

**TEREX®**

# Warm Mix Asphalt System

5/2009

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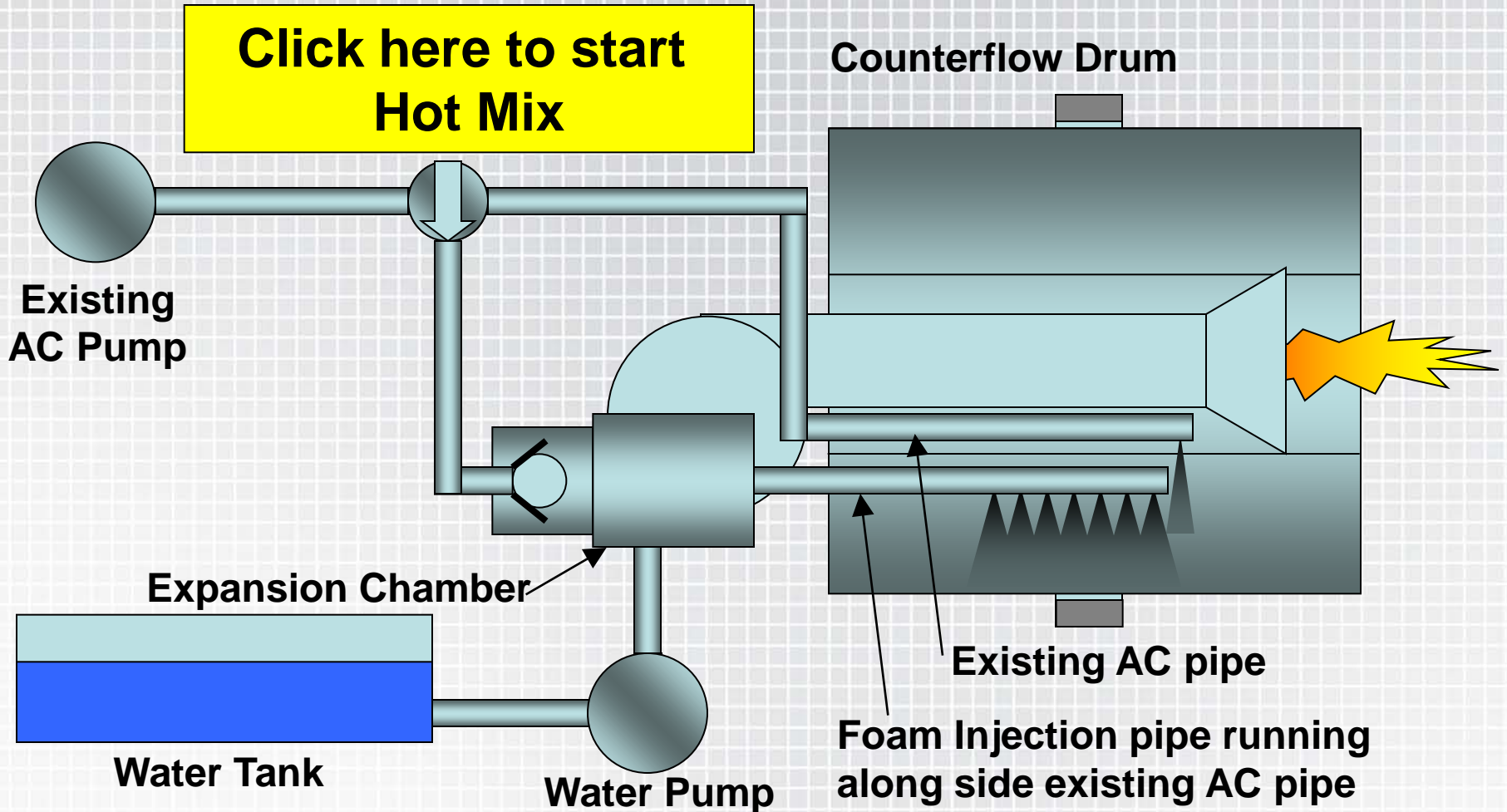
- **Features:**

- Reduces mix temperatures by up to 90° F without costly additives
- Uses Terex patented, field-proven foamed asphalt technology, originally pioneered in 1998
- Single expansion chamber ensures consistent AC/water mix at any production rate
- Produces foamed asphalt just outside of the drum and immediately injects it into the drum's mixing chamber, evenly coating the aggregate
- No moving parts (except water pump and meter)
- Fast easy installation into existing drum
- Complete kit requires only jacketed AC and water feed pipes to be customer-supplied
- Complete AC system is hot oil jacketed
- Patent pending

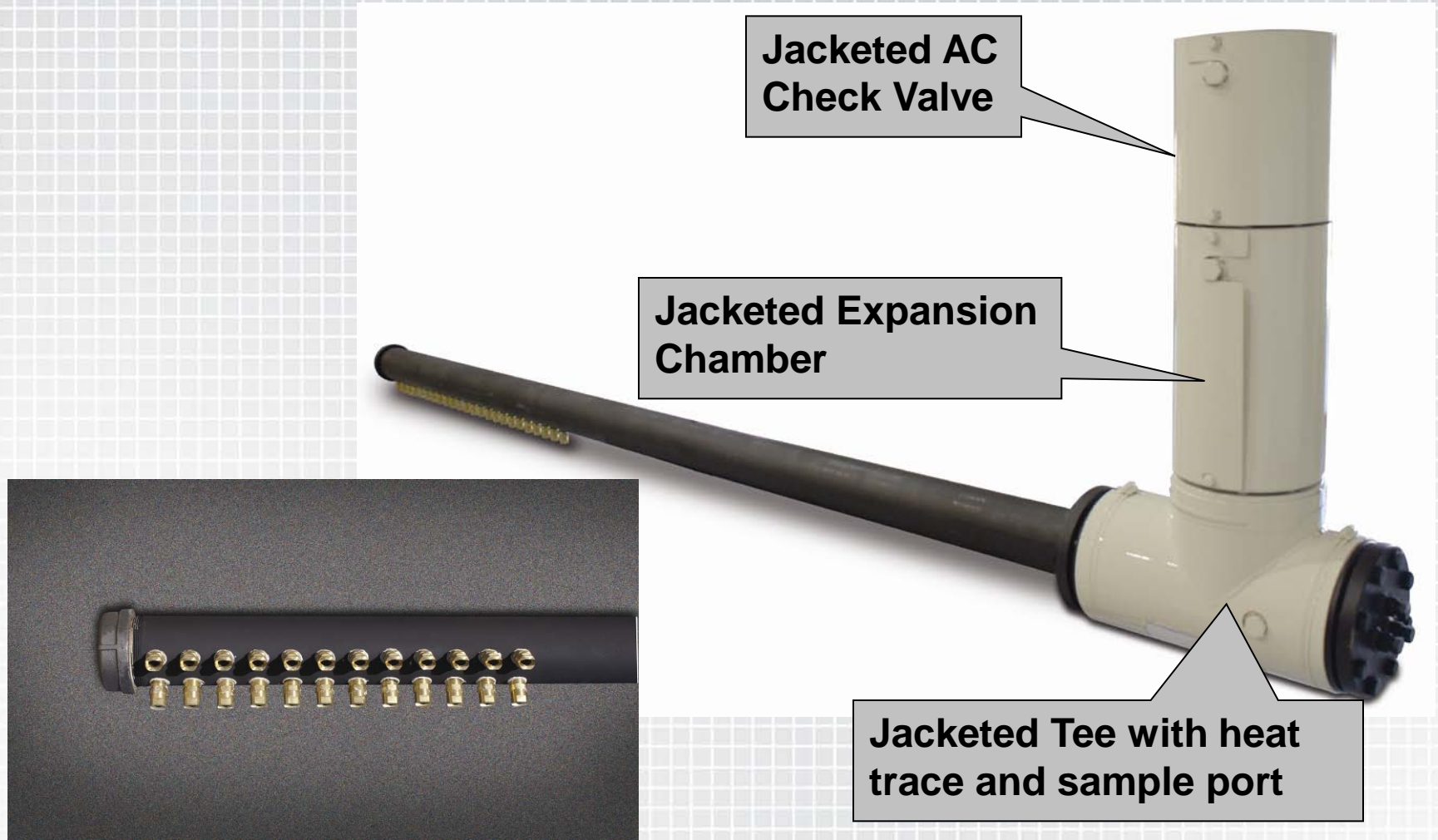


# Terex Foam Warm Mix Process

[Click here to start Hot Mix](#)



# Injection Pipe Components:



# Controls and Water Skid:

- PLC control system to accurately control water injection and foam production
  - The display shows water flow rate as both GPM and TPH
- Water skid includes tank, filter, 5 hp (3.73 kW) variable-frequency motor driving positive displacement water pump, high-accuracy water meter and calibration valve
- Three-way, jacketed, electrically actuated AC valve
- Asphalt and water check valves to prevent reverse flow of AC and water
- Patented foam expansion chamber
- Inject tube with multiple nozzles, adjustable for specific drum designs
- Existing AC inject pipe is retained for “hot mix” production





# Key Features:

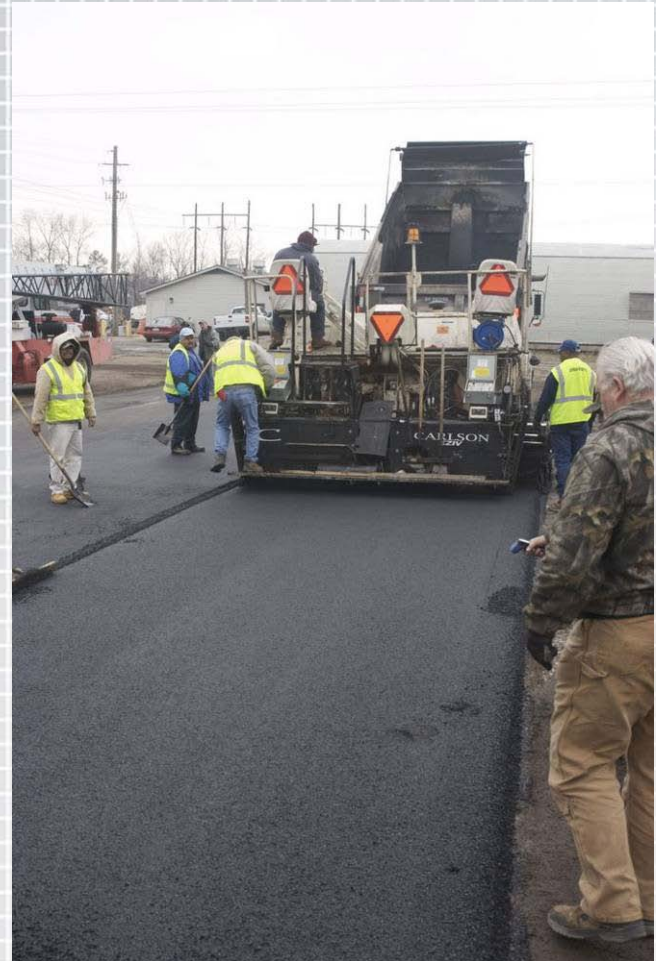
- Asphalt and water check valves to prevent reverse flow of AC and water
- AC line is internally heated to prevent plug-ups
- Spray nozzles provide longer dwell time
  - Ability to increase/decrease pressure without using solenoids

# Plant Control I/O needed

- Analog input providing accurate AC tons per hour
  - 0 – 10 VDC or 4 – 20 ma
  - Customer will need to supply loop power for this output also
- Digital input to start/stop
  - 115 VAC
  - Input needs to be timed to “ON” when the AC needs to hit the drum mixing chamber
  - Input needs to be “OFF” when the AC is “re-circulating”
  - Input needs to be “OFF” when AC is in “suck back” mode
  - Two contacts provided on the PLC digital input card
  - (No need to isolate with a relay)
- Digital outputs
  - Water running
  - Water fault
  - Digital outputs are isolated hard contacts so customers can supply any input source they choose for feedback



# Tested in 1992 Cedarapids Magnum Drum



# Testing and results

- Installed on a 1990s-vintage Cedarapids Magnum Plant
- Mixing temperatures were lowered to between 245 to 280 degrees F, whereas common mixing temperatures for this same Type E design is 335 degrees in its hot mix form.
- Mix was then trucked to the paving site and laid at ambient temperatures as low as 37 degrees F.
- The rollers compacted the mix at temperatures ranging from 180 to 245 degrees F.
- Crews reported that even at these lower temperatures, the mix was very workable for the rollers and by hand.
- Lab tests of the warm mix asphalt showed compaction densities, air voids and other lab tested criteria closely matched results found in the same mix design produced using traditional hot mix techniques
- Rutting performance tests revealed the warm mix asphalt performed better.



# Lehman Roberts internal report

- Overall we were very pleased with the process. Aesthetically there was no noticeable difference and it
- was very workable for a longer period of time despite the cold temperatures. Based on this one trial the
- Warm Mix is at least as good, if not better than "normal" mix.

## Warm Mix Asphalt trial

January 23, 2008

The mix that was made had been used last fall at the Memphis International Airport with great success. We started the mix at a plant temperature of 300 degrees with no water being added. Then we began injecting 80psi of clean water while continually dropping the temperature until it reached 270 degrees. Then we pulled the mix from the trucks and ran 2 samples. On the first sample we ran AC content, Gradation, Theoretical Gravity, Bulk Specific Gravity, Air Voids, Moisture content, Stability, APA (Rut Test), Nuclear Density test and Core Density samples. On the second sample we allowed a 1 hour drying time to compare the effect of the moisture/drying factor of being kept in the silo for an hour. Following is a table comparing the original mix, ran last fall, the test of the samples ran as soon as we pulled from the truck and the oven cured samples.

	Original	Warm Mix I	Warm Mix II(oven cured)
AC Content	5.63%	5.69%	5.59%
Gradation	Good	Good	Good
Theoretical Gravity	2.452	2.450	2.446
Bulk Specific Gravity	2.382	2.378	2.377
Air Voids	2.9%	2.9%	2.8%
Moisture Content	.04%	.10%	.00%
Stability	1850	1775	1675
Nuclear Density	94%-96%	91%-94%	N/A
Core Density	N/A	91.8%	N/A
Rut Test**	12.0	10.4	N/A

\*Due to inclement weather we were forced to pave on our yard. The ambient temperature was 37 degrees during paving and the sub-base was a Gravel / Limestone / Dirt mix with a high moisture content. The original mix was for a Low Volume road with target Air Voids of 3%.

\*\*A Complete cycle on the APA is 8000 strokes. We had to interrupt the test at 6650 strokes due to the amount of rutting that was evident. This is not unusual for non-modified surface mixes, especially Low volume designs. As you can see above the Warm mix outperformed the original design by a fairly significant amount. It should be noted that the Original blend was lab created where the Warm Mix was a plant run batch. Plant run mix tends to run better in the APA.

Overall we were very pleased with the process. Aesthetically there was no noticeable difference and it was very workable for a longer period of time despite the cold temperatures. Based on this one trial the Warm Mix is at least as good, if not better than "normal" mix.



# Installation on E3-400P (RK Hall)



Inject Pipe Installed



Mixing chamber and piping installed  
(no insulation)



Water system detail

**RK Hall purchased the system to reduce odor that was a source of complaints from neighbors. The system successfully address their concerns and has been used daily since mid July**

# Hot Mix vs Warm Mix Comparison

- Results from Lehman Roberts Customer demonstration days
- Comparison of same mix design made as “hot mix” then “warm mix”

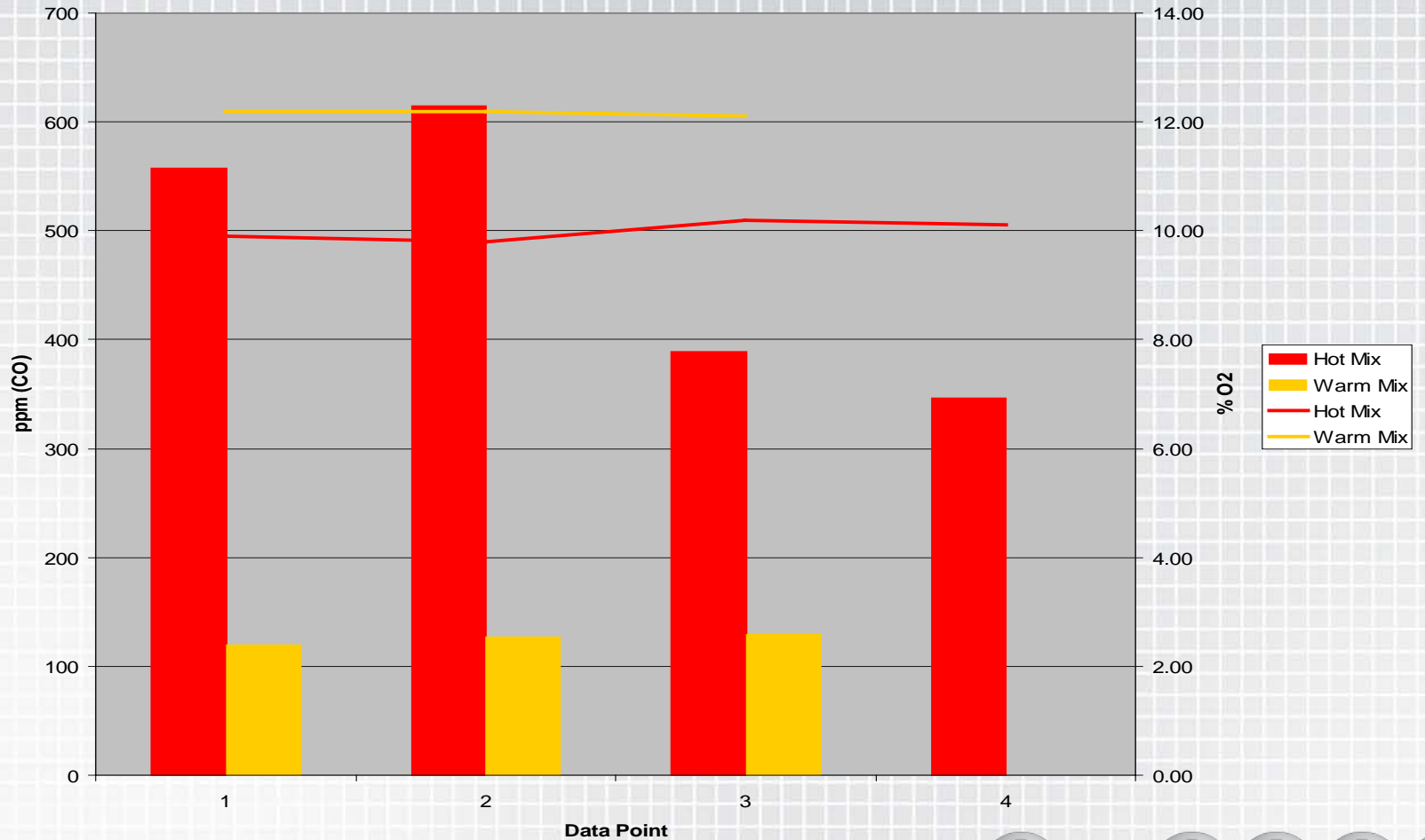
CUSTOMER		Lehman-Roberts						MATERIAL TYPE		Lime Stone 411-E						
	DATE	TPH	BAGHOUSE			DRUM		%		PPM		TIME	PPM		RAP	%
			MIX	BURNER	DAMPER	INLET	OUTLET	DELTA	PRESSURE	OF	PPM		PPM	NOX		
			TEMP	%	%	TEMP F	TEMP F	P"	WC	O2	CO					
Hot Mix	04/14/08	250	344	32	49	259	223	3.50	0.12	9.90	558	1:40 PM	40	38	20	4.40
	04/14/08	250	337	28	48	257	219	3.40	0.11	9.80	615	1:50 PM	22	21	20	4.40
	04/14/08	250	326	26	46	246	214	3.30	0.11	10.20	389	2:10 PM	41	39	20	4.40
	04/14/08	250	318	28	48	267	223	3.50	0.08	10.10	346	2:20 PM	30	29	20	4.40
Warm Mix	04/15/08	250	265	22	51	287	243	3.70	0.12	12.20	120	12:35PM	37	35	20	4.20
	04/15/08	250	255	22	51	294	251	3.70	0.11	12.20	127	12:40 PM	40	38	20	4.20
	04/15/08	250	250	22	51	296	255	3.60	0.13	12.10	129	12:45 PM	41	38	20	4.20
	04/18/08	250	230	22	47	269	227	3.00	0.10			9:20 AM			20	4.00
	04/18/08	250	260	20	47	264	228	3.10	0.12			9:25 AM			20	4.00
	04/18/08	250	263	20	47	265	229	3.00	0.12			9:30 AM			20	4.00
	04/18/08	250	257	20	47	268	231	2.90	0.10			9:35 AM			20	4.00
	04/18/08	250	263	20	47	267	231	3.00	0.10			9:40 AM			20	4.00



# Hot Mix vs Warm Mix Temperatures



# Stack Analysis Results



# Hot Mix vs Warm Mix

	411-E Hot Mix	411-E Warm Mix
AC Content	5.53% (5.5%)	5.35%(5.5%)
Gradation	Good	Good (Fine)
Theoretical Gravity	2.451	2.458
Bulk Specific Gravity	2.379	2.364
Air Voids	2.9%	3.8% (3.5%)
Moisture Content	0.08%	.20%
Stability	1775(1500)	1750 (1500)
Temperature at Paver	310 °F	260 °F
Nuclear Density	93%-95%	93%-95%
Core Density	93.7%	92.2%



# Installation:

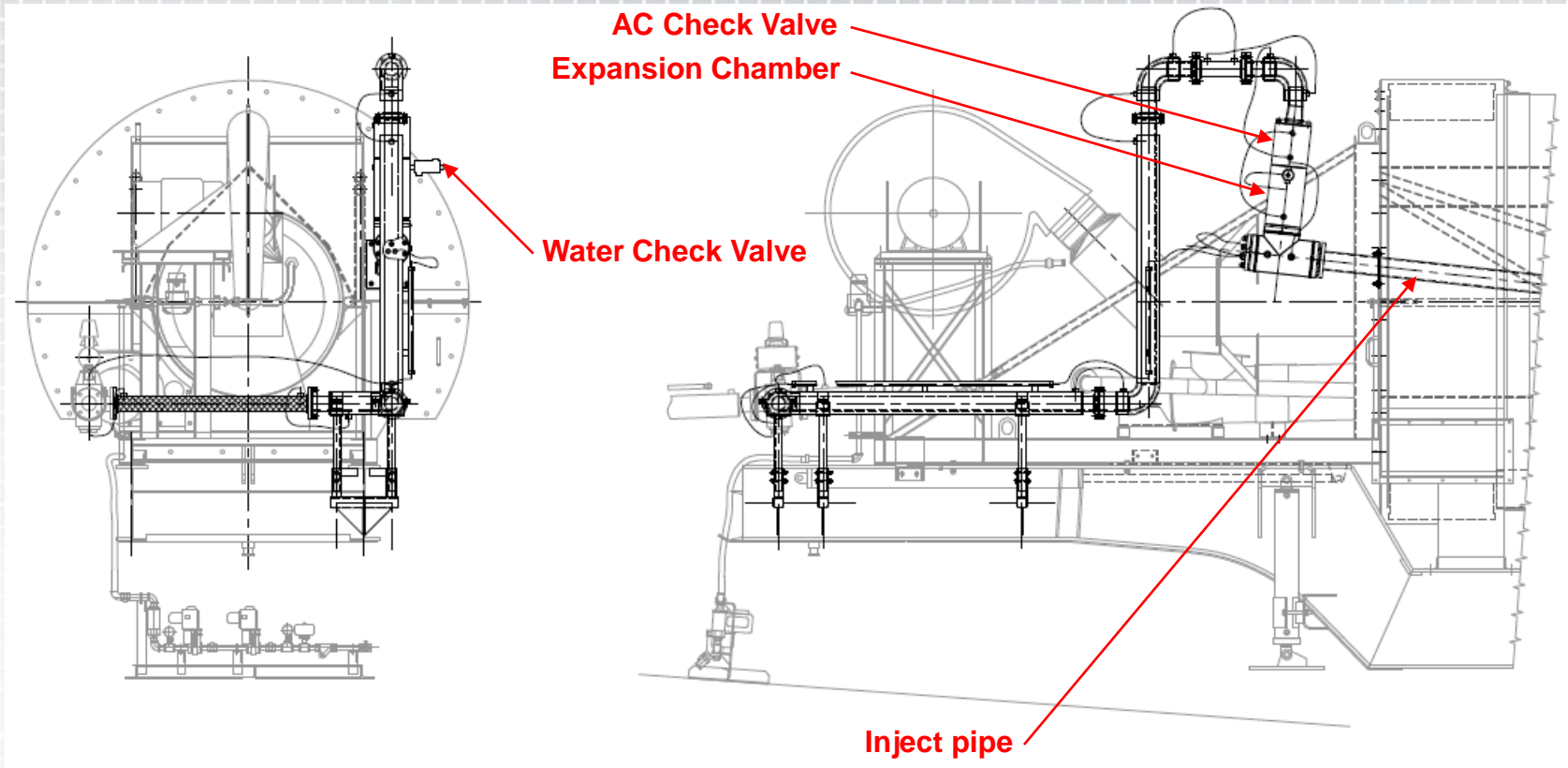
## Standard Installation

- Typically takes 48 man hours
  - Welder, Electrician
- Jib Crane / Boom truck
- Standard hand tools

# Installation options available:

Components included:	New	Retrofit	
	Terex Drum	Terex Drum	Other Drum
Foam Inject pipe	✓	✓	✓
Retain Existing AC pipe for hotmix		✓	✓
Expansion Chamber	✓	✓	✓
AC and Water Check Valves	✓	✓	✓
Hot Oil Jumpers	✓	✓	✓
Stand Alone Controls			✓
Water Skid	✓	✓	✓

# Installation on new E3 drum





# WMA at TEREX Latin America

