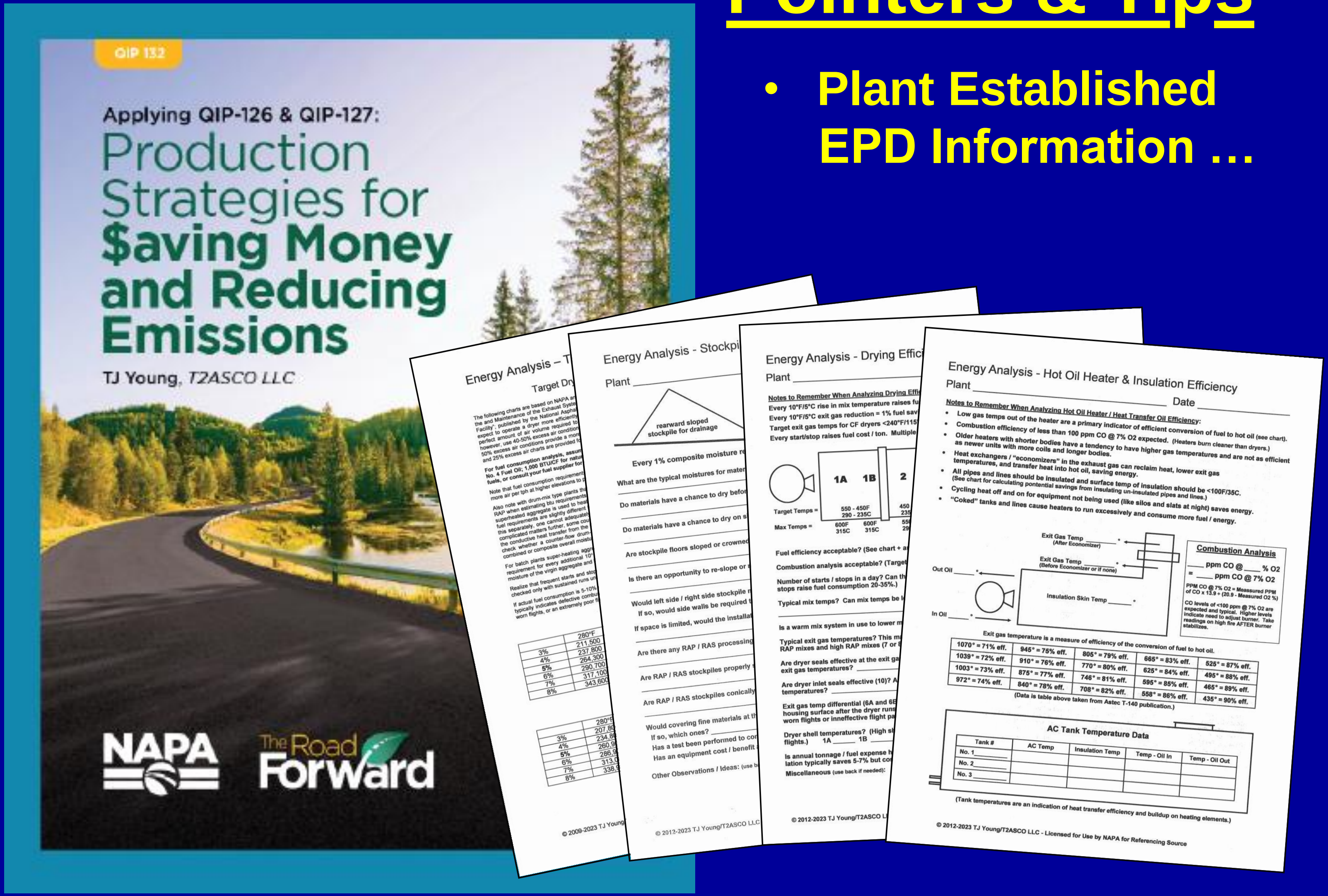
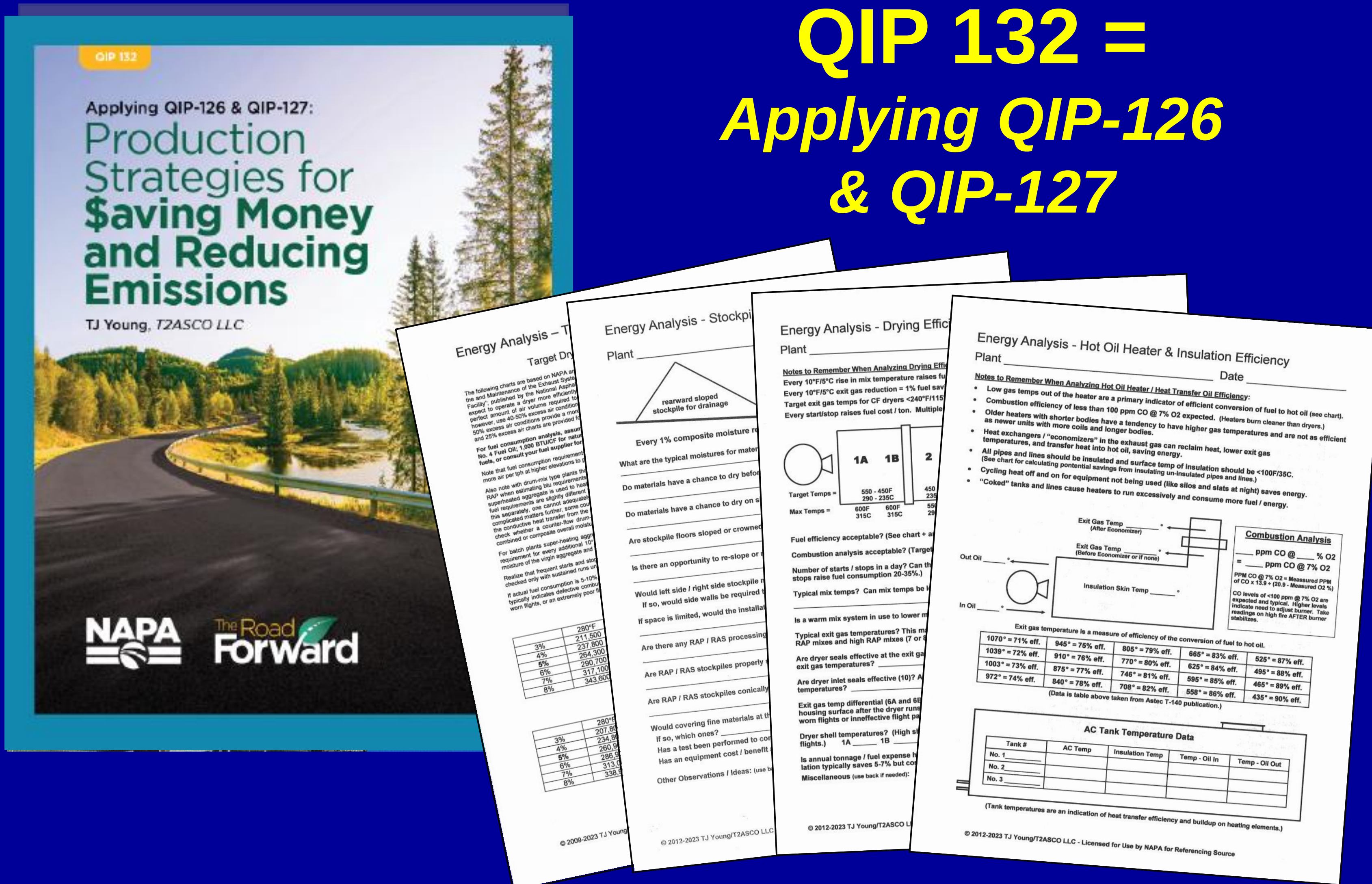
Pointers & Tips

- Plant Established EPD Information …



QIP 132 =
Applying QIP-126 & QIP-127



Worksheets for identifying ways to reduce energy consumption & EPD values

EPDs Estab. by Plant by Mix

1. Energy Consumed Per Ton to Dry / Heat
2. Energy Consumed per Ton to Keep Tanks and Plant Hot
3. Energy Consumed to Run Plant Equipment (loader, skid steer, fork lift, etc.)
4. Electricity Consumed to Run the Plant (deduct lab, office, shop, office, etc.)
5. Energy Used Bringing Materials into Plant
6. Energy Used Taking Unused Materials / Waste Products Away (baghouse fines, used oil, etc.)

Areas Addressed inThis Talk…

1. Split in the plant of energy used between different plant functions
2. Breaking down energy for each plant function
3. Ways to isolate energy when sharing fuel for different functions
4. Tips where to first start when building EPDs
5. Suggestion for collecting EPD values of material components from different suppliers

Plant Supplied Information

"Big Three" Energy Consumption Areas…

1. Drying and Heating
2. Storing Asphalt Cement & Keeping Plant Hot
3. Electrical Energy Use

Plant Supplied Information

"Big Three" Energy Consumption Areas…

1. **Drying and Heating …**
   (50-75% of energy)
2. **Storing Asphalt Cement & Keeping Plant Hot …**
   (20-30% of energy)
3. **Electrical Energy Use …**
   (10-15% of energy)

Plant Supplied Information

Complications …

1. **Drying and Heating …**
   - Gas may used for both drying & hot oil heat system – *how do you separate?*

2. **Storing Asphalt Cement & Keeping Plant Hot …**
   - Hot oil system used both for heating AC tanks & plant components – *how do you separate?*

3. **Electrical Energy Use …**
   - Electricity used for plant, lab, shop, security lights – *how to separate?*

Drying/Heating Energy Breakdown

- Obtain fuel bills from fuel supplier by month
- If sharing fuel (i.e. gas) for both burner and hot oil heater separate …
  - Contact supplier to see if can read meter remotely by day or learn how to read meter yourself
  - Track fuel used for days not running dryer (exact hrs)
  - Take several days of samples
  - Average, then x 30
  - Remove from monthly bill
  - Document your reasoning

Storage Energy Breakdown

- Obtain fuel supplier bills by month
- If sharing fuel (i.e. oil) for hot oil heater, plant equipment, and plant components, separate …
  - Track fuel used per day for equipment for 30 days (do more than once & average)
  - Establish fuel consumed over weekend to keep tanks and plant hot (average per day)
  - Turn off plant components during production while plant is hot?
  - Split costs by function & document your analysis for EPD

Electrical Energy Breakdown

- Obtain electric bills from utility by month
- If sharing electricity for different buildings …
  - Contact utility to see if they can read meter remotely by day … or provide daily usage (most can)
  - Track electrical energy on days when JUST plant is running (no office or shop / weekends?)
  - Track electrical energy of security lights when no production or office on weekends
  - Create averages + split energy
  - Document your analysis for EPD

Energy Impact / Material Transport

- List Aggregate Materials by Supplier:
  - Location of Each Supplier Before Transport
  - Energy Impact of Transport …
    - Nautical Miles to Pickup Point
    - Rail Miles to Pickup Point
    - Truck Miles to Pickup Point
    - Pickup Point to Plant

Energy Impact / Material Transport

- List Asphalt Materials by Supplier:
  - Location of Each Supplier Before Transport
  - Energy Impact of Transport …
    - Nautical Miles to Pickup Point
    - Rail Miles to Pickup Point
    - Truck Miles to Pickup Point
    - Pickup Point to Plant

Energy Impact / Material Transport

- List Additive Materials by Supplier:
  - Location of Each Supplier Before Transport
  - Energy Impact of Transport …
    - Nautical Miles to Pickup Point
    - Rail Miles to Pickup Point
    - Truck Miles to Pickup Point
    - Pickup Point to Plant

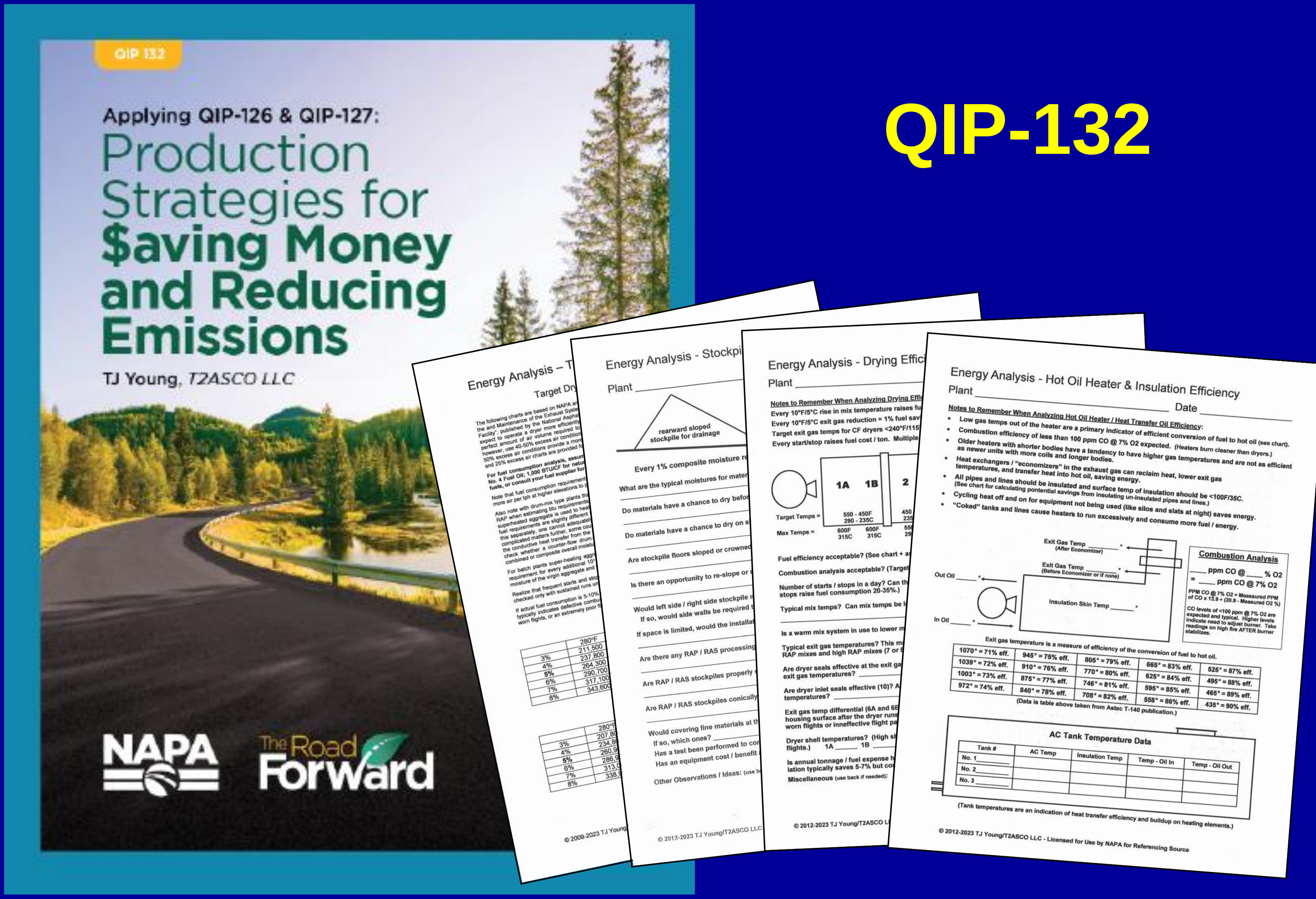
Example Collection Spreadsheet

Suppliers (Sources)								
	Supplier 1	Supplier 2	Supplier 3	Supplier 4	Supplier 5	Supplier 6	Supplier 7	Supplier 8
Company Name	Martin Marietta Materials - Ruby Quarry	Martin Marietta Materials - St. Mary's	Martin Marietta Materials - Nova Scotia	Associated Asphalt - Transmontaigne	Associated Asphalt - Savannah	Hi-Tech Asphalt Solutions	Carmeuse Americas	Ingevity
Company Website	www.martinmarietta.com	www.martinmarietta.com	www.martinmarietta.com	www.associatedasphalt.com	www.associatedasphalt.com	www.htas.com	www.mintekresources.com	www.ingevity.com
Contact Name	Chris Wilson	Chris Wilson	Chris Wilson	Kurt Korinek	Kurt Korinek	Erin Soto	Darrell Nicholson	Matthew LaChance
Email	chris.wilson@martinmarietta.com	chris.wilson@martinmarietta.com	chris.wilson@martinmarietta.com	kkorinek@associatedasphalt.com	kkorineck@associatedasphalt.com	customerservice@htas.com	[illegible]	matthew.lachance@ingevity.com
Phone Number	706-833-6111	706-833-6111	706-833-6111	(941) 519-5639	(941) 519-5639	(804) 779-4871	470-599-2510	843-697-3673
Office Number	904-414-8837	904-414-8837	904-414-8837			(866) 871-5495		
Address Line 1	137 Pitts Chapel Road	6700 Co Rd 3	17 Upper Quarry Road	3425 Tallyrand Ave	7 Foundation Drive	6055 Mechanicsville Turnpike	4921 Old Gawl City Road	5598 Virginia Ave
Address Line 2								
City	Macon	St. George	Aulds Cove	Jacksonville	Savannah	Mechanicsville	Macon	Charleston
State	Georgia	Georgia	Nova Scotia, CANADA	Florida	GA	Virginia	Georgia	South Carolina
ZIP Code	31217	31562	B0E2G0	32206	31408	23111	31206	29406
Material	Aggregates	Sand	Aggregates	Binder	Binder	Fiber, natural - Cellulose	Lime	M1 (WMA)
From Ruby to Soutel TRAIN	270 miles							
From Soutel to 12th TRUCK	3.3 miles							
From Stokes to 12th TRUCK		27 miles						
From NS to Dames Pt OCEAN			1622 miles					
From Dames Pt to 12th TRUCK			26 miles					
From Transmontaigne to 12th TRUCK				10.2 miles				
From Savannah to 12th TRUCK					144 miles			
St. Ronda NC 28670 to 12th TRUCK						462 miles (from Ronda, NC)		
From Macon to 12th TRUCK							223 miles	
								see below

Suggested Plan of Attack …

1. Designate an EPD Champion
2. Build a Spreadsheet to Collect Your Data
   (*Energy, Material Sources, Locations, Mileage, etc.)*
3. Complete EPD on Simplest Plant First
   (No Shop, No Office, No Other Activities on Site)
4. Complete Your EPDs
   (Remember EPD is for complete year … use your target materials)
5. Employ Energy Reduction Techniques *(QIP132)*
6. Refile Your EPDs
7. Consider Keeping EPDS Current as a Culture

QIP-132

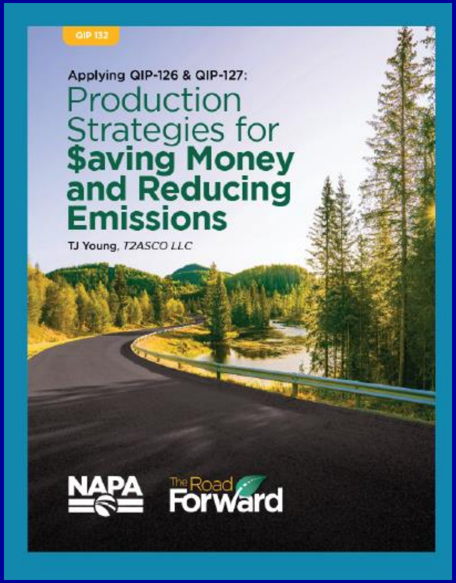

QIP 132
Applying QIP-126 & QIP-127:
Production Strategies for $aving Money and Reducing Emissions
TJ Young, T2ASCO LLC
NAPA
The Road Forward
Energy Analysis - Hot Oil Heater & Insulation Efficiency
Energy Analysis - Drying Effici
Energy Analysis - Stockpi
Combustion Analysis
AC Tank Temperature Data

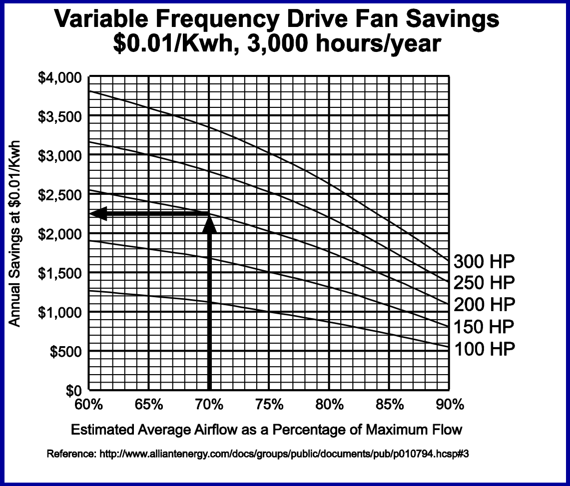
Plant Energy – Electrical Costs

<u>Falls Into Two Categories</u>:

- Reduce your “Peak Demand” = “Demand Charge”
- Reduce your KW Consumption During Operation

(Utility subsidies are still available some markets)

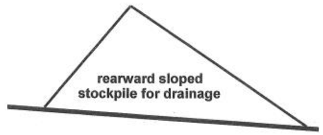




Plant Energy - Aggregate Moistures

Energy Analysis - Stockpile Management

Plant ______________________ Date ______________



Every 1% composite moisture reduction lowers fuel consumption 10% and raises tph 13%!

What are the typical moistures for materials at this site? (List by material type - moistures vary) __________

Do materials have a chance to dry before being transferred to this plant? __________

Do materials have a chance to dry on site before being fed into the dryer? __________

Are stockpile floors sloped or crowned to promote drainage? __________

Is there an opportunity to re-slope or re-profile the stockpile floor to improve drainage? __________

Would left side / right side stockpile management be useful at this site? __________
If so, would side walls be required to increase stockpile capacity? __________

If space is limited, would the installation of "French drains" be useful / possible at this site? __________

Are there any RAP / RAS processing techniques that would help reduce moisture during processing? ______

Are RAP / RAS stockpiles properly sloped to promote drainage? __________

Are RAP / RAS stockpiles conically shaped and/or crowned to reduce moisture from rain/snow events? ____

Would covering fine materials at this site significantly reduce moisture added from rain/snow events? ______
If so, which ones? __________ What is the estimated moisture reduction? __________
Has a test been performed to confirm this? ______ What percentage of the mix is this material? ________
Has an equipment cost / benefit analysis been done? ________ Outcome? __________

Other Observations / Ideas: (use back if needed)

Plant Energy – Drying / Heating

Energy Analysis – Theoretical BTU Expectations

Target Dryer Fuel Consumption Expectations

The following charts are based on NAPA and CIMA/BAEB industry standards outlined in "IS52: The Performance of the Operation of the and Maintenance of the Exhaust System in a Hot Mix Asphalt Facility", and "TAS22: "Performance Expectations for Your Plant Facility"; published by the National Asphalt Pavement Association, in Lanham, MD. These documents conclude that one cannot expect to operate a dryer more efficiently than under 25% excess air conditions (as a percent of stochiometric volume - or the perfect amount of air volume required to combust and convert fuel to useable energy). Most burner and plant manufacturers, however, use 40-50% excess air conditions when sizing and designing plant equipment. Field operating experience also shows that 50% excess air conditions provide a more practical guideline to use when establishing dryer performance expectations. Both 50% and 25% excess air charts are provided for analysis. Actual production performance should fall within these two ranges.

For fuel consumption analysis, assume 138,000 BTU/Gal for No.2 fuel oil; 142,000-145,000 BTU/Gal for Reclaimed and/or No. 4 Fuel Oil; 1,000 BTU/CF for natural gas; 2,500 BTU/CF for vaporized propane, and 92,000 BTU/Gal for liquid propane fuels, or consult your fuel supplier for their declared values.

Note that fuel consumption requirements do not change with elevation, although production expectations do. One needs to move more air per tph at higher elevations to properly burn the fuel, but the fuel (BTU) requirement remains essentially unchanged.

Also note with drum-mix type plants that it is practical to simply look at total composite moistures of both the virgin aggregate and RAP when estimating btu requirements per ton. Technically with counter-flow drum-mixers, the aggregate is superheated, then the superheated aggregate is used to heat the RAP; and conductive heat transfer is not equivalent to convective heat transfer, so the fuel requirements are slightly different than with parallel-flow plants. Without knowing the RAP moisture percentage and analyzing this separately, one cannot adequately estimate the fuel consumption required to heat and dry the RAP in these type plants. To complicated matters further, some counter-flow drum-mixers add RAP to the combustion zone area of the plant, taking advantage of the conductive heat transfer from the flights and shell and the radiant heat transfer from the flame, lowering the required btus. To check whether a counter-flow drum-mixer is operating within expected ranges, therefore, it is practical to simply look at the combined or composite overall moisture and check it against the charts provided.

For batch plants super-heating aggregate to heat RAP, and known virgin aggregate discharge temperatures, add 2% to the btu requirement for every additional 10° additional temperature to that shown on this chart; or one can also calculate the combined moisture of the virgin aggregate and RAP as suggested above to arrive at an estimated btu requirement for efficiency analysis.

Realize that frequent starts and stops raise fuel consumption 20-30% above these values. Therefore, fuel consumption should be checked only with sustained runs under known moisture and temperature conditions.

If actual fuel consumption is 5-10% more than the values shown on these charts, further investigation to the cause is warranted. It typically indicates defective combustion flights (and material dropping through the developing flame), an improperly tuned burner, worn flights, or an extremely poor flight design, in that order – once frequent starts and stops are eliminated from the analysis.

BTU's Required (50% Excess Air Conditions)

	280°F	290°F	**300°F**	310°F	320°F	330°F
3%	211,500	215,800	220,200	224,600	229,000	233,400
4%	237,800	242,700	247,700	252,700	257,600	262,600
5%	264,300	269,700	**275,200**	280,700	286,200	291,700
6%	290,700	296,600	302,700	308,800	314,800	320,900
7%	317,100	323,600	330,200	336,800	343,400	350,000
8%	343,600	350,600	357,800	365,000	372,100	379,300

BTU's Required (25% Excess Air Conditions)

	280°F	290°F	**300°F**	310°F	320°F	330°F
3%	207,800	212,000	217,300	221,700	226,000	230,300
4%	234,800	239,600	244,400	249,300	254,200	259,100
5%	260,900	266,200	**271,600**	277,000	282,500	287,900
6%	286,900	292,800	298,800	304,800	310,800	316,700
7%	313,000	319,400	325,900	332,400	338,900	345,400
8%	338,900	345,900	353,000	360,000	367,100	374,200

Energy Analysis - Drying Efficiency:

Plant ______________________ Date ___________

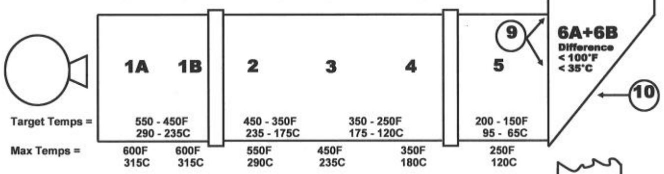
<u>Notes to Remember When Analyzing Drying Efficiency</u>:

Every 10°F/5°C rise in mix temperature raises fuel consumption 2%.

Every 10°F/5°C exit gas reduction = 1% fuel savings. 40°F/20°C gas savings = 4% fuel savings.

Target exit gas temps for CF dryers <240°F/115°C and 10°F/5°C above mix temp for PF dryers

Every start/stop raises fuel cost / ton. Multiple starts/stops raises fuel consumption 20-35%.

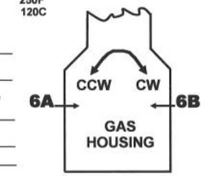


Fuel efficiency acceptable? (See chart + analysis below) ______________

Combustion analysis acceptable? (Target 350 ppm CO @ 7% O2) __________

Number of starts / stops in a day? Can they be reduced? Qty? (Multiple starts / stops raise fuel consumption 20-35%.) ______________

Typical mix temps? Can mix temps be lowered to better manage fuel costs? ____



Is a warm mix system in use to lower mix temps? ______________

Typical exit gas temperatures? This may vary with tph or between virgin / low RAP mixes and high RAP mixes (7 or 8). ______________

Are dryer seals effective at the exit gas end (9)? Are they artificially pulling down exit gas temperatures? ______________

Are dryer inlet seals effective (10)? Are they artificially pulling down the exit gas temperatures? ______________

Exit gas temp differential (6A and 6B)? Differential can be measured off the gas housing surface after the dryer runs at least one hour. 100°F/35°C or more shows worn flights or inneffective flight pattern. ______________

Dryer shell temperatures? (High shell temperatures indicates worn or ineffective flights.) 1A _____ 1B _____ 2 _____ 3 _____ 4 _____ 5 _____

Is annual tonnage / fuel expense high enough to consider shell insulation? Insulation typically saves 5-7% but costs $15-30,000 to install. ______________

Miscellaneous (use back if needed):

<u>Combustion Analysis</u>

____ ppm CO @ ____ % O2

= ____ ppm CO @ 7% O2

PPM CO @ 7% O2 = Meassured PPM of CO x 13.9 ÷ (20.9 - Measured O2 %)

<u>Fuel Efficiency Analysis</u>

Typ BTU/Ton = ________

Req BTU/Ton = ________

(See chart vs. average moisture of RAP and VAM at final mix temp)

Fuel Efficiency Ratio = ____

(Actual BTU/Ton ÷ Required BTU/Ton is Fuel Efficiency Ratio)

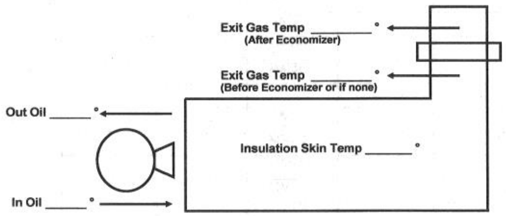
Plant Energy – Storing AC & Heating

Energy Analysis - Hot Oil Heater & Insulation Efficiency

Plant ______________________________ Date ______________

Notes to Remember When Analyzing Hot Oil Heater / Heat Transfer Oil Efficiency:

- **Low gas temps out of the heater are a primary indicator of efficient conversion of fuel to hot oil (see chart).**
- **Combustion efficiency of less than 100 ppm CO @ 7% O2 expected. (Heaters burn cleaner than dryers.)**
- **Older heaters with shorter bodies have a tendency to have higher gas temperatures and are not as efficient as newer units with more coils and longer bodies.**
- **Heat exchangers / "economizers" in the exhaust gas can reclaim heat, lower exit gas temperatures, and transfer heat into hot oil, saving energy.**
- **All pipes and lines should be insulated and surface temp of insulation should be <100F/35C. (See chart for calculating pontential savings from insulating un-insulated pipes and lines.)**
- **Cycling heat off and on for equipment not being used (like silos and slats at night) saves energy.**
- **"Coked" tanks and lines cause heaters to run excessively and consume more fuel / energy.**



Combustion Analysis

____ ppm CO @ ____ % O2
= ____ ppm CO @ 7% O2

PPM CO @ 7% O2 = Meassured PPM of CO x 13.9 ÷ (20.9 - Measured O2 %)

CO levels of <100 ppm @ 7% O2 are expected and typical. Higher levels indicate need to adjust burner. Take readings on high fire AFTER burner stabilizes.

Exit gas temperature is a measure of efficiency of the conversion of fuel to hot oil.

1070° = 71% eff.	945° = 75% eff.	805° = 79% eff.	665° = 83% eff.	525° = 87% eff.
1039° = 72% eff.	910° = 76% eff.	770° = 80% eff.	625° = 84% eff.	495° = 88% eff.
1003° = 73% eff.	875° = 77% eff.	746° = 81% eff.	595° = 85% eff.	465° = 89% eff.
972° = 74% eff.	840° = 78% eff.	708° = 82% eff.	558° = 86% eff.	435° = 90% eff.

(Data is table above taken from Astec T-140 publication.)

AC Tank Temperature Data

Tank #	AC Temp	Insulation Temp	Temp - Oil In	Temp - Oil Out
No. 1_________				
No. 2_________				
No. 3 _________				

(Tank temperatures are an indication of heat transfer efficiency and buildup on heating elements.)

Un-Insulated Pipe and Hot Oil Line Savings Potential Calculation - (All plants have some quantity of un-insulated pipes and lines. Use this form to calculate energy savings potential from insulating pipes / lines better.)

Pipe or Hot Oil Line	Linear Feet Not Insulated	Savings / Mo. Per Linear Foot	MM/BTU's Saved / Mo.	Savings in $ ___ / Mo.*
4" Jacketed AC Pipe (per foot)		1.084MM		
5" Jacketed AC Pipe (per foot)		1.346MM		
6" Jacketed AC Pipe (per foot)		1.599MM		
7" Jacketed AC Pipe (per foot)		1.849MM		
8" Jacketed AC Pipe (per foot)		2.743MM		
1" Hot Oil Pipe (per foot)		.347MM		
1½" Hot Oil Pipe (per foot)		.453MM		
2" Hot Oil Pipe (per foot)		.570MM		
2½" Hot Oil Pipe (per foot)		.698MM		
3" Hot Oil Pipe (per foot)		.865MM		
½" Hot Oil Jumper (per foot)		.080MM		
¾" Hot Oil Jumper (per foot)		.126MM		
1" Hot Oil Jumper (per foot)		.174MM		
1½" Hot Oil Jumper (per foot)		.219MM		
Total Savings Potential →				

* Multiply MM BTU / Month x $29.00. $29.00 per MM BTU is based on $4.00 diesel fuel and 138,000 BTU's/Gallon. MM = Million. The values in this chart are determined from data from Turner & Malloy and Astec's T140 publication.

Heating and Storage Cost Calculation (Calculate When Plant Not Producing):

Stop Fuel Units: ________ - Start Fuel Units: _________ = Total Fuel Units: __________
Cost Fuel Unit: _________ x Total Fuel Units: ________ = Total Fuel Cost: __________
Stop Test Time : ________ - Start Test Time: _________ = Total Test Time (hrs) ________
Total Fuel Cost: ________ ÷ Total Test Time (hrs) _____ = Cost per Test Hour _________
Cost per Test Hour: __________ ÷ Total Gallons Stored = Store Cost per Gallon _______
Store Cost per Gallon x 30,000 = Cost to Store 30,000 Gallon This Facility ____________

Miscellaneous Notes This Facility:

____

____

____

____

Suggested Plan of Attack …

1. **Designate an EPD Champion**
2. **Build a Spreadsheet to Collect Your Data**
   (*Energy, Material Sources, Locations, Mileage, etc.)*
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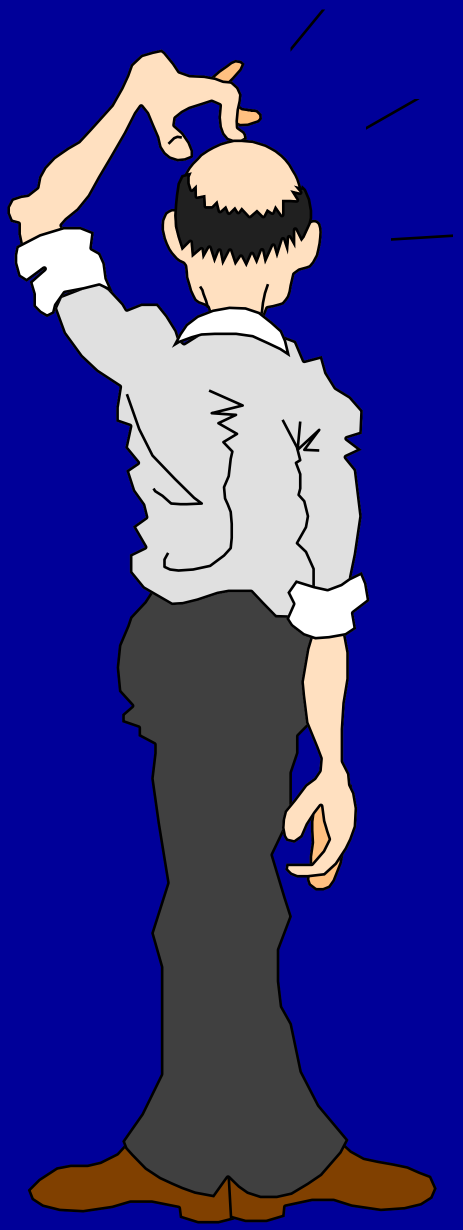
Questions?
Comments?
Contributions?



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