FG 01-95EE/5529
DOE/EE/15529--T/

INTEROFFICE MEMORANDUM

TO: FILE
FROM: DON CURRY
SUBJECT: THERMODYNE(TM) EVAPORATOR PROGRAM/UMO
DATE: NOVEMBER 26, 1996
CC:

This report will include the detail of expenditure of the final \$6,000 grant received for DOE.

The money was expended finally on a new instrument called the MAC120. This instrument was the first of it's kind to be able to read moisture percentages above 212°F.

the cost of the instrument was \$7,000 plus \$1,200 in adapters for the dryers including the adapter for the university test system

The instrument was taken to Ireland for the dryer startup there and it was a success in value.

See attached test reports.

This concludes the reports for the MAC 120 instrument.

END

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MASTER

BD Final

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Not given to Van Lee
12/2/96

November 13, 1996

LF-31 Dryer Operation Results from November 1996 Trip

Friday, Nov. 1, 1996

1. Received data from Ronnie Alexander on previous runs. (in Appendix)
2. Discussed objectives of the trip which include the following:
 - Reduce airflows and increase temperatures to more accurately represent field dryers. Lurgan's runs to date have been at very low temperatures because they are putting only 1.1 Metric tonnes/day through the dryer which can dry at least 4 - 5 MT/day.
 - Dry in both steam & air to 8% product moisture to accurately compare the difference.
 - Operate with 1 heater only due to small tonnage and drying load.
 - Calculate heater efficiency even though there is low tonnage through the dryer. Lurgan's runs to date have been with all heaters operating. This greatly increases gas usage as the heaters are clicking on and off very often to meet the small load. This burns excess propane. We want a steady, clean burn on one heater only.
3. Inspected the dryer. Everything looks good.

Saturday, Nov. 2, 1996

1. This day is devoted to COLD TESTS on the dryer. All tests are at 70°F in order to determine fan volumes, heater pressure drops, air distribution to each plenum, etc. No damper adjustments will be made today. The dampers will be left "as is" for these initial measurements.
2. Fans tripped out on overload at 47 - 48 Hertz. The 25 HP motors are all 50 Hertz. The motor FLA are 33.5 amps. However, the starters are set to trip at 32 amps. Also, the VFD's are set to limit the Hz which can be entered at the keypad to 47-48 Hz because the amps drawn is approaching 32-33 amps. It appears that the fans are moving more air than anticipated because the motors & starters are tripping out at less than 50 Hz.
3. Ronnie and I set all three fans at 45.0 Hz. for the COLD TESTS. This will be our BASELINE OPERATING POINT. All other Hz. Settings can be referenced to these settings to determine airflows. Room temperature is 22-23°C (72-73°F).

BASELINE OPERATING POINT

<u>Fan #1</u>		<u>Fan #2</u>		<u>Fan #3</u>	
415 V	1350 RPM	415 V	1350 RPM	415 V	1350 RPM
29.7 A	45.0 Hz.	28.7 A	45.0 Hz.	29.0 A	45.0 Hz.

PLENUM STATIC PRESSURE DISTRIBUTION

Pass	Plenum	Static Pressure	Damper Position
Pass #1	Top	1.75" w.c.	100% open
Pass #1	Bottom	1.75" w.c.	60% open
Pass #2	Bottom	1.45" w.c.	100% open
Pass #2	Top	1.90" w.c.	80% open
Pass #3	Top	0.75" w.c.	100% open
Pass #3	Bottom	0.75" w.c.	50% open
Pass #4	Top	1.00" w.c.	80% open
Pass #4	Bottom	0.75" w.c.	60% open

270°F

4. From the above measurements and the total nozzle area for each plenum, we can calculate our initial airflow distribution per plenum. We will use a pressure drop through the nozzle of $1.78 \times VP$ (velocity pressure).

INITIAL PLENUM AIRFLOW CALCULATIONS

Pass	Plenum	VP = SP/1.78	Nozzle Velocity	Nozzle Area	Airflow CFM	Total Airflow
Pass #1	Top	0.983"	3,971 fpm	3.675 ft ²	14,594	22,000 CFM
Pass #1	Bottom	0.983"	3,971 fpm	1.875 ft ²	7,446	
Pass #2	Bottom	0.815"	3,615 fpm	3.675 ft ²	13,284	21,000 CFM
Pass #2	Top	1.067"	4,138 fpm	1.875 ft ²	7,758	
Pass #3	Top	0.42"	2,600 fpm	3.675 ft ²	9,554	14,300 CFM
Pass #3	Bottom	0.42"	2,600 fpm	1.875 ft ²	4,874	
Pass #4	Top	0.56"	3,002 fpm	1.875 ft ²	5,628	8,700 CFM
Pass #4	Bottom	0.42"	2,600 fpm	1.20 ft ²	3,120	
					TOTAL	66,000 CFM

These airflows are higher than design even at the reduced motor speed of 45.0 Hertz.

5. We attempted to take tachometer readings on the fans and motors to verify RPM. However, the tachometer kept sticking and was not reliable. Ronnie will get another one tomorrow if possible.

The motor nameplate is 1480 rpm. This was originally 1425 RPM but was changed by Baldor. Twin City was made aware of the change, but they sheaved the fans for a 1425 RPM motor. The fans are actually turning at a higher RPM than design.

- Measured Fan Sheave O.D. = 9 5/8"
- Measured Motor Sheave = 8 7/8"
- Ratio = $8.875/9.625 = 0.92$
- Twin City's Specified Fan sheave P.D. = 9.4"
- Twin City's Specified Motor sheave P.D. = 8.6"
- Ratio = $8.6/9.4 = 0.91$, $0.91 \times 1480 \text{ RPM} \times 45/50 \text{ Hz.} = \underline{1212 \text{ Fan RPM}}$
- $1480 \text{ Motor RPM} \times 45/50 \text{ Hz.} = \underline{1332 \text{ Motor RPM}}$

These are the expected RPM's which will be checked by tachometer tomorrow.

6. We moved on to measure the fan static pressures and the heater pressure drops. This was done by removing the internal access door for Fan #3 and Ronnie closing me inside the dryer. With a spotlight and gages, I was able to record the following pressures.

FAN AND HEATER STATIC PRESSURES

Fan	Inlet SP & Heater PD	Outlet SP	Add for transition	Approx. Fan SP
Fan #1	- 1.9" w.c.	+ 1.8" w.c.	0.25" w.c.	4.0" w.c.
Fan #2	- 1.5" w.c.	+ 1.7" w.c.	0.25" w.c.	3 1/2" w.c.
Fan #3	- 2.0" w.c.	+ 0.9" w.c.	0.25" w.c.	3 1/4" w.c.

These pressures are much lower than anticipated. The reason is the heater pressure drops are much lower than Eclipse predicted. Based on Eclipse information, the heater PD should have been closer to 3 1/2" w.c. They gave us a very conservative design figure.

The fans are moving more air at 45 Hertz than anticipated due to the low Eclipse heater pressure drop and slightly higher fan RPM due to the 1480 RPM motor. The low heater pressure drop is the major reason for the higher airflows.

7. Although the accurate tachometer readings were done on Sunday, I will introduce them here. They are 1218 Fan RPM and 1348 Motor RPM (agrees with keypad). The fan curve for the 330 BCPL's at 1218 RPM is attached. It indicates airflows from 20,000 CFM to 22,000 CFM

at SP's from 3 ¼" to 4.0". These agree with the airflows as calculated from the plenum static pressure readings.

Based on the fan curve, fan SP's, and plenum SP's we will conclude the following are the airflows to the plenums at 45.0 Hertz with the damper positions as indicated on this day and with all of the air going to the plenums (No bypass air) This will be our BASELINE.

BASELINE AIRFLOW WITH NO BYPASS AIR

Fan	Pass	Plenum	Airflow CFM	% Top %Bottom	Total Airflow
Fan #1	Pass #1	Top	13,650	65%	21,000 CFM
	Pass #1	Bottom	7,350	35%	
Fan #2	Pass #2	Bottom	13,230	63%	21,000 CFM
	Pass #2	Top	7,770	37%	
Fan #3	Pass #3	Top	9,020	66%	13,600 CFM
	Pass #3	Bottom	4,620	34%	
Fan #3	Pass #4	Top	5,280	63%	8,400 CFM
	Pass #4	Bottom	3,080	37%	
			TOTAL		64,000 CFM

Sunday, Nov. 3, 1996

1. The first item today is to go through all of the VFD settings with Ronnie. We did this and it all looks good. Ronnie now knows how to set the parameters of the VFD's and I encouraged him to write down all of the settings in case something gets changed. I had a listing of the settings as recommended by Ed Cowern.
2. The next order of business today is to bypass some air around the plenums. We will do this by removing the three access doors on the supply ducts and short-circuiting some of the air back to the heaters. This will result in less air on the product and the need for increased temperatures to do the drying. In essence we are now modifying the dryer by reducing its capacity to allow testing at the low tonnages that Lurgan is putting through it.

We will use the new plenum pressure drop readings to calculate the lower plenum airflows. The total fan airflows will go up some so the heater pressure switches are still satisfied. In the past Ronnie could not go below 25 Hz, or the heaters would come off-line due to insufficient airflow. This bypass air method will allow us to go lower in airflow onto the product.

The 3 access doors on the supply ducts were removed. Fan #1 has a 24" x 30" bypass opening. This is 720 in² as compared to the total nozzle open area for Pass #1 of 800 in². Fan #2 has a 24" x 30" bypass opening. This is 720 in² as compared to the total nozzle open area for Pass #2 of 800 in². Fan #3 has a 24" x 36" bypass opening. This is 864 in² as compared to the total nozzle open area for Pass #3 & Pass #4 of 1242 in².

PLENUM STATIC PRESSURES WITH BYPASS AIR

Pass	Plenum	Static Pressure	Damper Position
Pass #1	Top	0.65" w.c.	100% open
Pass #1	Bottom	0.65" w.c.	60% open
Pass #2	Bottom	0.65" w.c.	100% open
Pass #2	Top	1.00" w.c.	80% open
Pass #3	Top	0.20" w.c.	100% open
Pass #3	Bottom	0.35" w.c.	50% open
Pass #4	Top	0.50" w.c.	80% open
Pass #4	Bottom	0.35" w.c.	60% open

The new airflows to the plenums with bypass air will be calculated by taking the square root of the pressure ratios and multiplying by the old airflows with no bypass air. Static pressure varies as the square of the CFM.

The new total airflow through the fans were also estimated. They increase slightly. The bypass air conditions are as follows.

AIRFLOW WITH BYPASS AIR

Fan	Pass	Plenum	Plenum CFM	% Top %Bottom	Bypass CFM	Total Fan Airflow
	Pass #1	Top	8,500 CFM	65%		
	Pass #1	Bottom	4,500 CFM	35%		
Fan #1		Subtotal	13,000 CFM		9,000 CFM	22,000 CFM
	Pass #2	Bottom	9,500 CFM	63%		
	Pass #2	Top	5,500 CFM	37%		
Fan #2		Subtotal	15,000 CFM		7,000 CFM	22,000 CFM

	Pass #3	Top	5,300 CFM	66%		
	Pass #3	Bottom	2,700 CFM	34%		
Fan #3		Subtotal	8,000 CFM		6,000 CFM	14,000 CFM
	Pass #4	Top	3,800 CFM	63%		
	Pass #4	Bottom	2,200 CFM	37%		
Fan #3		Subtotal	6,000 CFM		3,000 CFM	9,000 CFM
		TOTAL	42,000 CFM		25,000 CFM	67,000 CFM

We are now bypassing 37% of the air directly back to the heaters and impinging 63% of the air onto the articles through the nozzles.

We can now ratio all CFM's from this point based on motor speed.

3. Ronnie elected to use our spray nozzles instead of the steam precharge system because Lurgan is moving away from steam as new emissions regulations may require them to start shutting down boilers. The spray nozzles can be used with the 100 psig water pressure available or at 400 psig with the booster pump which is in place.

There are also both large and small sprays in order to experiment with which sprays provide the best absorption. Ronnie has installed only a strainer in his line. This has let some particles pass which have clogged the small nozzles. Ronnie does want to install a better filter in the line so the small nozzles will not clog.

We found that the 400 psig pressure provided a much finer spray which we believe will more readily be evaporated. We have decided to operate with the booster pump. We also checked to make sure all sprays we were intending to use were operating.

At 400 psig the sprays will deliver the following volumes of water:

- Large Spray = 0.28 GPM = 2.34 pounds/min. of water
- Small Spray = 0.08 GPM = 0.67 pounds/min. of water

These numbers will be used to calculate water evaporation and humidity elevation load from operating the dryer with the sprays on to simulate a higher tonnage. In theory, every 2 large sprays will add the equivalent water evaporation load as 1 metric ton of production per day.

4. Water Leakage - With the sprays on some of the water leaked out of the dryer around the heater house. There was some puddling with all sprays on. Not much. Ronnie suggests that the gasket around the bottom heater may be allowing water to pass. This gasket was pushed out of place in some spots around the heater perimeter during installation. Ronnie was made aware of this in July and he fixed the gaskets. However, he did admit that they did not inspect the entire perimeter of the heaters. If the gasket was pushed out of place and not fixed, then air could also be leaking in around the heaters during operation. This could be a major source of air leakage into the dryer. We should recommend that Ronnie check all of the heater gaskets.

The puddling can be tolerated for a short time in order to precharge the dryer more quickly. To avoid puddling, turn on fewer sprays and allow more time to precharge the dryer.

5. Exhaust Fan - Twin City put the fan sheave on the motor and the motor sheave on the fan. This results in 900 RPM on fan (design of 2400 RPM) and 1500 RPM for motor. These were tachometer readings.

The mistake by Twin City actually matches the tonnage at 1 - 1.5 MT/Day very well. However, if we want to operate at 4 MT/day in AIR mode, then we would have to speed up the fan to dump more air back in the dryer. At this point in time, Ronnie wants to leave it alone and for the low tonnage it is no problem. It is also no problem for STEAM mode as much less exhaust is required and all of the hot, moist air can be dumped back over the moulding machine for preheating.

Ronnie does not want to dump air back into the dryer after this week of testing. He wants to operate in STEAM mode only. He sees no benefit to the air dump back to the dryer except to drive up the energy usage of the dryer.

This fan is operating now at about 1,300 CFM total with 650 CFM dumped back into the dryer and 650 CFM dumped on top of the moulding machine. This is AIR mode. None is exhausted to atmosphere.

With STEAM mode operation, Ronnie simply removes the duct going back to the dryer, plugs the hole in the top, and dumps all of the exhaust onto his moulding machine. Whatever is not sucked into the machine by the vacuum system simply spills out into the room and rises to the roof vents. When Ronnie sees moisture pouring out from the machine hood, then he knows the dryer has essentially been precharged and is ready to receive product.

6. Hot Test - We are now going to do a hot test on the dryer with no product but with sprays on to simulate production and verify the accuracy of the moisture meter. This is in AIR mode. We will dry product on Monday in AIR mode also. We will then dry product in STEAM mode on Tuesday for a comparison. When J.J. Post and J. Kienstra are here on Wednesday & Thursday, we can decide which tests to run on those days.

All runs this week will be with reduced airflows to the product due to bypass air.

HOT TEST - NO PRODUCT - SPRAYS ON

Fan #1		Fan #2		Fan #3	
-----	1350 RPM	-----	1350 RPM	-----	1350 RPM
-----	45.0 Hz.	-----	45.0 Hz.	-----	45.0 Hz.
Temp.	200°C	Temp.	158°C	Temp.	142°C
	(392°F)		(316°F)		(288°F)

Sprays	1 large	Sprays	1 large	Sprays	1 large
			1 small		1 small
Gas Meter Readings: 3.5 m ³ /hr : xxx.x total : x:xx PM					
Gas Meter Readings: x.x m ³ /hr : xxx.x total : x:xx PM					
Gas Meter Readings: x.x m ³ /hr : xxx.x total : x:xx PM					

TEMPERATURES & HUMIDITIES

	Location	Location	Location	Location
	#1	#2	#3	#4
Dry Bulb Temp.	270°F	150°F	340°F	285°F
Wet Bulb Temp.	148°F	108°F	144°F	150°F
Dewpoint Temp	-----	102°F	-----	143.5°F
Meter Reading	-----	7.8%	-----	19.3 %
Dewpoint Temp.	-----	106°F	-----	140°F
% Difference	-----	3.8%	-----	2.5%

Reference the attached sketch for the sampling port locations #1 through #4.

The moisture meter readings are within a few percent of the thermometer readings. We can accept the meter readings for the drying tests this week.

At Location #2 there is a very low moisture level. This is due to the inflow of room air at this point. The temperature stack effect is larger than anticipated and is contaminating the dryer. The fix for this problem is a slight pressurization at this point to get an outflow of moist air. This will require some baffling and a small duct from the plenums to the lower opening to pressurize the area. Also block off the opening a little better.

The air contamination will be magnified at the low tonnage because the moisture evaporation in the dryer is low.

7. Based on our observations to date, the 2 major points of air leakage into the dryer are:

- 1) Bottom opening in internal baffle through which product exits the dryer.
 - This can be corrected by pressurizing the area.
- 2) Heater gasketing has been pushed out of place and air is leaking past.
 - This can be corrected by pushing the gaskets back in place and/or filling the gasket cavity with some sort of form - in - place gasketing product. There are weep holes in the heater plate through which high temperature silicone caulking or another product could be injected to fill the gasket cavity.

Monday, Nov. 4, 1996

AIR DRYING TEST

Fan #1		Fan #2		Fan #3	
281 V	900 RPM	272 V	870 RPM	263 V	840 RPM
18.0 A	30.0 Hz	18.2 A	29.0 Hz	18.2 A	28.0 Hz
Temp.	250°C	Temp.	161°C	Temp.	130°C
	(482°F)		(322°F)		(265°F)
Sprays	OFF	Sprays	OFF	Sprays	OFF
Exhaust air dumping into top of dryer					
Production: 12.4 ko/min., 40% coverage, filler flats, 74% in, 8% out, 60.6 g BD					
Gas Meter Readings: 3.8 m ³ /hr : 366.6 total : 3:15 PM					
Gas Meter Readings: 3.2 m ³ /hr : 370.0 total : 4:00 PM					
Gas Meter Readings: 3.4 m ³ /hr : 371.2 total : 4:15 PM					

TEMPERATURES & HUMIDITIES

	Location	Location	Location	Location
	#1	#2	#3	#4
Dry Bulb Temp.	220°F	-----	390°F	-----
Wet Bulb Temp.	144°F	-----	166°F	-----
Meter Reading	18.7%	3.2%	-----	21.9%
Dewpoint Temp.	138°F	-----	-----	144°F

During this drying test, Ronnie and I adjusted the dampers on the top pass to get a flatter product. The filler flats came out flatter as we put more air on the bottom plenum and less on the top. He knows how to "shape" now to get a good product. We could have gotten it even better, but Ronnie did not want to upset the article position on the carriers.

He stated that the product quality was acceptable. I suggested that Ronnie do "shaping" adjustments with a cold dryer by simply placing a wet product on a tray on the top pass and determine how much air can be put on the bottom plenum before the article starts to move.

The top damper on Pass #1 is at 50% and the bottom damper is at 100% open. We measured the new plenum pressures on Tuesday with a cold dryer at 45.0 Hz. They were 0.50" on the top plenum and 0.80" on the bottom plenum. Based on these, the new air distribution numbers at 45.0 Hz. Fan speed are as follows:

45.0 HZ. REVISED AIRFLOW WITH BYPASS AIR
(use this distribution for all tests)

Fan	Pass	Plenum	Plenum CFM	% Top %Bottom	Bypass CFM	Total Fan Airflow
	Pass #1	Top	7,450 CFM	60%*		
	Pass #1	Bottom	5,000 CFM	40%*		
Fan #1		Subtotal	12,450 CFM		9,550 CFM	22,000 CFM
	Pass #2	Bottom	9,500 CFM	63%		
	Pass #2	Top	5,500 CFM	37%		
Fan #2		Subtotal	15,000 CFM		7,000 CFM	22,000 CFM
	Pass #3	Top	5,300 CFM	66%		
	Pass #3	Bottom	2,700 CFM	34%		
Fan #3		Subtotal	8,000 CFM		6,000 CFM	14,000 CFM
	Pass #4	Top	3,800 CFM	63%		
	Pass #4	Bottom	2,200 CFM	37%		
Fan #3		Subtotal	6,000 CFM		3,000 CFM	9,000 CFM
		TOTAL	41,450 CFM		25,550 CFM	67,000 CFM

AIRFLOW ONTO PRODUCT FOR AIR TEST

Fan	Motor Speed	Plenum CFM	Bypass CFM	Total Airflow
Pass #1	30.0 Hz.	8,300 CFM	6,400 CFM	14,700 CFM
Pass #2	29.0 Hz.	9,700 CFM	4,500 CFM	14,200 CFM
Pass #3	28.0 Hz.	5,000 CFM	3,700 CFM	8,700 CFM
Pass #4	28.0 Hz.	3,700 CFM	1,900 CFM	5,600 CFM
	TOTAL	26,700 CFM	16,500 CFM	43,200 CFM

1. Heater Observations - I tried to measure inlet temperature but could not accurately. Even with a 5 foot piece of copper tubing as a holder for the thermometer.
 - Heaters have non-uniform temperatures across them, hot & cold spots. I could not get a uniform temperature at the inlet for heat input calculations to airstream. The bypass air returning directly to the heater inlets and mixing with return air from the plenums doesn't help the situation.

- Baffles are not tight to top & bottom of housing. They could be adjusted to deflect airflow over heater tubes more efficiently. It is difficult to say if this would improve heater efficiency.
 - Also, there is too much bypass air around the end of the heater tubes. We could put a thin, bendable piece of metal in this space to see how much the heater moves and how big the space is during operation. At Orono with the electric heaters, we only needed 1" of clearance at the ends of the tubes to prevent overheating of the tube bundle.
2. We both agree that the dryer makes a very nice filler flat in air mode with impingement drying.
The shape could be improved even more to get a very flat product.

Tuesday, Nov. 5, 1996

STEAM DRYING TEST

<u>Fan #1</u>		<u>Fan #2</u>		<u>Fan #3</u>	
-----	-----	-----	-----	-----	-----
-----	32.0 Hz.	-----	32.0 Hz.	-----	28.0 Hz.
Temp.	230°C	Temp.	185°C	Temp.	120°C
	(446°F)		(365°F)		(248°F)
Sprays	(2) large	Sprays	(2) large	Sprays	(2) large
	(2) small		(2) small		(2) small
Plug in top of dryer					
Production: 12.5 ko/min., 40% coverage, filler flats, 74% in, 8% out, 60.6 g BD					
Gas Meter Readings: 5.1 m ³ /hr : 405.2 total : 5:30 PM					
Gas Meter Readings: 4.4 m ³ /hr : 408.2 total : 5:45 PM					
Gas Meter Readings: --- m ³ /hr : 412.2 total : 6:05 PM					

TEMPERATURES & HUMIDITIES

	Location	Location	Location	Location
	#1	#2	#3	#4
Meter Reading	-----	-----	-----	62.0%
Dewpoint Temp.	-----	-----	-----	189°F

FLOW ONTO PRODUCT FOR STEAM TEST

Fan	Motor Speed	Plenum CFM	Bypass CFM	Total Airflow
Pass #1	32.0 Hz.	8,850 CFM	6,800 CFM	15,650 CFM
Pass #2	32.0 Hz.	10,700 CFM	4,950 CFM	15,650 CFM
Pass #3	28.0 Hz.	5,000 CFM	3,700 CFM	8,700 CFM
Pass #4	28.0 Hz.	3,700 CFM	1,900 CFM	5,600 CFM
	TOTAL	28,250 CFM	17,350 CFM	45,600 CFM

1. The product was a bit flatter with the steam drying mode. However, Ronnie did not see the large difference in shrinkage which he had seen with his low temperature drying tests a couple of weeks ago.
2. The air leakage into the dryer was such that even without the exhaust air dump into the top of the dryer the humidity inside the dryer only reached 20-22% by volume without the sprays on. We will run all steam tests with the sprays on to drive the moisture levels as high as possible. We can try to approximate the water evaporation and humidity elevation energy loads caused by the sprays for our energy efficiency calculations. We will assume that half of the small sprays are plugged.

Wednesday, Nov. 6, 1996

J.J. Post and J. Kienstra arrived from Van Leer to observe the dryer in operation. J.J. Post & J. Kienstra wanted to dry in both steam and air today but with a filler flat made as heavy as possible to "load" the dryer with as much moisture as possible. We also dried down to 2-3% moisture to determine if more product quality differences between air & steam might surface. We performed the steam drying test first, then the air drying test by opening an access door to introduce air to the dryer.

STEAM DRYING TEST

Fan #1		Fan #2		Fan #3	
-----	-----	-----	-----	-----	-----
-----	50.0 Hz.	-----	40.0 Hz.	-----	40.0 Hz.
Temp.	258°C	Temp.	194°C	Temp.	148°C
	(496°F)		(381°F)		(298°F)
Sprays	(2) large	Sprays	(2) large	Sprays	(2) large
	(2) small		(2) small		(2) small
Plug in top of dryer					
Production: 12.5 ko/min., 40% coverage, filler flats, 74% in, 8% out, 75.9 g BD					

TEMPERATURES & HUMIDITIES

	Location	Location	Location	Location
	#1	#2	#3	#4
Meter Reading	-----	-----	-----	57.4%
Dewpoint Temp.	-----	-----	-----	185°F

FLOW ONTO PRODUCT FOR STEAM TEST

Fan	Motor Speed	Plenum CFM	Bypass CFM	Total Airflow
Pass #1	50.0 Hz.	13,800 CFM	10,600 CFM	24,400 CFM
Pass #2	40.0 Hz.	13,300 CFM	6,200 CFM	19,500 CFM
Pass #3	40.0 Hz.	7,100 CFM	5,300 CFM	12,400 CFM
Pass #4	40.0 Hz.	5,300 CFM	2,700 CFM	8,000 CFM
	TOTAL	39,500 CFM	24,800 CFM	64,300 CFM

AIR DRYING TEST

Fan #1		Fan #2		Fan #3	
-----	-----	-----	-----	-----	-----
-----	42.0 Hz.	-----	42.0 Hz.	-----	40.0 Hz.
Temp.	258°C	Temp.	189°C	Temp.	156°C
	(496°F)		(372°F)		(313°F)
Sprays	OFF	Sprays	OFF	Sprays	OFF
Access door partially open					
Production: 12.5 ko/min., 40% coverage, filler flats, 74% in, 8% out, 73.7 g BD					

TEMPERATURES & HUMIDITIES

	Location	Location	Location	Location
	#1	#2	#3	#4
Meter Reading	-----	-----	-----	20.5%
Dewpoint Temp.	-----	-----	-----	142°F

FLOW ONTO PRODUCT FOR AIR TEST

Fan	Motor Speed	Plenum CFM	Bypass CFM	Total Airflow
Pass #1	42.0 Hz.	11,600 CFM	8,900 CFM	20,500 CFM
Pass #2	42.0 Hz.	14,000 CFM	6,500 CFM	20,500 CFM
Pass #3	40.0 Hz.	7,100 CFM	5,300 CFM	12,400 CFM
Pass #4	40.0 Hz.	5,300 CFM	2,700 CFM	8,000 CFM
	TOTAL	38,000 CFM	23,400 CFM	61,400 CFM

1. There was not a noticeable difference in product quality in either mode. There were noticeable marks on the product due to dropping the heavy article onto the carriers from a relatively high height above the tray, called blow-off height. This was at 2-3% product moisture and a 74 gram bone dry weight which is heavy for filler flats.
2. We decided to run a light product weight tomorrow and dry to 2-3% moisture to see if there is any difference in product quality at a lighter than normal weight.

Thursday, Nov. 7, 1996

AIR DRYING TEST

Fan #1		Fan #2		Fan #3	
-----	-----	-----	-----	-----	-----
-----	30.0 Hz.	-----	29.0 Hz.	-----	28.0 Hz.
Temp.	251°C	Temp.	161°C	Temp.	129°C
	(484°F)		(322°F)		(264°F)
Sprays	OFF	Sprays	OFF	Sprays	OFF
Access door partially open					
Production: 12.5 ko/min., 40% coverage, filler flats, 74% in, 8% out, 52.2 g BD					

TEMPERATURES & HUMIDITIES

	Location	Location	Location	Location
	#1	#2	#3	#4
Meter Reading	-----	-----	-----	13.7%
Dewpoint Temp.	-----	-----	-----	126°F

AIRFLOW ONTO PRODUCT FOR AIR TEST

Fan	Motor Speed	Plenum CFM	Bypass CFM	Total Airflow
Pass #1	30.0 Hz.	8,300 CFM	6,400 CFM	14,700 CFM
Pass #2	29.0 Hz.	9,700 CFM	4,500 CFM	14,200 CFM
Pass #3	28.0 Hz.	5,000 CFM	3,700 CFM	8,700 CFM
Pass #4	28.0 Hz.	3,700 CFM	1,900 CFM	5,600 CFM
	TOTAL	26,700 CFM	16,500 CFM	43,200 CFM

1. The 3 molds on the machine are producing different products and levels of shaping. However, J. Kienstra & J.J. Post noticed a slight trapezoid shape in the finished product which was verified with measurements. This shape seemed to be common with all the articles, but to varying degrees. Sometimes only one side of the article was noticeably sloped which the other appeared straight. It is unclear if this is due to the moulding machine or dryer. J. Kienstra thinks it is dryer related. We will look for this shape during the steam drying test.

STEAM DRYING TEST

1. We were in the middle of the steam test when we had a tray jam and had to shut down the dryer. The moisture levels were still climbing. I would estimate somewhere around 40% or 169°F dewpoint temperature. I increased the airflow on the second pass and lowered it on the top pass to get the top pass temperature a bit closer to 250°C. At the time of the jam Pass #1 temperature was at about 230°C.
2. When the trays jammed on Pass #3 & #4, we opened all of the doors and cold room air rushed into the dryer. After removing the jam, Ronnie retrieved some of the products from the top pass of the dryer. They were scorched bone dry, light brown in color, and quite flat and well shaped. Ronnie remarked that they slid inside each other even better than the articles we had previously made in both air & steam. No tendency to stick together. They fell right out of each other.

Although Kienstra and Post were looking closely at the edge of the filler flats, Ronnie remarked that the true indication of a good product is the centerline distance between each of the cells and the ability of the filler flats to "de-nest" easily. In this regard, the filler flats which were steam dried and then scorched as the moisture flashed off them in the air environment were superior to the other filler flats dried this week.

3. Ronnie wants to do more testing this week on this steam/air drying concept. He also wants to convert the dryer to a combination steam/air dryer by partitioning the top pass off from the rest of the dryer. J.J. Post wants to run a different product which may show greater differences between steam and air drying and convert to a 2 pass dryer to shorten drying times.

In order to accomplish these changes, we must redesign the airlocks, redesign the top access door seals, redesign the weighted take-up system, rework the conveyor length and trays, rework the exhaust duct intake, etc. It will take some effort to target all of the modifications necessary to convert from 4 pass to 2 pass and from steam or air to hybrid drying in steam on the first pass and air on the last pass.

LF - 31 DRYER ACTION POINTS

(as listed by J.J. Post with discussion by R. Alexander, J. Kienstra, & J. Bernier)

<u>Action Point</u>	<u>Who?</u>
1. Produce an article which is more difficult to dry, such as b block, SFP. This might be a high sided article with a tendency to deform inside the dryer. Since there are production and cost issues involved, Van Leer will decide which article and notify Merrill in writing of the specifications.	Van Leer
2. Submit a proposal to improve the dryer airlocks. There are two possibilities to consider. The first is pressurizing the lower opening. The second is the horizontal divider within the dryer to allow its operation as a steam dryer on Pass #1 And an air dryer on Pass #4. Send to J.J. Post, R. Alexander, B. Philbrook, J. Kienstra.	Lurgan/
Merrill
3. Write report on trials this week.	Lurgan/
Merrill
4. Convert the dryer to a 2-pass dryer. Discuss the cost.	Lurgan/
Merrill
5. Submit a proposal to test the moisture on different dryers at Lurgan, Leopack, Chinnet, etc. We would use Merrill's meter for these tests.	Merrill
6. Lurgan to submit a monthly progress report to all parties to keep everyone up to date on the progress of the dryer modifications and testing.	Lurgan

END