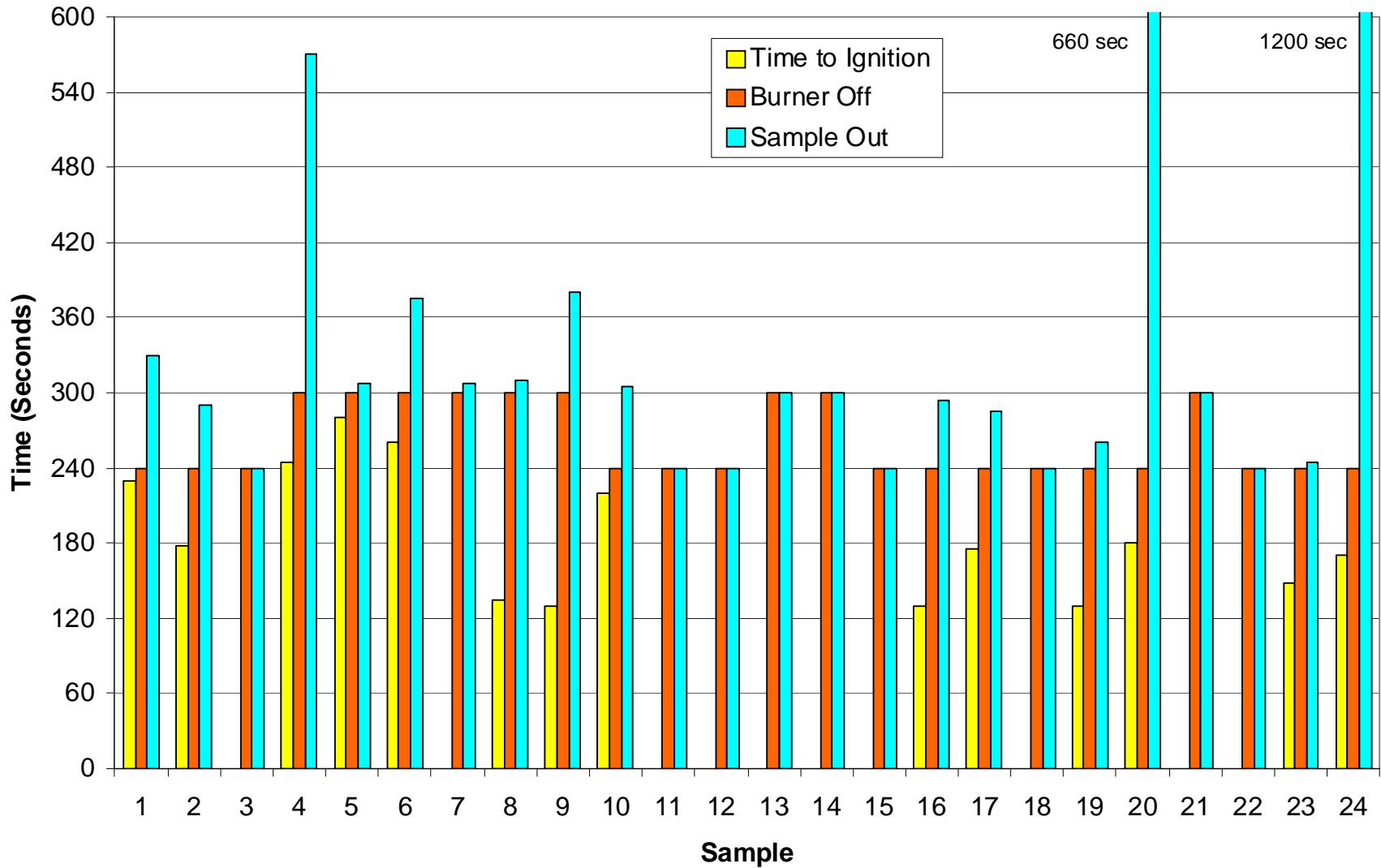


Problems Encountered with Truncated Cone

Wide range of test results based on melting process



Vertically-Oriented Solid WE-43 Cone Test Results



Truncated Cone on Side

Determine if ignition will continue horizontally

No ignition 6:00



9/20/11

Horizontal Thin Cylinder Sample

Ignition 6:15
Burner off 7:00



Horizontal Thin Cylinder Sample (post test)

Sample completely burns up



9/21/11

Horizontally Mounted Thin Rectangular Box

Determine ignition/burning on thin-walled specimen



Horizontally Mounted Thin Rectangular Box



Horizontally Mounted Thin Rectangular Box

Burn at 4:10

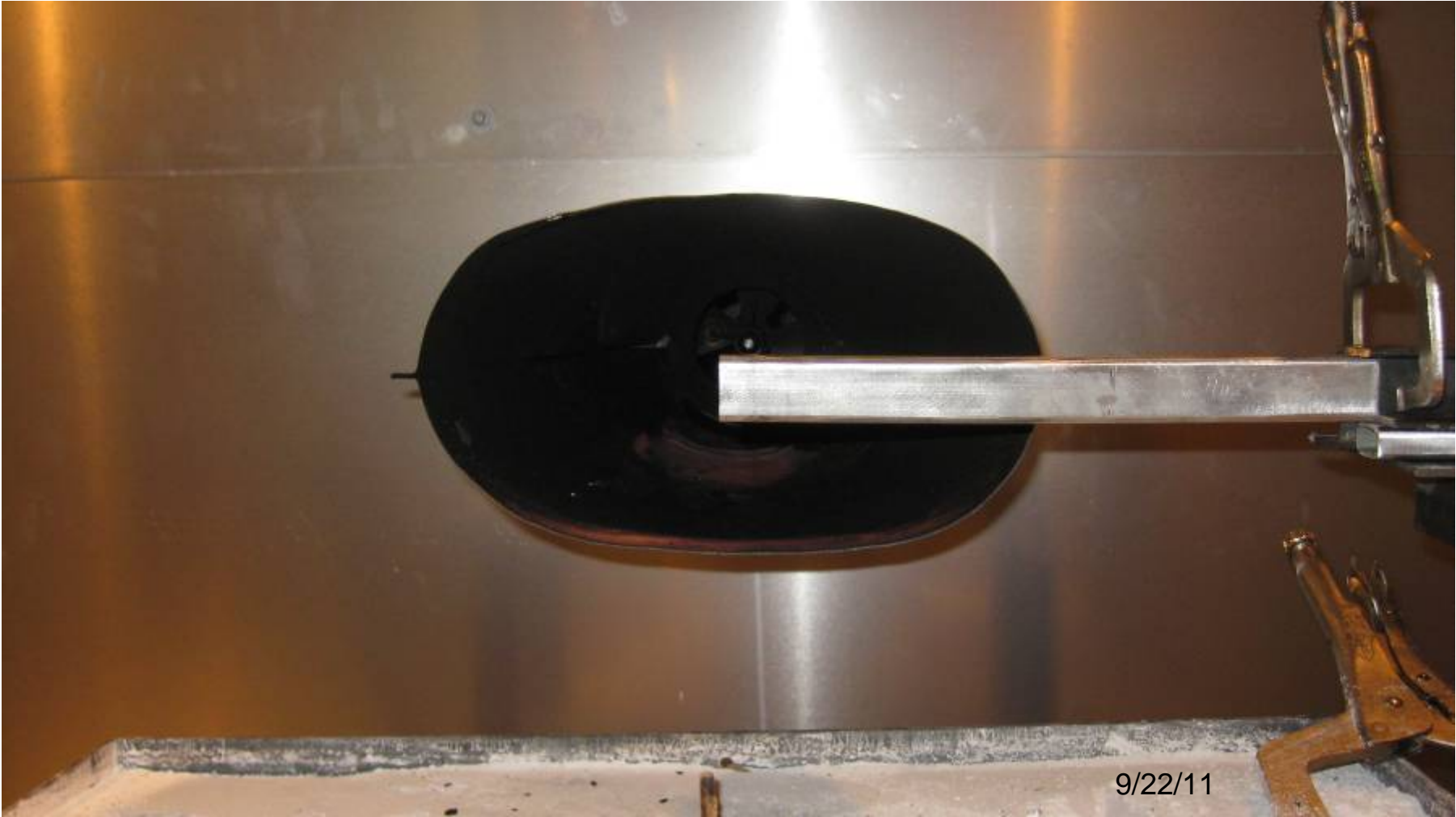
Burner off 5:00

Sample out 6:20

After burn 1:20



Horizontally Mounted Thin Rectangular Baggage Bar



Horizontally Mounted Thin Rectangular Baggage Bar



Horizontally Mounted Thin Rectangular Baggage Bar

Burn at 2:50

Burner off 4:00

Sample out 4:20

After burn 0:20

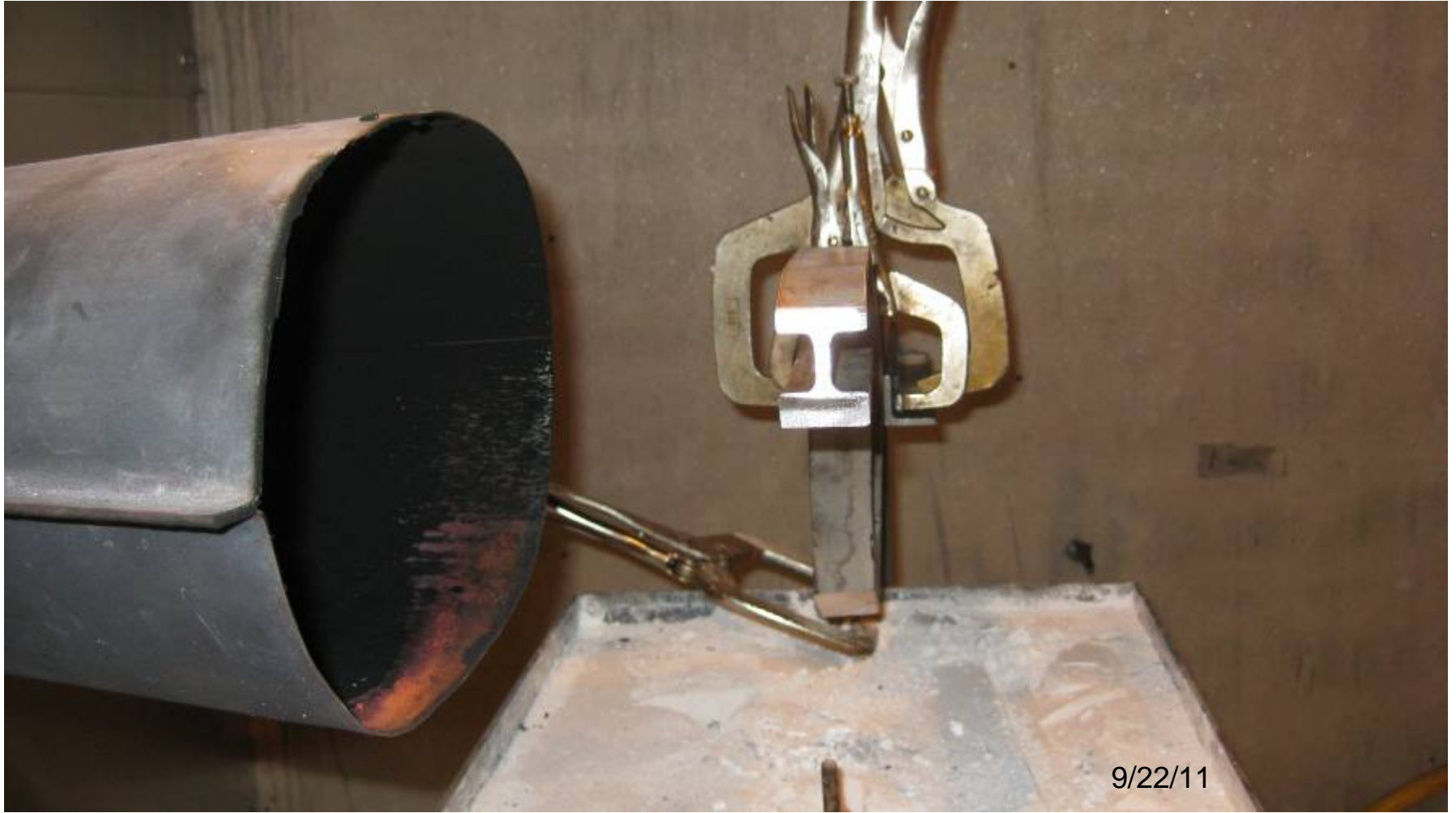


9/22/11

Leg Plate "I" Web Mounted Horizontally



Leg Plate "I" Web Mounted Horizontally



Leg Plate "I" Web Mounted Horizontally

Burn at 4:45

Burner off 5:00

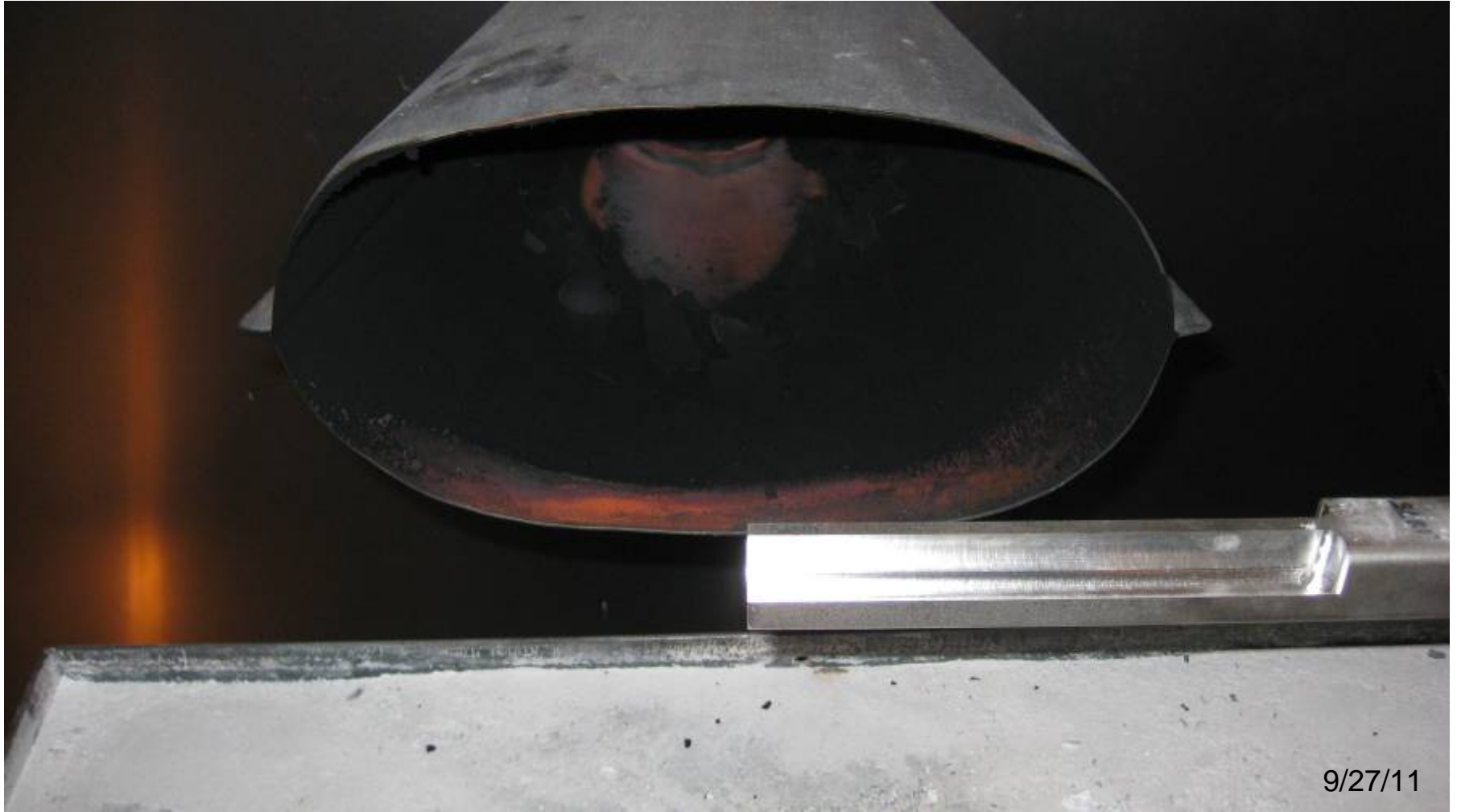
Sample out 6:30

After burn 1:30



9/22/11

“T” Web Machined from Leg Post, Mounted Horizontally
3/16” Vertical Web x 1/2” Horizontal Web



“T” Web Machined from Leg Post, Mounted Horizontally
3/16” Vertical Web x 1/2” Horizontal Web



“T” Web Machined from Leg Post, Mounted Horizontally

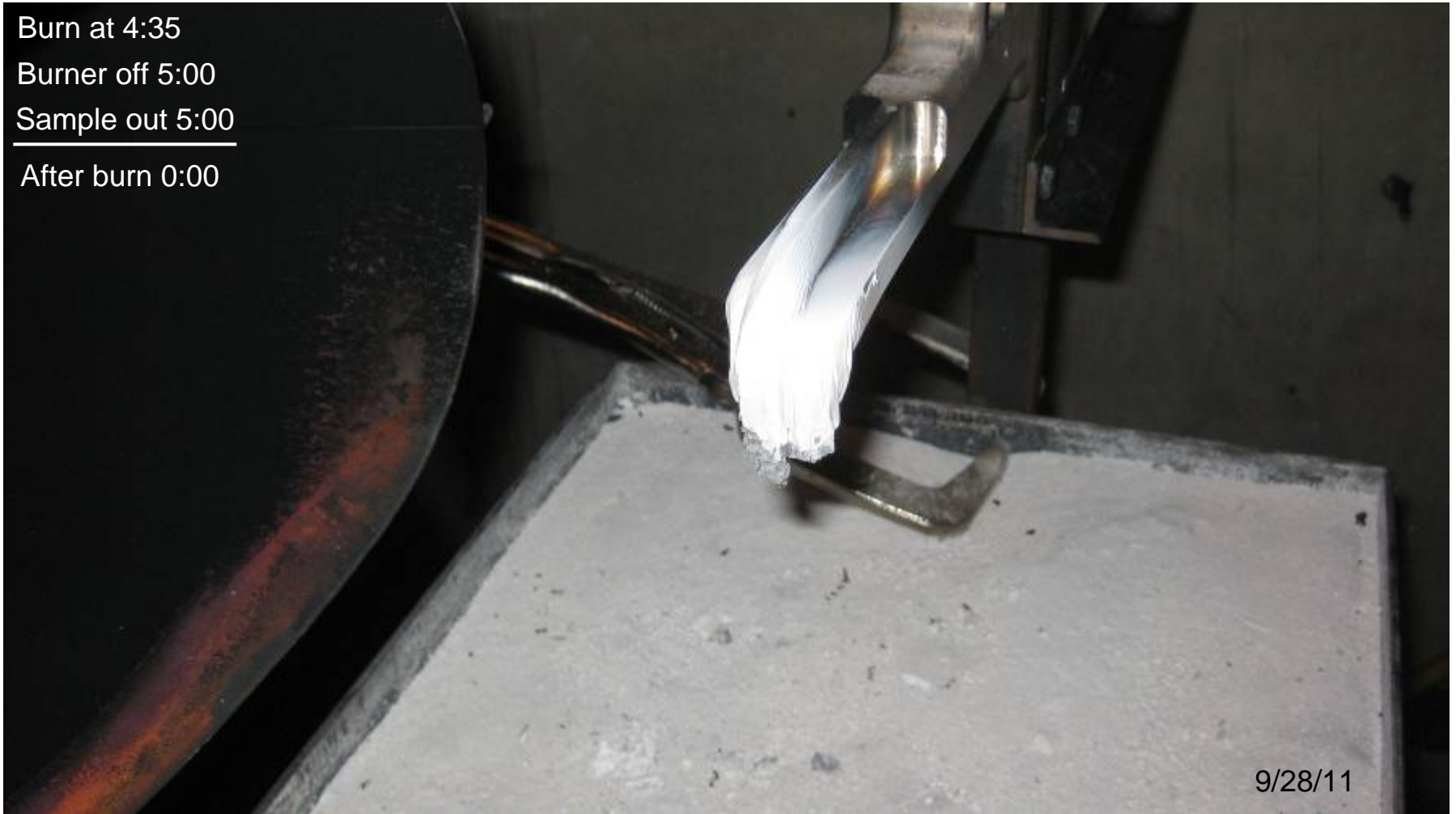
1/8” Vertical Web x 1/2” Horizontal Web

Burn at 4:35

Burner off 5:00

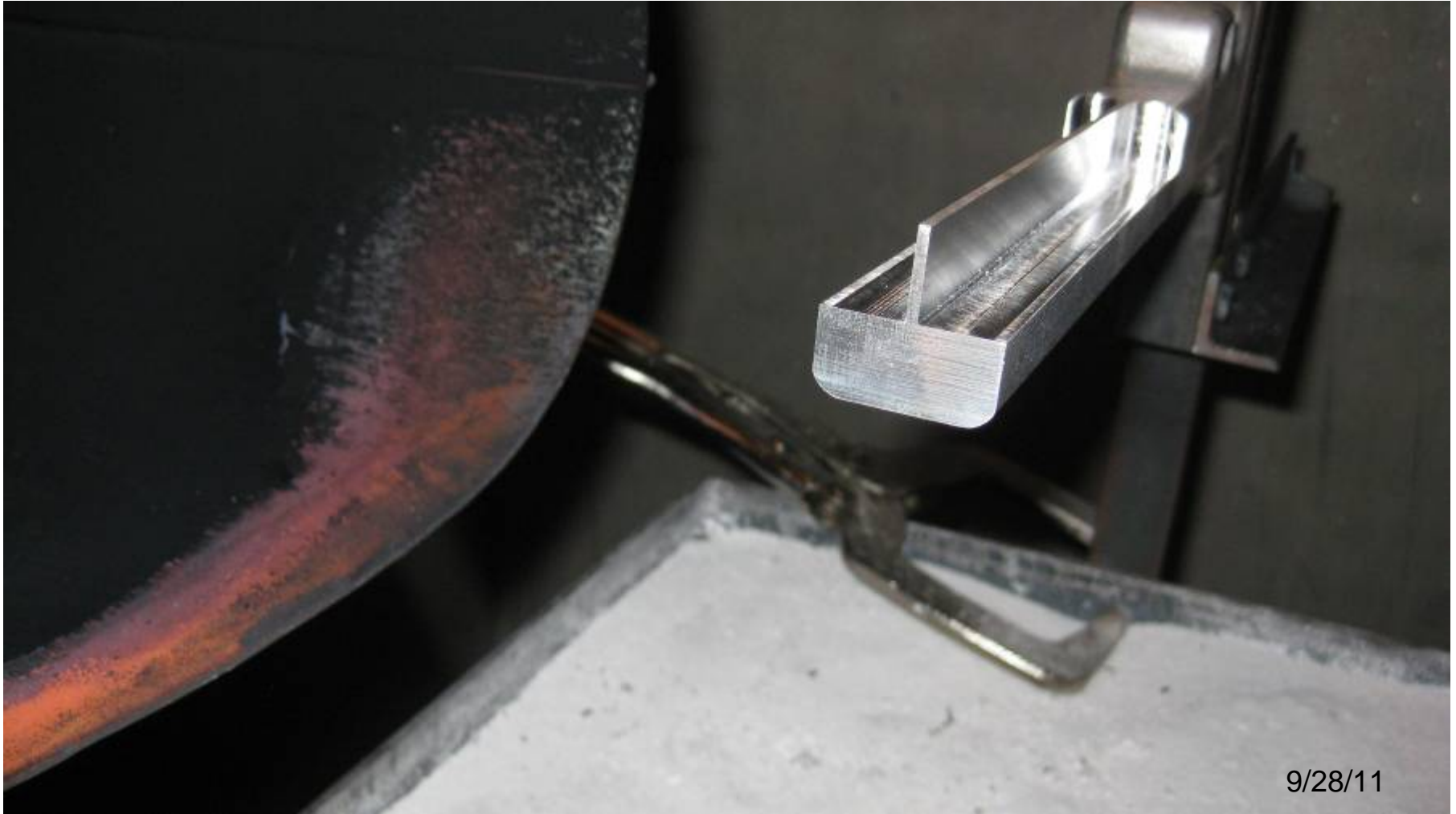
Sample out 5:00

After burn 0:00



9/28/11

“T” Web Machined from Leg Post, Mounted Horizontally
1/16” Vertical Web x 1/2” Horizontal Web



“T” Web Machined from Leg Post, Mounted Horizontally

1/16” Vertical Web x 1/2” Horizontal Web

Burn at 4:50

Burner off 5:00

Sample out 5:50

After burn 0:50



Inverted Cone WE-43, Suspended Vertically



9/29/11

Inverted Cone WE-43, Suspended Vertically



Inverted Cone WE-43, Suspended Vertically

Burner off 5:00
Sample out 5:00

After burn 0:00



9/29/11

Inverted Thinner Cone AZ-31, Suspended Vertically



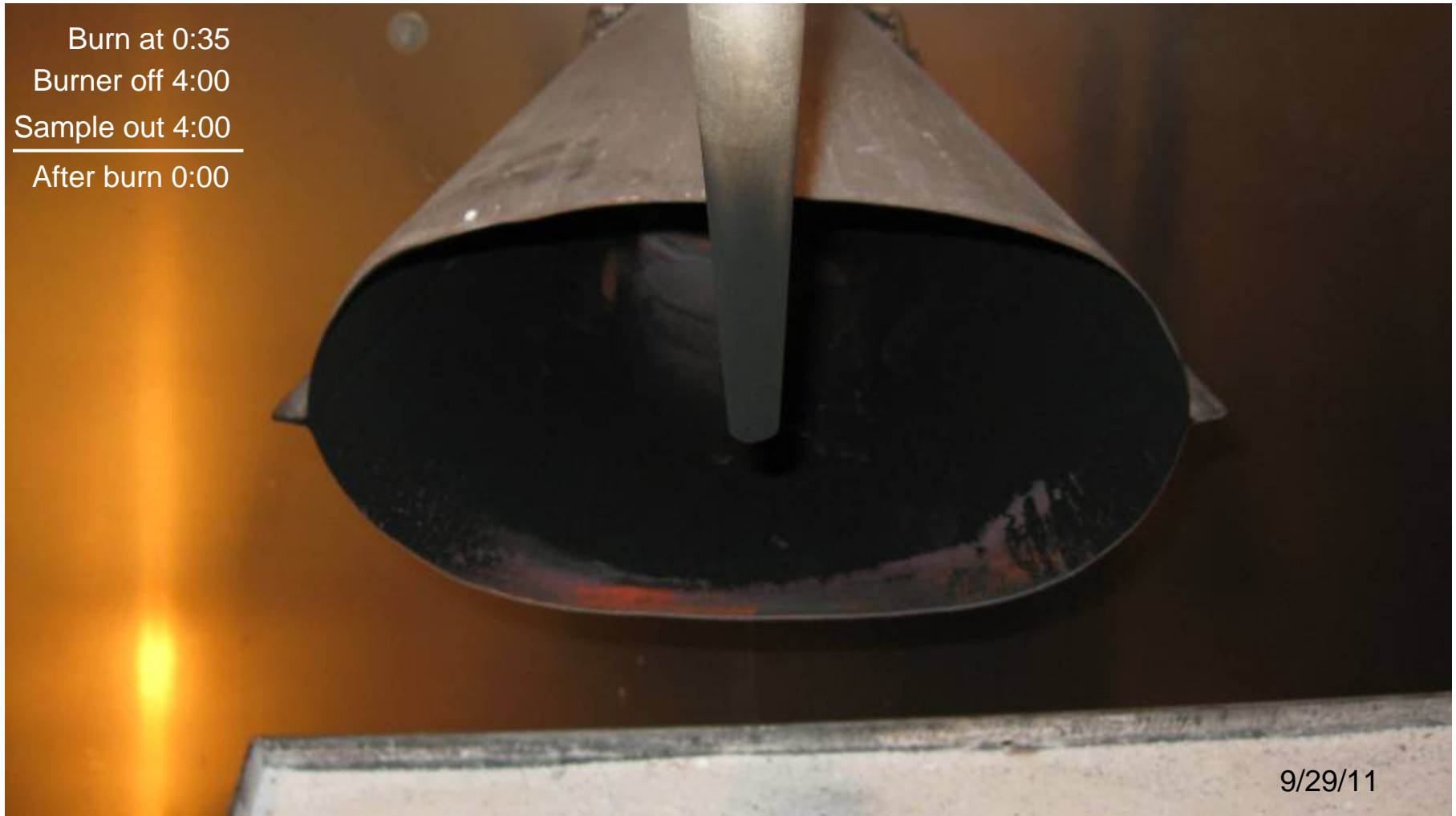
Inverted Thinner Cone AZ-31, Suspended Vertically



Inverted Thinner Cone AZ-31, Suspended Vertically



Inverted Thinner Cone AZ-31, Suspended Vertically



Inverted Thinner Cone AZ-31, Suspended Vertically (repeat)



Circular Tube WE-43, Mounted Horizontally

Test 1



9/30/11

Circular Tube WE-43, Mounted Horizontally

Test 1



Circular Tube WE-43, Mounted Horizontally

Test 2



9/30/11

Circular Tube WE-43, Mounted Horizontally

Test 2

Burn at 2:27
Burner off 4:00
Sample out 5:30

After burn 1:30



9/30/11

Circular Tube WE-43, Mounted Vertically

Test 1



Circular Tube WE-43, Mounted Vertically

Test 1



9/30/11

Circular Tube WE-43, Mounted Vertically

Test 1



Circular Tube WE-43, Mounted Vertically

Test 2



Burn at 2:33

Burner off 4:00

Sample out 5:35

After burn 1:35

9/30/11

Various Tested Samples



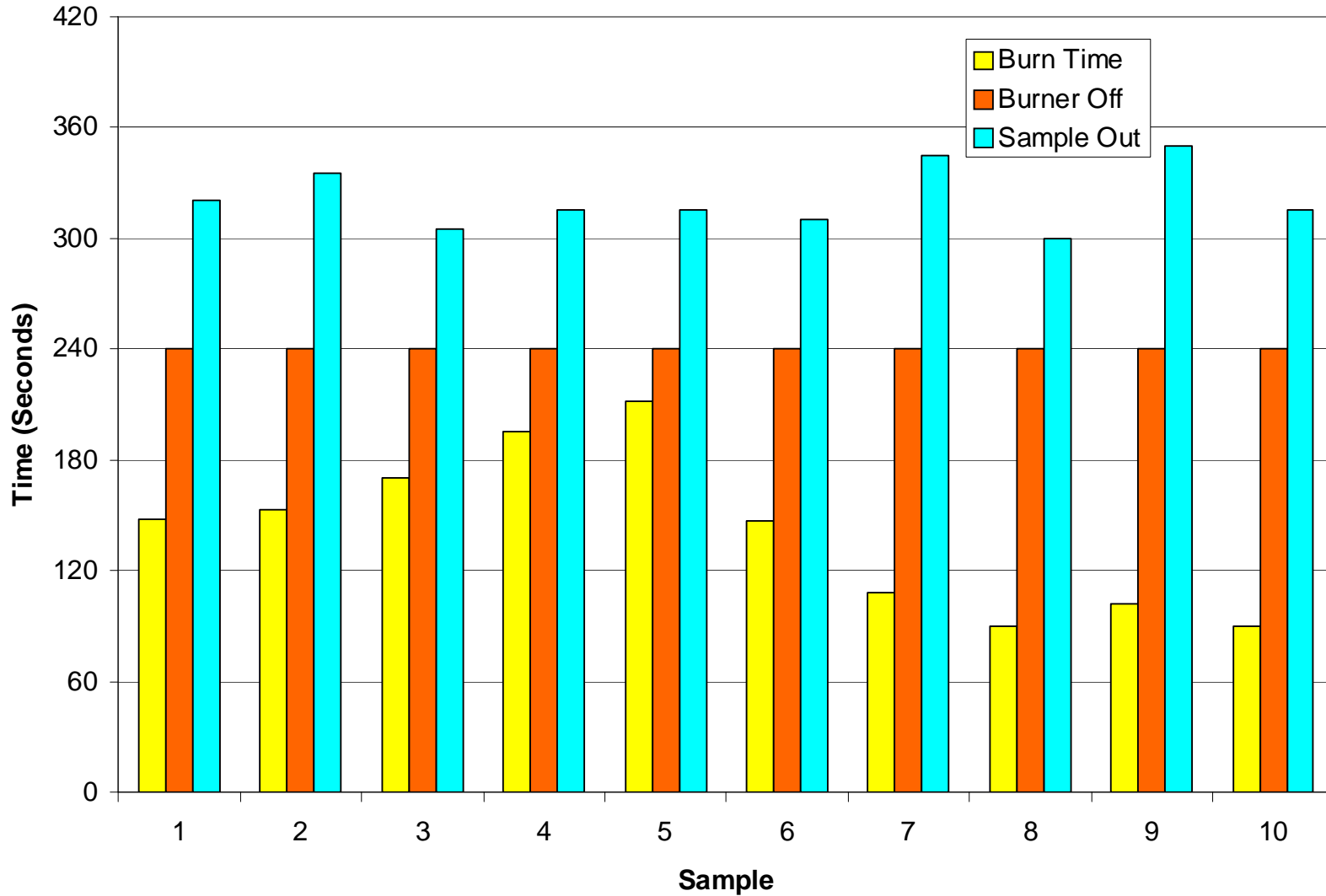
9/30/11

Circular Tube WE-43, Test Results



10/03/11

Vertically-Oriented WE-43 Hollow Cylinder Test Results



Circular Tube Aluminum, Mounted Vertically

...for comparison to mag-alloy samples

Test 1



Circular Tube Aluminum, Mounted Vertically

...for comparison to mag-alloy samples



Circular Tube Aluminum, Mounted Vertically

...for comparison to mag-alloy samples



Conical Tube WE-43, Mounted Vertically

Standard 8-inch WE-43 cone drilled-out, 5.5 inches high



Conical Tube WE-43, Mounted Vertically

Standard 8-inch WE-43 cone drilled-out, 5.5 inches high, volcano effect



Conical Tube WE-43, Mounted Vertically

Standard 8-inch WE-43 cone drilled-out, 5.5 inches high (repeat)



10/05/11

Conical Tube WE-43, Mounted Vertically

Standard 8-inch WE-43 cone drilled-out, 5.5 inches high (repeat)



Burn: none
Burner off 6:00
Sample out 6:00

After burn 0:00

10/05/11

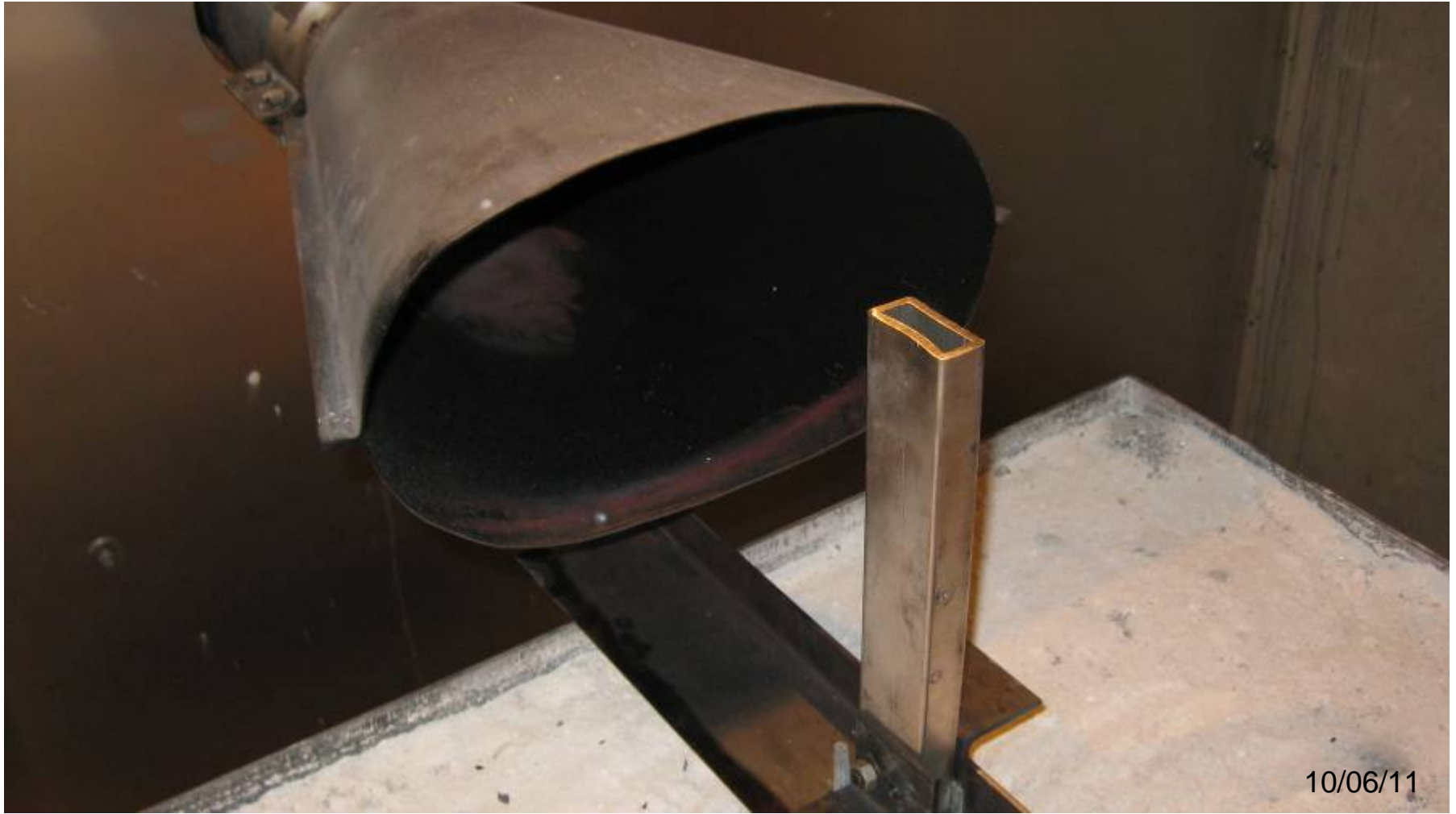
Rectangular Box Section WE-43, Mounted Vertically



Rectangular Box Section WE-43, Mounted Vertically



Rectangular Box Section WE-43, Mounted Vertically (rotate 90°)



Rectangular Box Section WE-43, Mounted Vertically (rotate 90°)



Conical Tube WE-43, Mounted Vertically

10/11/11 milled-out WE-43 cone, 5.5 inches high (3 inch deep milling)



10/11/11

Conical Tube WE-43, Mounted Vertically

10/11/11 milled-out WE-43 cone, 5.5 inches high (3 inch deep milling)



Summary of Results

Truncated cone sample suffered from repeatability issues:

- Time of ignition dependent on resulting molten shape
- Duration of burning following burner flame removal also dependent on resulting molten shape

Hollow cross-sections demonstrated better ignitability than solid cross-sections

- Thinner wall has tendency to ignite simultaneous to melting
- Thick cross sections melt into complex shapes prior to ignition, reducing repeatability

Hollow cylinder test sample demonstrates good repeatability

- Time of ignition and duration of after flame very consistent
- Resulting molten shape also very repeatable, demonstrating test robustness

Planned Activities

Continue with testing of hollow cylinders to further define repeatability

Experiment with smaller diameter hollow cylinders to determine repeatability

Experiment with hollow cylinders in other mag-alloys?

Experiment with other hollow shapes?

Begin to refine test parameters (i.e., time to ignition, exposure time, after flame duration)