Transparency in Certification Testing: Real-Time Monitoring and Remote Witnessing

In Preparation For

Symposium on Understanding and Reducing Residential Wood Combustion Emissions

NEW YORK STATE OF OPPORTUNITY. | NYSERDA Supported

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Agenda

- A Bit of History
- Round Robin Testing
- Kelvin Development
- Live Demonstration
- Example Reports
- Take Away Points
- Questions and Comments

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A Bit of History

renewtech holdings, LLC

agfuel

ClearStak®

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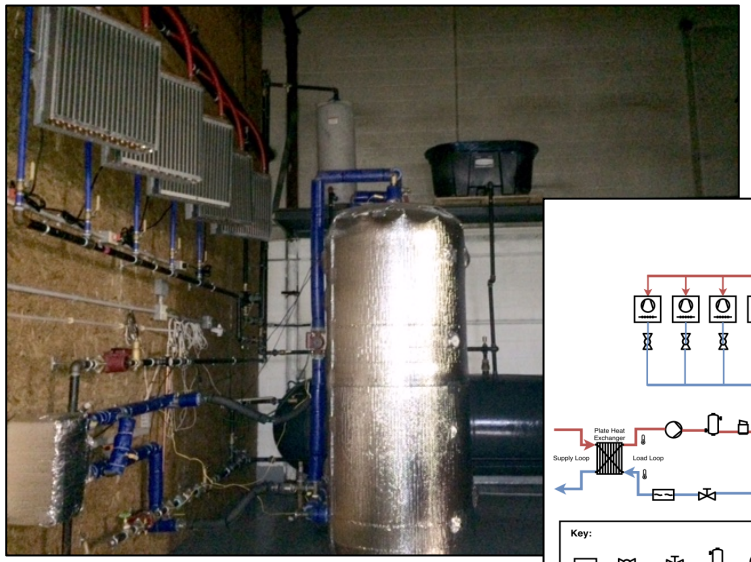
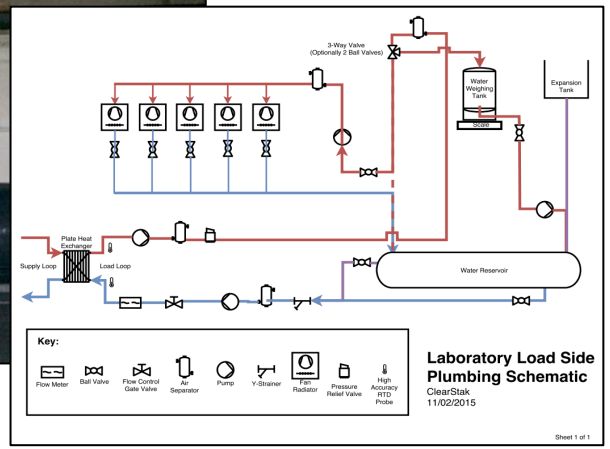
The New ClearStak

- NOW ISO 17025 Accredited!
- NOW EPA Accredited!





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Round Robin Testing

The goal of this project will be to perform Round Robin testing of automated, high-efficiency wood fired heating systems previously evaluated by the BNL test method.

1. Initiate the quantification of inter- and intra- laboratory variability for advanced cordwood- and pellet-fired boilers evaluated by the BNL test method (Now known as Method 28 WHH – PTS by the latest NSPS from the EPA)
   - On-going
2. Thorough analysis of variables affecting cold start operation (fuel configuration, fuel dimension, and kindling quantity)
   - On-going
3. **Provide a transparent data collection and sharing system that will allow manufacturers, state and federal agency staff members to remotely witness real-time emissions testing**
4. **Make operational data, emissions measurements, and video via live stream available over any web-connected device such as a computer or smartphone**

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KELVIN

The ability to observe furnace/stove data remotely

- An existing product of Biomass Controls

  Supported by mobile applications and web browsers

  Experience for yourself..

  - Download from App Store or Play Store.. Or go to http://managemyfurnace.com/app/UserLogin.html
  - Instructions can be found at www.biomasscontrols.com
  - Login: demo@clearstak.com
  - Password: demo

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Product Development (2012)...

- Provide Manufacturers with useful information on how their product was operating
  - Continuous live stream of data
  - Data and report exports
  - Analysis of behavior overtime
  - Monitor energy output
  - Pinpoint product failure
  - Determine average fuel rate
  - Notifications/Alerts

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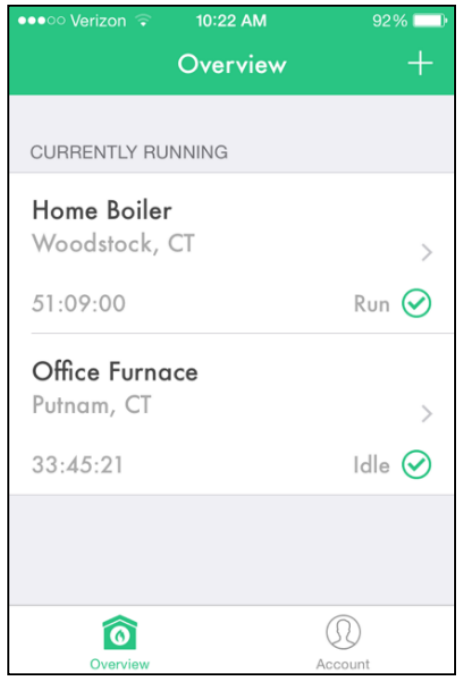
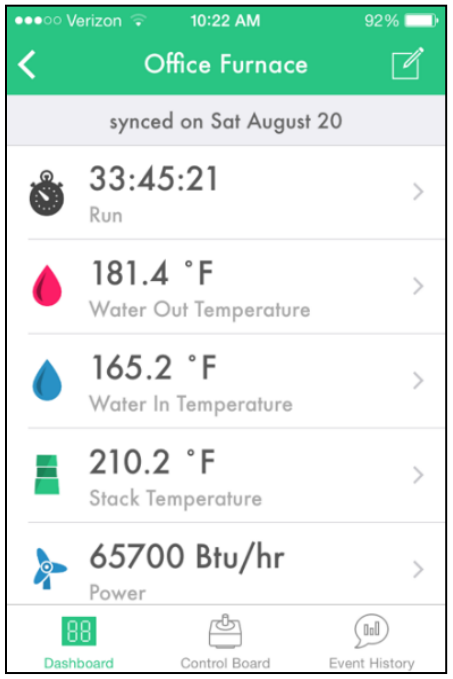
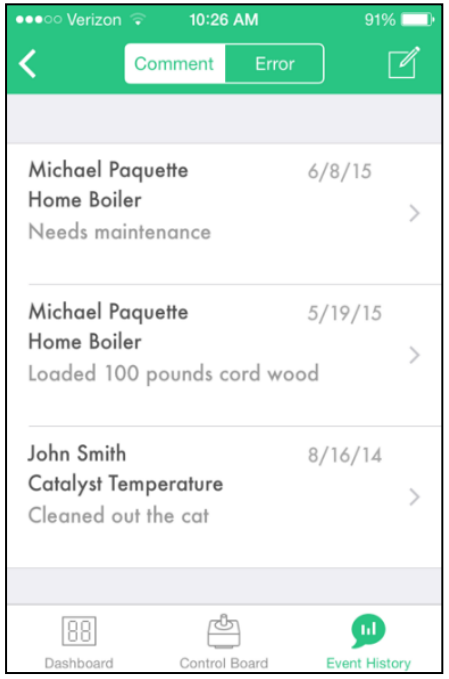
Kelvin & Website Management







Mobile Application

- User furnace status list
- Live streaming data
- Calculated values (O2%, BTUs..)
- Event History (Errors, user comments..)
- Burn statistics
- Large data set exporting
- Total furnace run time
- Integration with third party data

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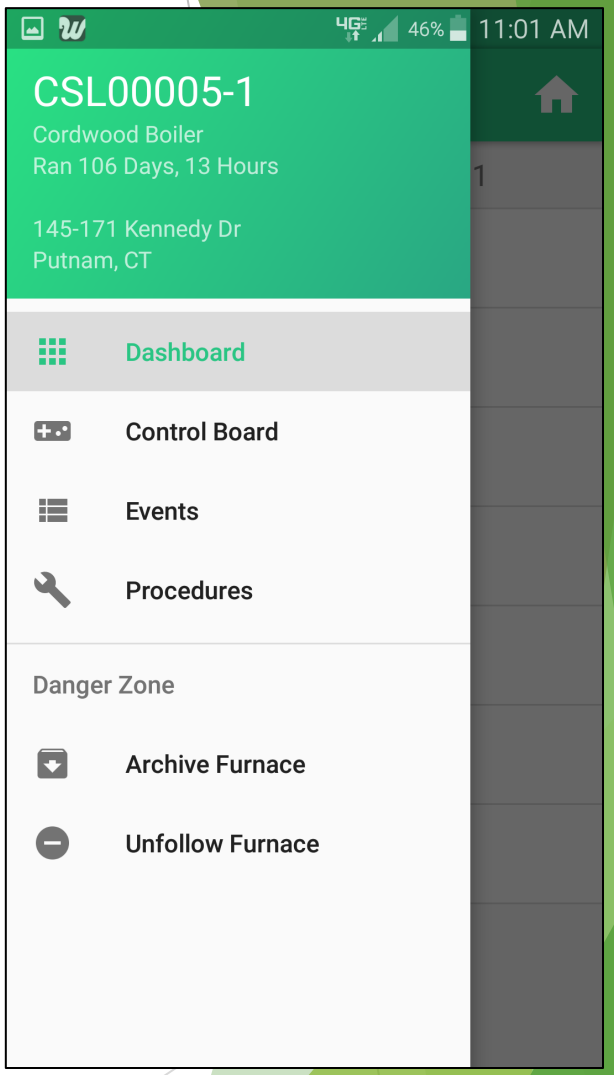
2016 Updates

- Early 2016, ClearStak partnered with Biomass Controls to customize Kelvin application for laboratory use
  - Transparency in testing
  - Regulators and manufacturers can view remotely
  - Added the following test procedures: ASTM E2515, ASTM E2618, Method 28, Method 28 WHH, Method 28 WHH PTS, CSA B415
  - Procedures in the form of a task list
    - When completed, each task is associated with time stamp and technician name
    - Add comments
    - Add images – test fuel, stack, equipment
    - Exported as CSV file and attach to reports
    - Improve repeatability and Reproducibility in testing



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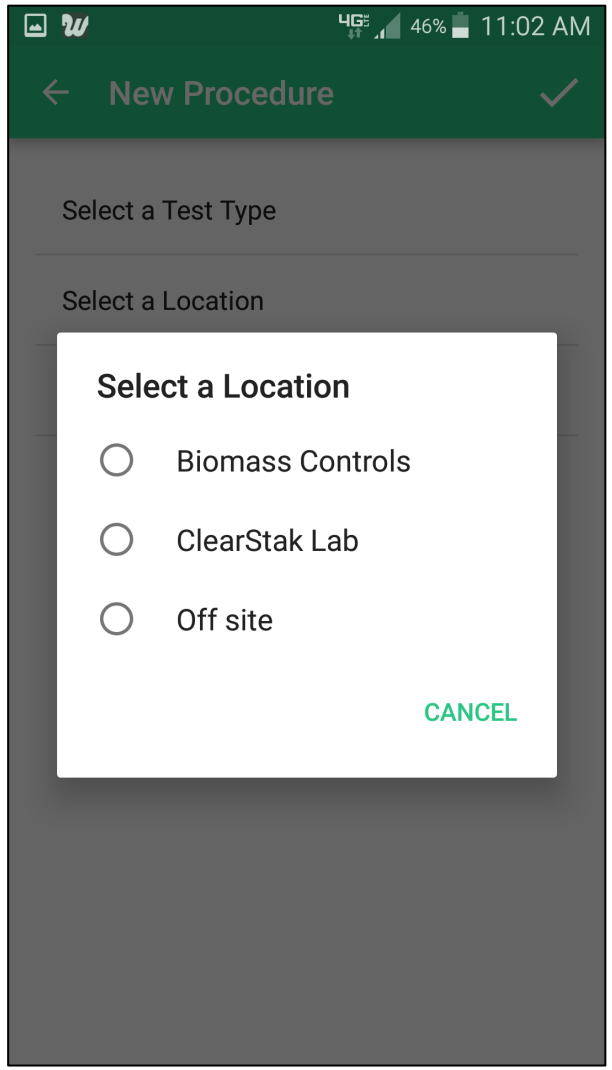
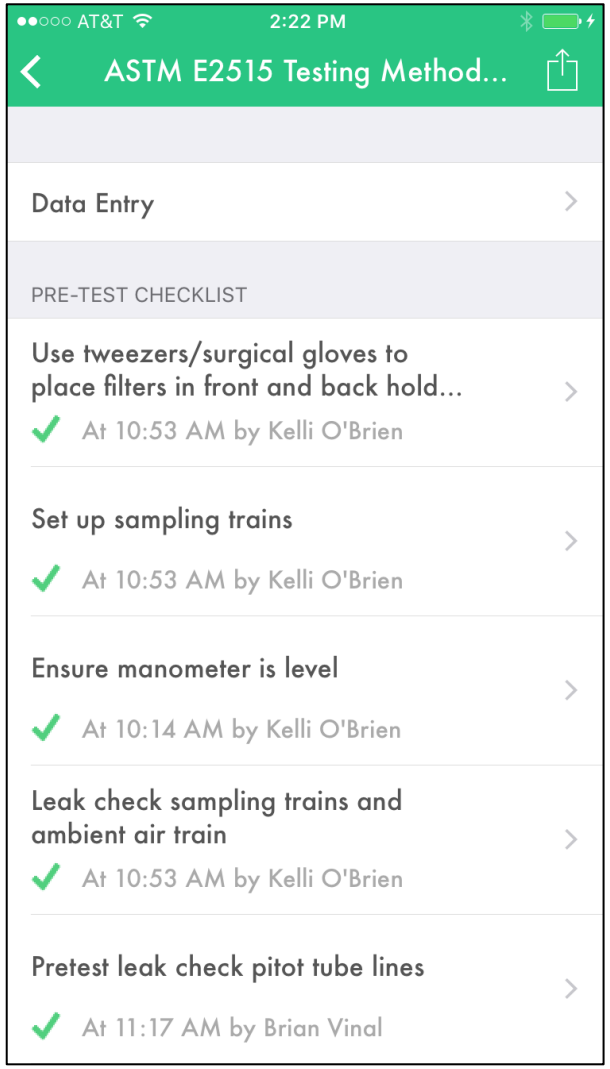
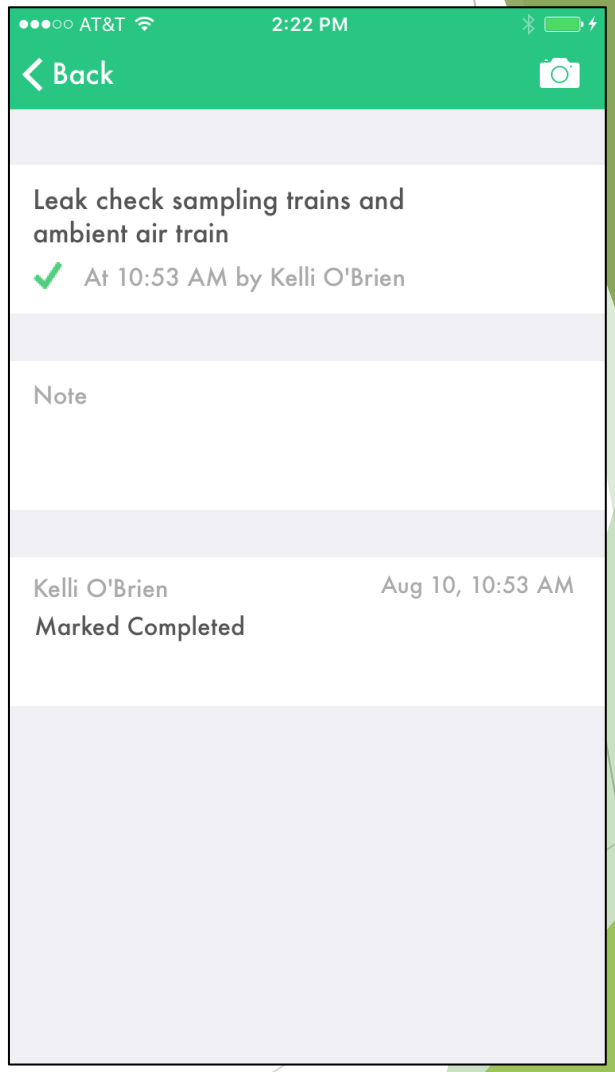

46% 11:02 AM
New Procedure
Select a Test Type
Select a Location
Select a Location
Biomass Controls
ClearStak Lab
Off site
CANCEL


AT&T 2:22 PM
ASTM E2515 Testing Method...
Data Entry
PRE-TEST CHECKLIST
Use tweezers/surgical gloves to place filters in front and back hold...
At 10:53 AM by Kelli O'Brien
Set up sampling trains
At 10:53 AM by Kelli O'Brien
Ensure manometer is level
At 10:14 AM by Kelli O'Brien
Leak check sampling trains and ambient air train
At 10:53 AM by Kelli O'Brien
Pretest leak check pitot tube lines
At 11:17 AM by Brian Vinal


AT&T 2:22 PM
Back
Leak check sampling trains and ambient air train
At 10:53 AM by Kelli O'Brien
Note
Kelli O'Brien
Aug 10, 10:53 AM
Marked Completed

2016 Updates

- Late 2016, ClearStak worked with Biomass Controls to improve practicality of procedures
  - Customized for specific fuel types
    - Pellet, crib, cordwood
  - Separation of PM sampling and boiler operation tasks
  - Improved flow
    - Headings and subheadings to differentiate between different parts of burn
  - Hot start vs cold start procedures

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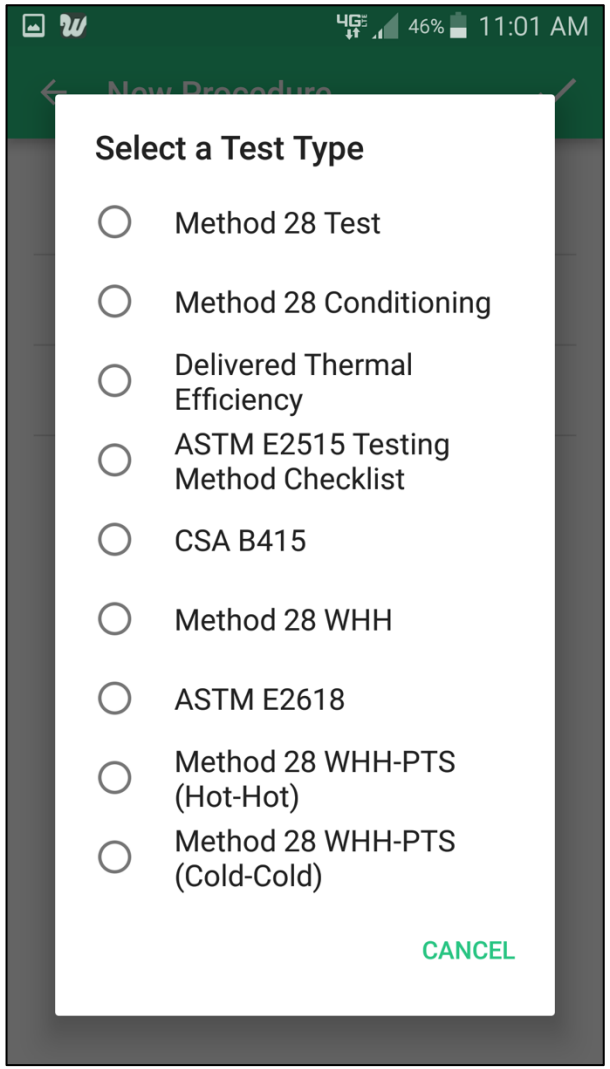
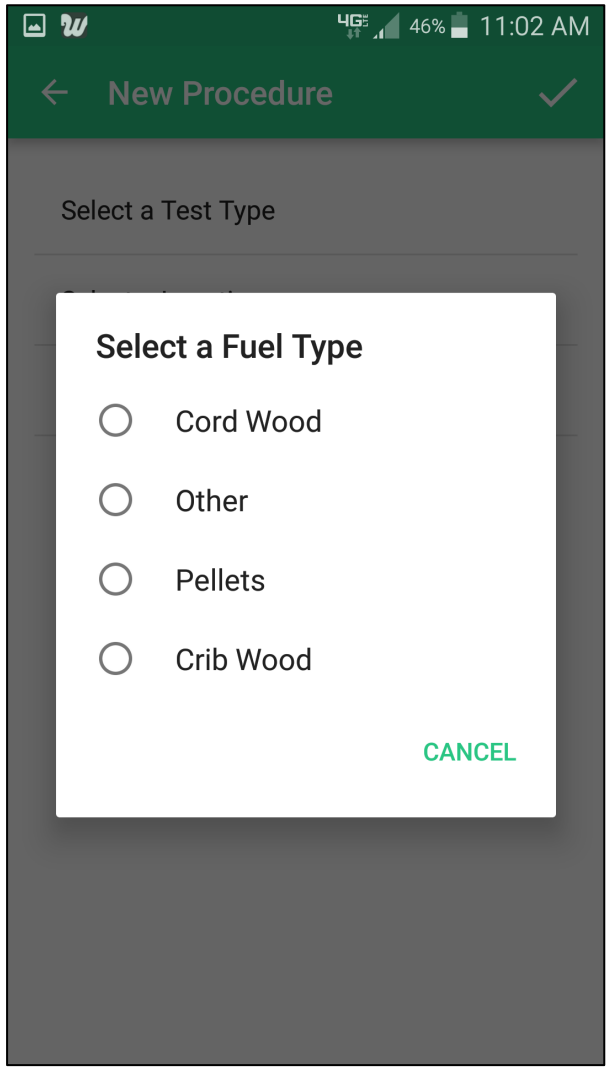
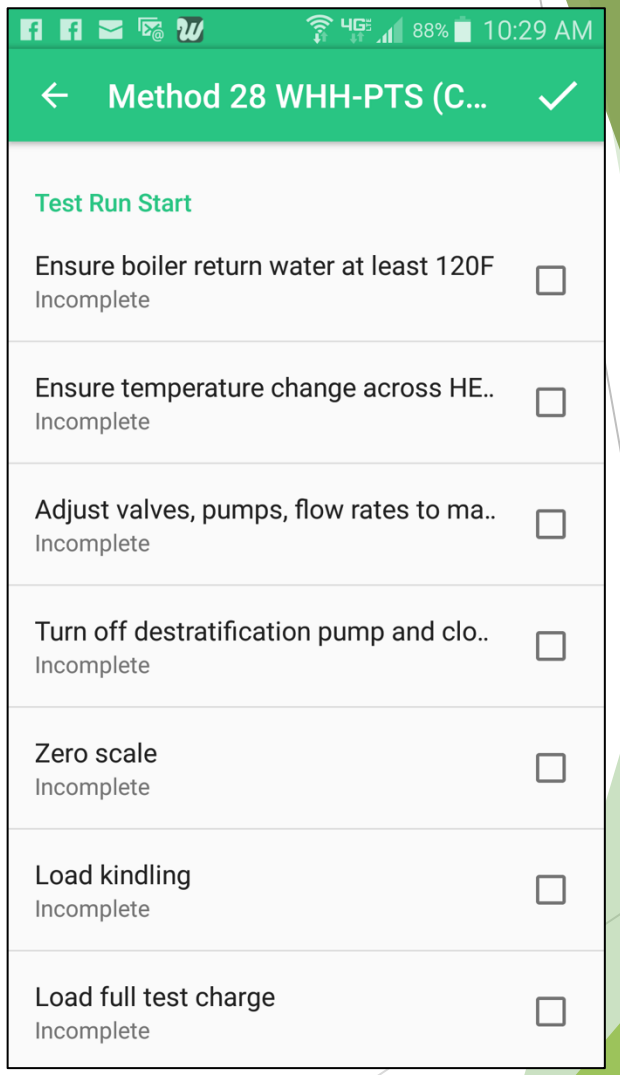

46% 11:01 AM
New Procedure
Select a Test Type
Method 28 Test
Method 28 Conditioning
Delivered Thermal Efficiency
ASTM E2515 Testing Method Checklist
CSA B415
Method 28 WHH
ASTM E2618
Method 28 WHH-PTS (Hot-Hot)
Method 28 WHH-PTS (Cold-Cold)
CANCEL


46% 11:02 AM
New Procedure
Select a Test Type
Select a Fuel Type
Cord Wood
Other
Pellets
Crib Wood
CANCEL


88% 10:29 AM
Method 28 WHH-PTS (C...
Test Run Start
Ensure boiler return water at least 120F
Incomplete
Ensure temperature change across HE..
Incomplete
Adjust valves, pumps, flow rates to ma..
Incomplete
Turn off destratification pump and clo..
Incomplete
Zero scale
Incomplete
Load kindling
Incomplete
Load full test charge
Incomplete

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- LIVE DEMONSTRATION

Example Reports

- Kelvin allows the user to customize how data is viewed
- Compresses **hours** of data to user friendly and easy to read format
- Reports and datasets are sent from Kelvin to the user's email

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Reporting

	A	B	C	D	E	F	G	H	I	J
1	CapturedDateTime	idDataReading	RunTime	Stack Temperature (F)	Status	Tank In temperature (F)	Tank Out Temperature (F)	Water In Temperature (F)	Water Out Temperature (F)	
923	1/27/2016 13:49	117323140	0002:43:22	298.4	Pdk_C	131	113	125.6	168.8	
924	1/27/2016 13:49	117323146	0002:43:28	298.4	Pdk_C	131	113	125.6	168.8	
925	1/27/2016 13:49	117323154	0002:43:33	300.2	Pdk_C	131	120.2	125.6	168.8	
926	1/27/2016 13:49	117323162	0002:43:39	296.6	Pdk_C	131	120.2	125.6	168.8	
927	1/27/2016 13:49	117323168	0002:43:45	298.4	Pdk_C	131	116.6	125.6	168.8	
928	1/27/2016 13:50	117323182	0002:43:55	298.4	Pdk_C	131	118.4	125.6	168.8	
929	1/27/2016 13:50	117323190	0002:44:01	294.8	Pdk_C	131	118.4	125.6	168.8	
930	1/27/2016 13:50	117323196	0002:44:06	298.4	Pdk_C	131	114.8	125.6	168.8	
931	1/27/2016 13:50	117323216	0002:44:22	296.6	Pdk_C	131	114.8	125.6	168.8	
932	1/27/2016 13:50	117323222	0002:44:27	296.6	Pdk_C	131	116.6	125.6	168.8	
933	1/27/2016 13:50	117323230	0002:44:32	298.4	Pdk_C	131	118.4	125.6	168.8	
934	1/27/2016 13:50	117323238	0002:44:38	294.8	Pdk_C	131	113	125.6	168.8	
935	1/27/2016 13:50	117323244	0002:44:43	294.8	Pdk_C	131	118.4	125.6	168.8	
936	1/27/2016 13:50	117323250	0002:44:48	294.8	Pdk_C	131	120.2	125.6	168.8	
937	1/27/2016 13:51	117323256	0002:44:53	296.6	Pdk_C	132.8	120.2	125.6	168.8	
938	1/27/2016 13:51	117323264	0002:44:58	296.6	Pdk_C	132.8	114.8	125.6	168.8	
939	1/27/2016 13:51	117323272	0002:45:04	296.6	Pdk_C	134.6	120.2	125.6	168.8	
940	1/27/2016 13:51	117323280	0002:45:09	296.6	Pdk_C	136.4	116.6	125.6	168.8	
941	1/27/2016 13:51	117323290	0002:45:19	294.8	Pdk_C	140	118.4	125.6	168.8	
942	1/27/2016 13:51	117323298	0002:45:24	294.8	Pdk_C	141.8	113	125.6	168.8	
							114.8	125.6	168.8	
							122	125.6	168.8	
							122	125.6	168.8	
							118.4	125.6	168.8	
							118.4	125.6	168.8	
							118.4	123.8	168.8	
							122	123.8	168.8	
							118.4	123.8	168.8	
							122	122	170.6	

	A	B	C	D	E	F
4						
5						
6						
7						
8	TASK NAME	SUBTASK NAME	UPDATED STATUS	PERSON WHO UPDATED STATUS	DATE OF STATUS UPDATE	DATA ENTRIES
9						
10	Wood and dilution tunnel preparation					
11						
12		Check that wood is cut to 80% of firebox depth	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
13						
14		Select 3 pieces from same batch of wood as test charge	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
15						
16		Cut 1/2 to 3/4 inch slice across center of length of each piece (3)	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
17						
18		Cut 2 slices of same size half way between center and ends (6)	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
19						
20		Immediately measure mass of each piece in lbs (9 total)	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
21						
22		Arrange slices in oven to provide separation between faces	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
23						
24		Dry each slice in oven at 220F for 24 hours or until no weight change	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
25						
26		Remove from oven and measure mass of each piece	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
27						
28		Calculate dry basis moisture content (MC) (method)	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
29						
30		Check MC is acceptable for test (method)	Completed	Corey Vann	12/3/2015 9:26	Marked Completed
31						
32		Measure MC within 4 hours of test start	Completed	Corey Vann	12/3/2015 9:26	Marked Completed

PTS Testing

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Test Summary

	A	B	C	D
1				
2	STATE	PERCENT OF RANGE	OCCURENCES	
3	Stand By	100%	1 times	
4				
5	VALUE NAME	MAXIMUM	MINIMUM	AVERAGE
6	Stack Temperature	215.60 F	208.40 F	210.20 F
7	Water Out Temperature	194.00 F	186.80 F	188.60 F
8	Water In Temperature	168.80 F	163.40 F	165.20 F
9	Catalyst Temperature	820.40 F	595.40 F	701.60 F
10	Fire Temperature	89.60 F	82.40 F	84.20 F
11	Flow Rate	12.00 gal/min	11.00 gal/min	11.00 gal/min
12	Oxygen Percent	8.30%	10.76%	12.52%
13	Water Delta T	19.80 F	23.08 F	25.20 F
14	Power	118800.00 Btu/hr	127189.02 Btu/hr	151200.00 Btu/hr
15				
16				
17				

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	A	B	C	D	E
	Delivered Thermal Efficiency				
	Load Side Report				
	Cord Wood Boiler				
	KELVIN MANUAL INPUT	METHOD VARIABLE	VALUE	UNIT OF MEASURE	
	Moisture of Fuel	N/A	20	%	
	Weight of Fuel	W(fuel)	50	lb	
	Fuel Type		Cord Wood		
	Flow Rate		4.54	GPM	
0	Test Start Time		1/21/2016 12:14		
1	Test End Time		1/21/2016 15:34		
2					
3	CONSTANT NAME	METHOD VARIABLE	VALUE	UNIT OF MEASURE	
4	LHV of Fuel	LHV	7988	Btu/lb	
5	HHV of Fuel	HHV	8600	Btu/lb	
6					
7	KELVIN CALCULATION	METHOD VARIABLE	VALUE	UNIT OF MEASURE	
8	Average HEX Inlet Temp		60	F	
9	Average HEX Outlet Temp		90	F	
0	Total Heat Input (HHV)	Q(in)	358333.3333	Btu	
1	Total Heat Input (LHV)	Q(inLHV)	332833.3333	Btu	
2	Total Heat Output	Q(out)	226999.9773	Btu	
3	Total Heat Output Rate	dQ(out)/dt	68100.06129	Btu/hr	
4	Delivered Efficiency (HHV)	n(del)	63.34883087	%	
5	Delivered Efficiency (LHV)	n(delLHV)	68.20229663	%	

Delivered Thermal Efficiency Report

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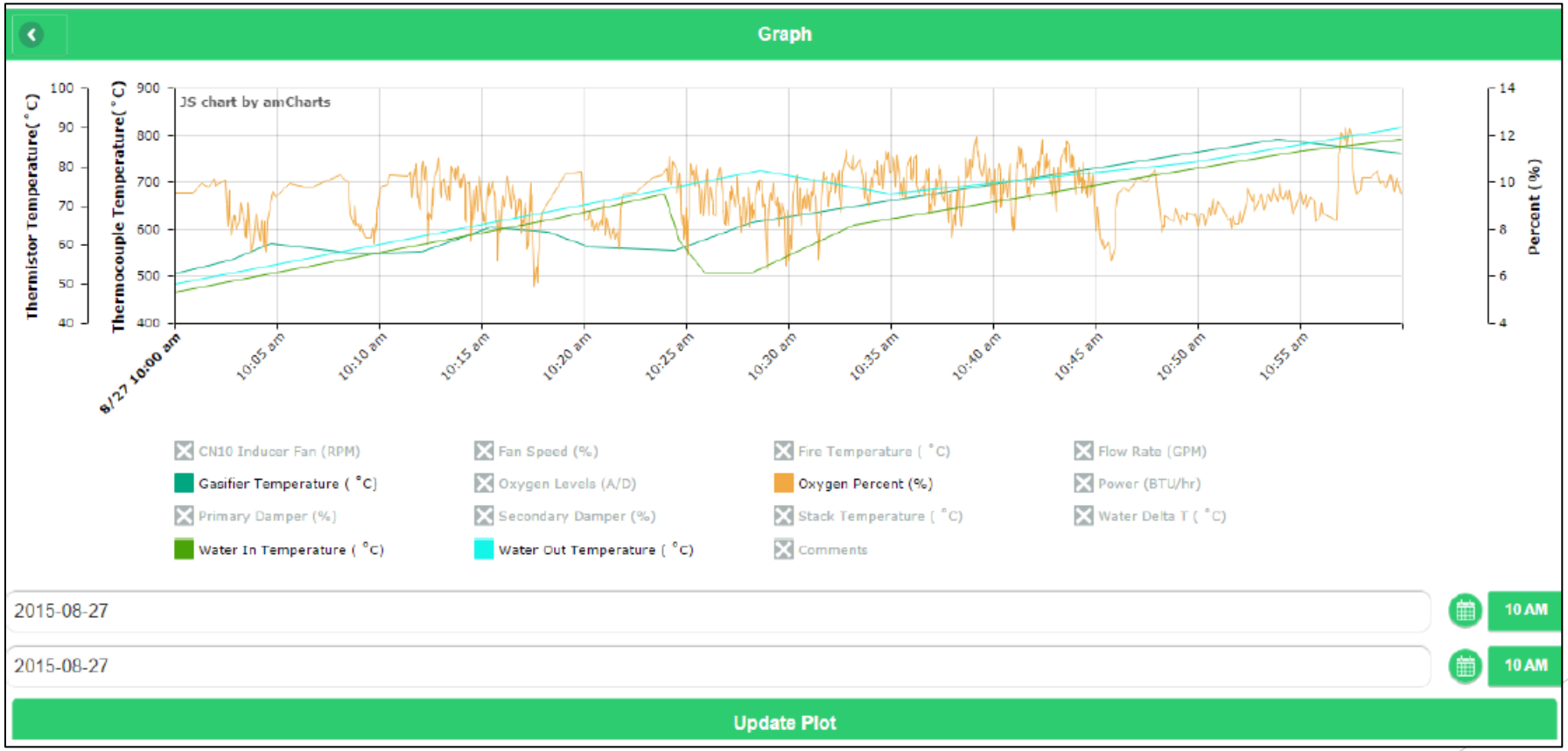
Data Plotter Capabilities in Kelvin Web Browser application



Take Away Points..

- Kelvin Application is a multi-functional tool that can benefit the regulators, the manufacturers, and the test lab
- Allows for transparency in the test lab
- Regulators and manufacturers can view operation remotely
  - Reduce cost of travelling
  - Pinpoint moments of failure or need of improvement
  - Data audits
- Improve repeatability and reproducibility of testing
  - Time stamped notes and tasks can be exported and attached to test reports for validation of test

Contact information

Thank you for your time!

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www.clearstak.com

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