

## **Fluidized-Bed Steam Dryers**

**Mark Suhr, Vice President Operations**

**Southern Minnesota Beet  
Sugar Cooperative  
Renville, Minnesota**

Southern Minnesota Beet Sugar Cooperative (SMBSC) began a 4-year expansion and modernization in 1999. Included in the project's first phase was eliminating the two direct-fired single pass rotary dryers for beet pulp and installing two Niro, size 10, fluidized-bed steam dryers.

In preparation of this advanced technology, SMBSC sent individuals to Europe to learn about the dryers capabilities. In addition, Arne Sloth Jensen, who was the lead steam dryer designer, provided technical training throughout the installation and initial startup. Niro reviewed all drawings and programming as well as provided an onsite engineer throughout the first year. In addition, maintenance personnel were trained on the rotary valves, both on preventative maintenance and repair.

SMBSC selected the steam dryers over the more conventional direct-fired dryers for two main reasons: environmental improvements and energy savings.

**Environmental** – In 1996, SMBSC established several core values. One was to “*pursue the highest quality, safety and environmental standards.*” The environmental standard was very important given SMBSC's history with the Minnesota Pollution Control Agency. To achieve a higher level of environmental improvements over conventional drying technology, SMBSC selected the fluidized bed steam dryers.

By utilizing the fluidized bed technology, SMBSC was able to expand without exceeding a PSD (Prevention of Significant Deterioration) threshold limit. The significance of this statement is that in a PSD review we had to calculate air emissions at the full-expanded slice capacity and maximum emission level over a full 365-day operation versus the planned 180-day slice campaign. Without the steam dryer installation, SMBSC would have undergone a major air permit modification, a lengthy permit process, and a review of BACT (Best Available

Control Technology) which most likely would have resulted in an outcome having extreme limitations on operating days.

The result of the steam dryers in emissions is compared to our conventional dryers and also to an improved multi-pass dryer with wet scrubber. As shown, the steam dryer clearly is the best for an emission reduction.

**Energy Savings** – Our goal was to only increase the incoming beets per day, with all other inputs, such as coal, fuel oil, limestone, chemicals, and labor, to remain flat or reduce on a daily basis.

In the analysis, strong consideration was given to a 3-pass rotary dryer with a direct-fired heat source and a heat source from a gas turbine after electrical generation.

The final analysis favored the steam dryers. An additional benefit was that it removed an energy source. It also allowed for a favorable long-term electrical supply contact to be negotiated.

The general steam drying principles and the fuel savings are well documented. The results of the steam dryer installation at SMBSC are presented in the following graphs.

Pulp Dryer Energy

Dryer Running Totals FY 2001

Pulp % on Beets FY 2000

Pulp % on Beets FY 2001

Total Energy (1998 vs. 1999)

It is clear that operating time and beet pulp dried are not as tightly correlated as desired. The major cause has not been the dryer itself or the rotary

valve. Instead, the major issue involves the main fan motor and ancillary equipment performance.

We have experienced two major dryer outages extending beyond 10 days both involved the main 1400-hp motor. The motor and fan are the same as the European units and operate at 690 incoming volts with variable frequency drives. In bringing the dryer up to full speed during the initial startup, a metallic rub was evident. Unfortunately, a shutdown was necessary after only the first two minutes of drying as the noise continued to increase in level. During the inspection, the main shaft, which has both the rotor windings and the fan assemblage attached, was discovered to have cracked and broke. A new shaft was fabricated locally with Niro and ABB observing the repair. The repaired motor was operational with a vibration sensor added for an additional safeguard. Within 30 days after the outage the dryer was back online.

The second major failure involved the motor's upper bearings. These are both thrust and radial support bearings. The cause is unclear at this time, but the repairs did require the fan rotor removal. The bearing failure is on the hot side of the motor but does have a rotating heat shield.

In addition to these two motor failures, the VFD has failed twice. Once a software correction to the drive was made and the environment for the drive improved, performance has been acceptable. We have not incurred any problems since the initial failure. It is important to note both failures were covered by NIRO's warranty.

The rotary valve performance has met expectations. The inlet and outlet valves were both sized the same for spare part consolidation, and also to allow the outlet to operate at a much slower speed than previous designs. This is important since the dried pulp is highly abrasive compared to press pulp and has a higher potential for corrosion. The warranty includes two years on the inlet

valve and one year on the outlet valve. The valves have easily met operating standards.

Our first campaign length was 229 days and we had a 45-day dry pulp campaign. The typical wear rate over a campaign is shown in the attached graphs identified as *Dryer 2 Inlet Rotary Valve and Dryer 2 Outlet Rotary Valve*.

The vapor off the dryers has shown a tendency to create a scale on the stainless steel heat transfer surfaces. The vapor is superheated and a condensate spray was installed to prevent pulp from plating into the surfaces as well as to desuperheat. This spray is critical to allow proper vapor utilization to the process and recover the energy as designed. This scale has not been properly analyzed to date. However, it is a very fine black material that can be removed with a pH change. Our experiences from these two campaigns will limit where the vapor can be utilized. The non-condensable vents, the vapor pipe and the evaporator body should be stainless steel or a fail-safe method of holding the pH up above 7 must be incorporated. The mild steel non-condensable vents lasted less than 45 days with 75% metal loss.

There was considerable discussion before the dryers were put into service on the need for properly conditioned pressed pulp as the feed. Our operating experience has tested the outer limits in particle size distribution, moisture and sugar content.

Moisture is not as critical as initially believed. During upset conditions, pulp as high as 88% moisture (12 D.S.) has been successfully dried to under 10% (90% D.S.) moisture. The dryer capacity is limited in pulp throughput by more than the maximum evaporation capacity. Our experience with high moisture pulp is approximately 60% of maximum evaporator capacity is achievable with little risk of losing fluidization.

High pulp losses have several additional challenges. Upon entering the dryer, the pulp begins to lose moisture and become very sticky. The pulp has stuck in the corners and bottom screen in the first and last cells. The hard dried pulp from this condition has created several cleaning outages. The second issue is the release of higher organic acid levels in the vapors and off the dried pulp both during and after decompression from the dryer. Acetic acid has been the most prevalent and creates an irritating odor. Sugar losses below 0.4% on beets completely eliminates this issue.

The particle size concern is created by processing deep frozen beets and the consequence of slicing beets into slabs instead of the normal cassettes. The larger particles do not dry consistently below 10% moisture. Overall, this has not been a serious issue. Design changes can be instituted if this potential problem becomes more serious.

The dryer control is done remotely. At start-up it is advisable to observe dry pulp leaving the dryer within 2 to 2 ½ minutes. If not, the feed needs to be stopped. Pulp moisture is controlled by the superheat amount. A recommendation is to observe the cyclone dust collector through the top sight glass during startup. This is generally not possible due to fouling on the sight glass. The interlock for injection steam for the cyclone venturi appears to provide sufficient security.

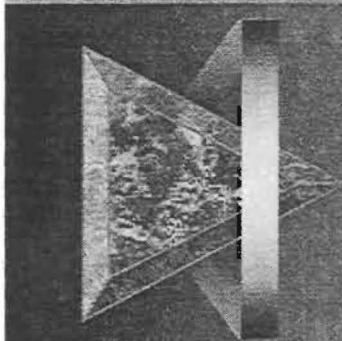
The dried pulp moisture variation is less than  $\pm 0.5\%$ . The pulp level sensing capacitance in the last cell and the outlet cyclone has been a nuisance. After time, the probe collects pulp and creates false trips. The sensing level concept is good. However, the ability to consistently measure this level has created more outages than a plugged dryer has.

The inlet chute gate and conveyor to the pulp dryer needs careful consideration. The rotary valve, especially during its adjustments for proper clearance, will allow vapor to enter the chute. The pulp and vapor combined can create an increase drag on the slide gate. The chute needs to be able to allow easy flow into the rotary valve with a relief when feeding the dryer ceases abruptly. The relief also allows pulp that would have reached a stoppage point in the conveying system to be recycled to avoid a high moisture sticky pulp from entering the dryer and creating a fluidization loss in the dryer.

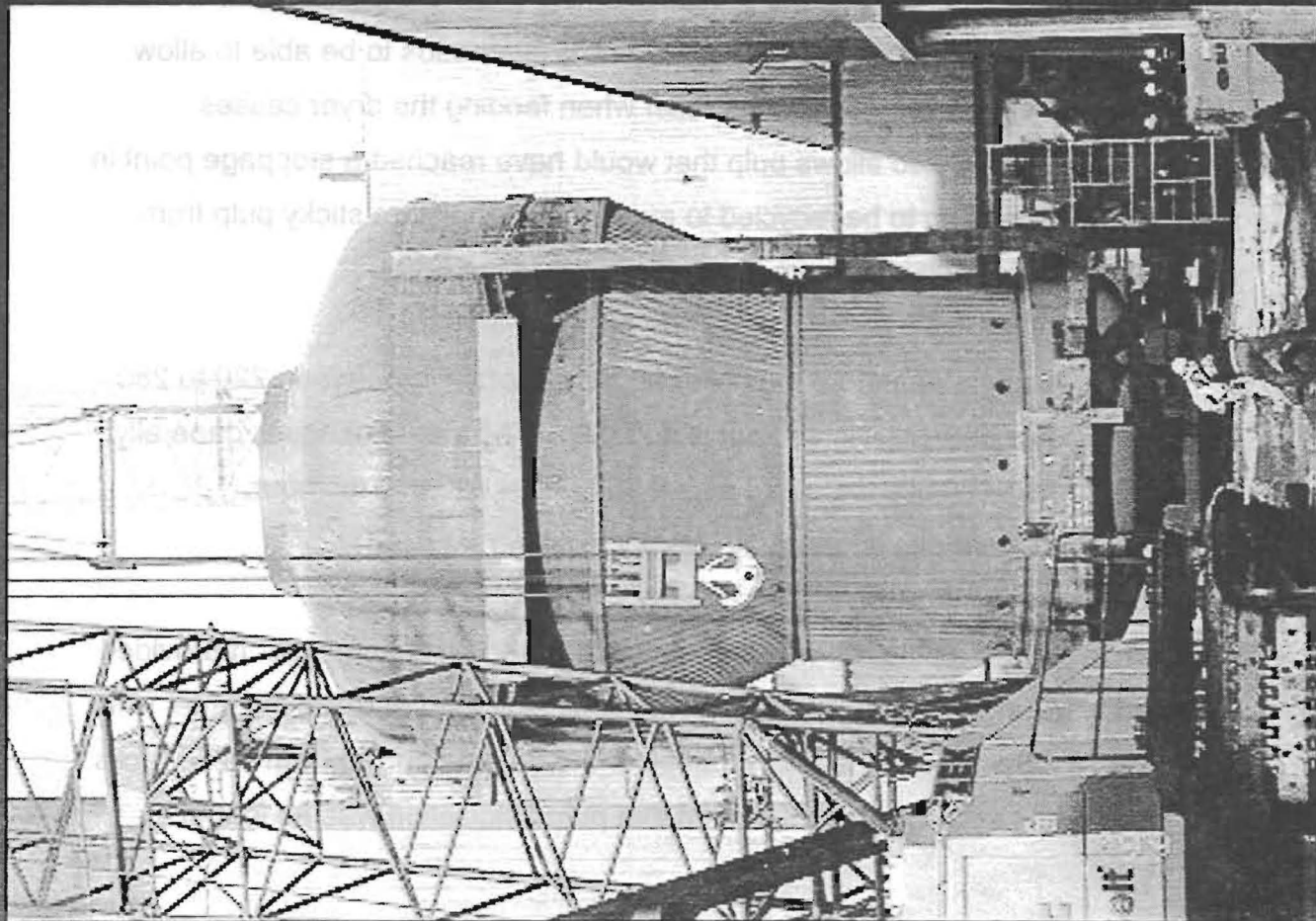
The supply steam from the boiler house generally is between 220 to 280 psig. Our boiler house steam output is 450 psig. The steam usage is generally around 120,000-150,000 lbs out of a total 350,000 – 400,000 lbs/hour. Therefore, we have and do generate electrical power.

In addition, a pulp run was completed after the first campaign. It provided additional training, revenue and employment. A high load of rocks did enter with this pulp. No damage to the rotary valves or the dryer occurred from these rocks. The rock would accumulate to the point that pulp fluidization was no longer possible.

After nearly two campaigns, the general conclusion about steam drying is that it saves energy and reduces environmental impacts. The need to keep the pressed pulp and dried pulp system simple and have the highest quality interlock devices is critical.

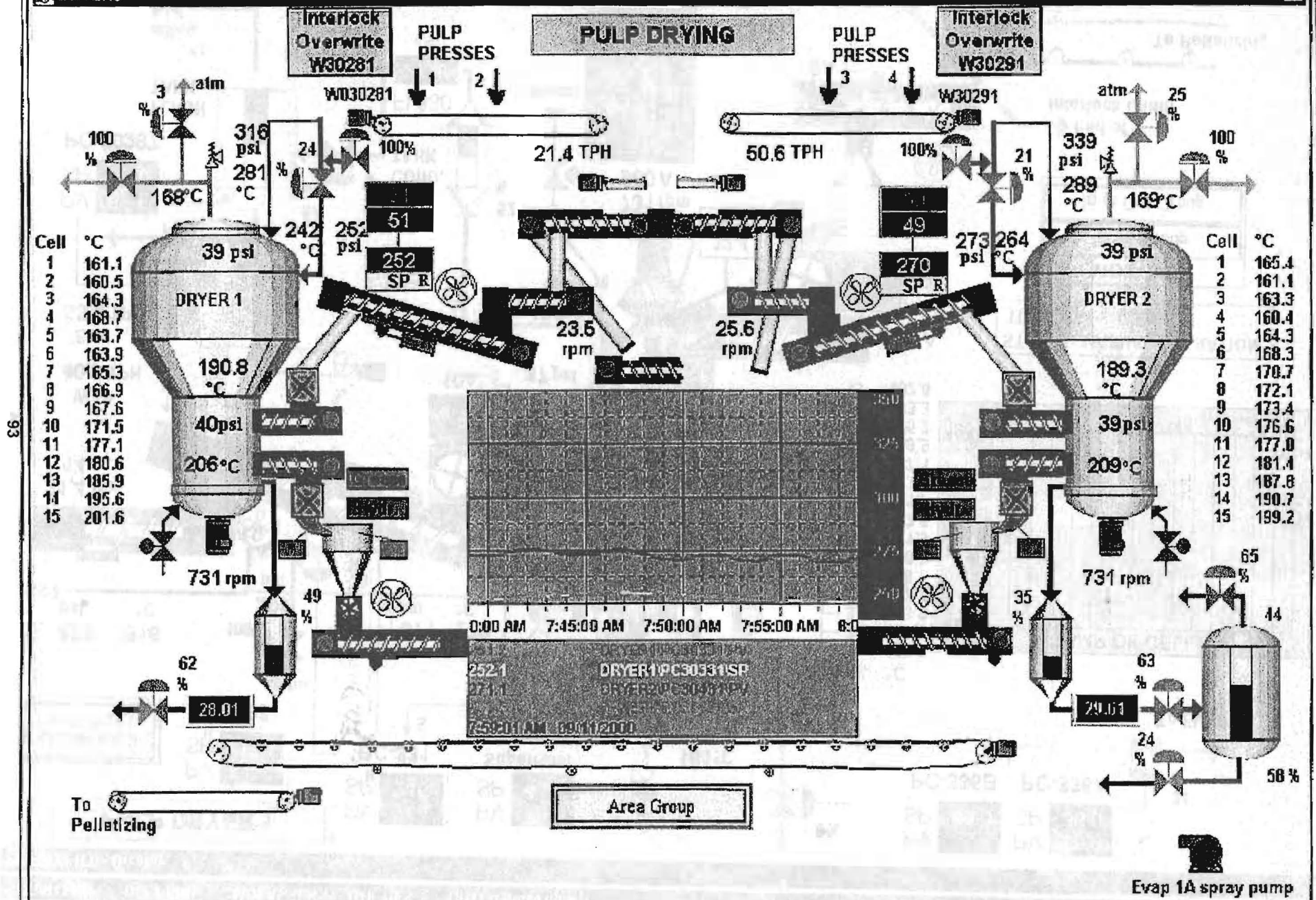


## ▼ Dryer Installation





DRYERS



Cell °C

1	161.1
2	160.5
3	164.3
4	168.7
5	163.7
6	163.9
7	165.3
8	166.9
9	167.6
10	171.5
11	177.1
12	180.6
13	185.9
14	195.6
15	201.6

Cell °C

1	165.4
2	161.1
3	163.3
4	160.4
5	164.3
6	168.3
7	170.7
8	172.1
9	173.4
10	176.6
11	177.0
12	181.4
13	187.8
14	190.7
15	199.2

0:00 AM 7:45:00 AM 7:50:00 AM 7:55:00 AM 8:00:00 AM

252.1 DRYER1 PC30331SP  
771.1  
7:59:01 AM 09/11/2000

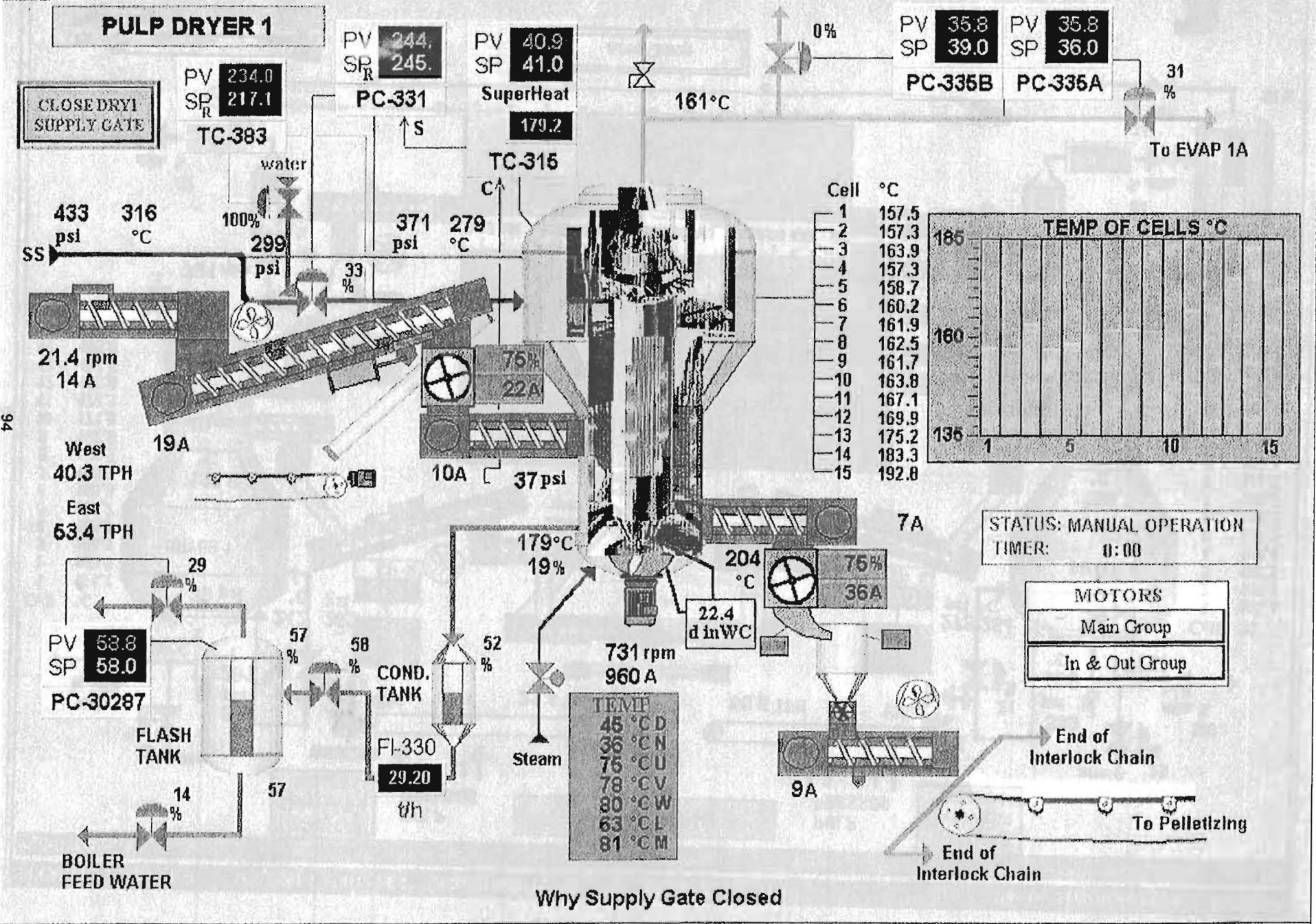
Area Group

To Pelletizing

Evap 1A spray pump

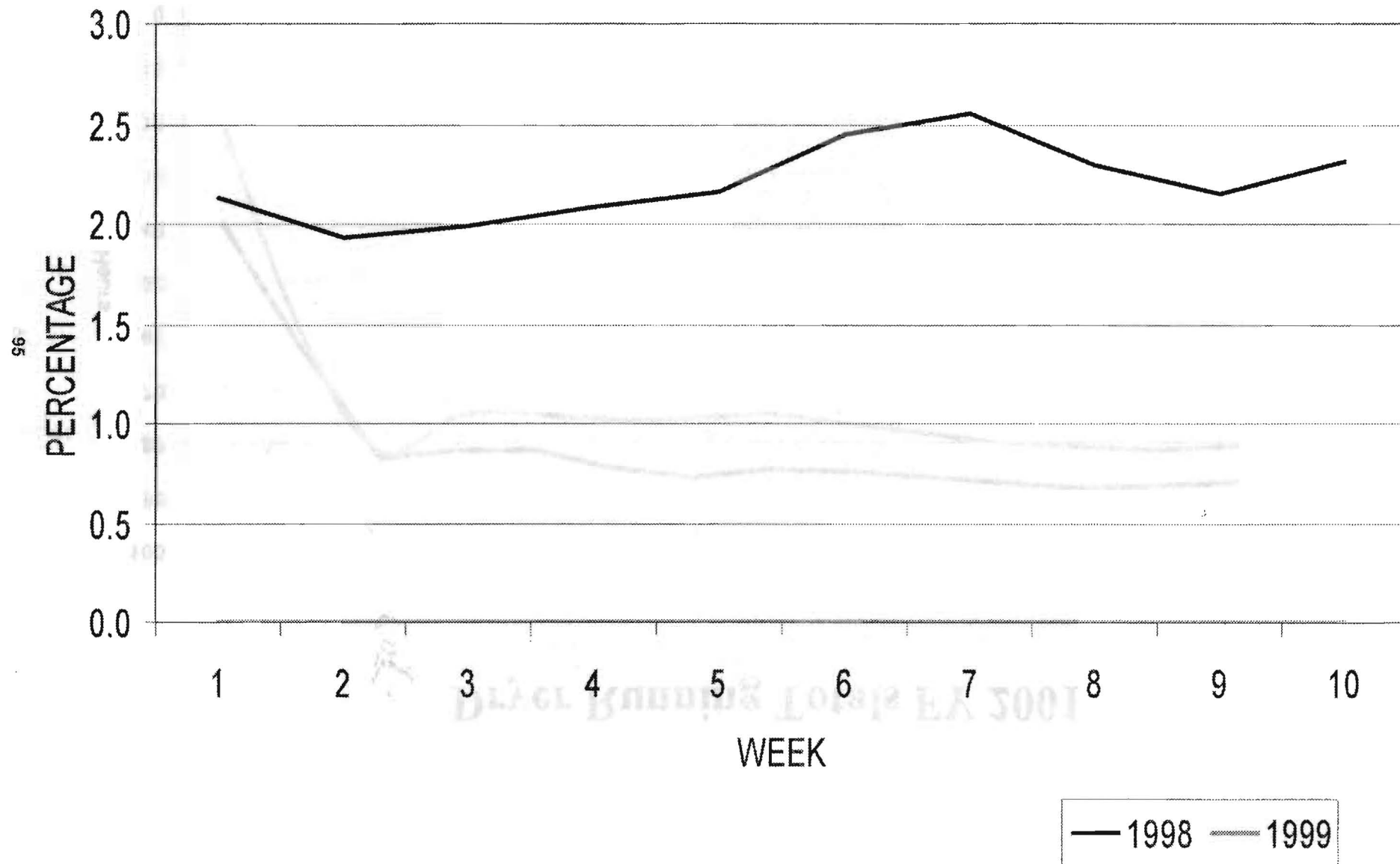
Alarms Silence

DRYER1 - Display

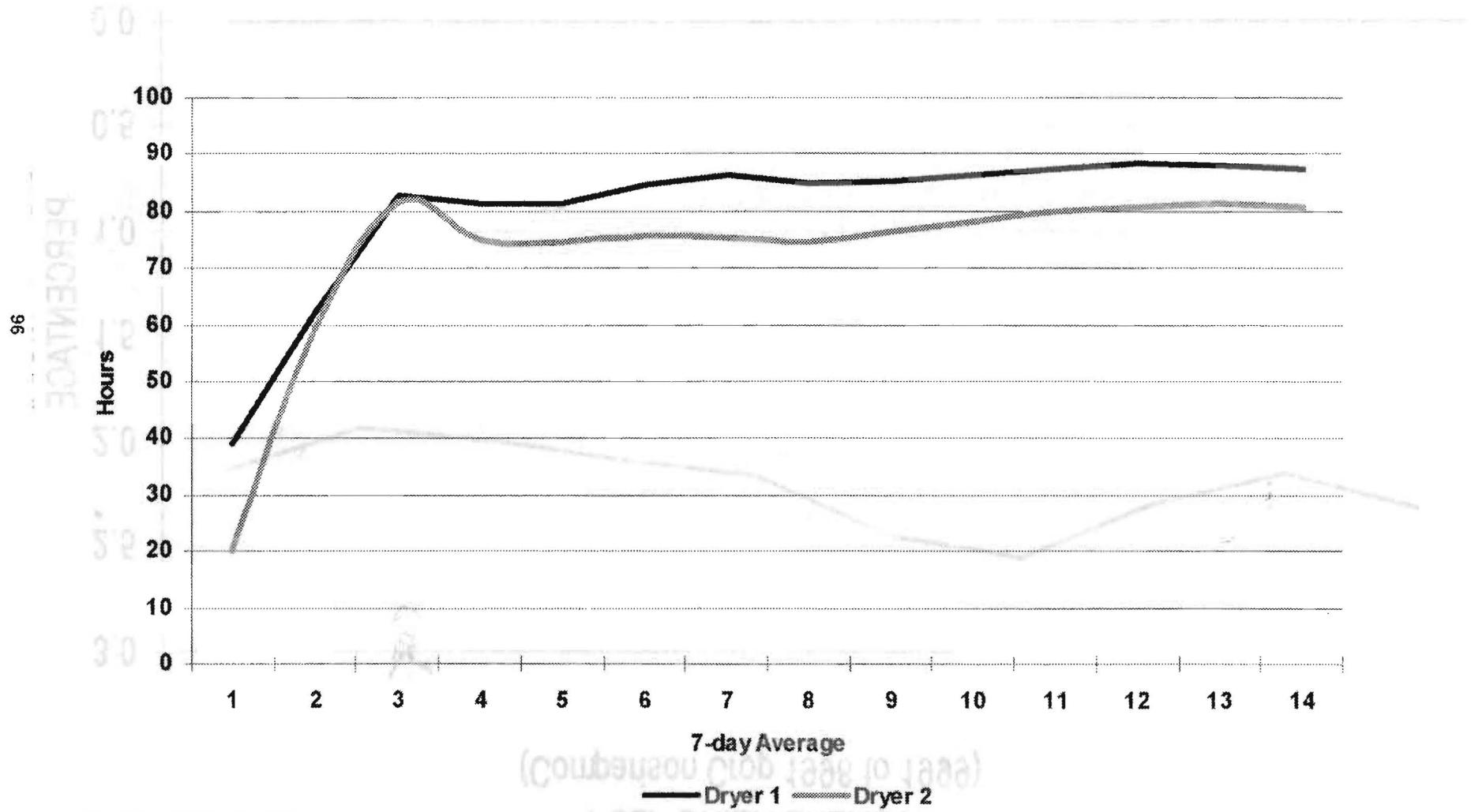


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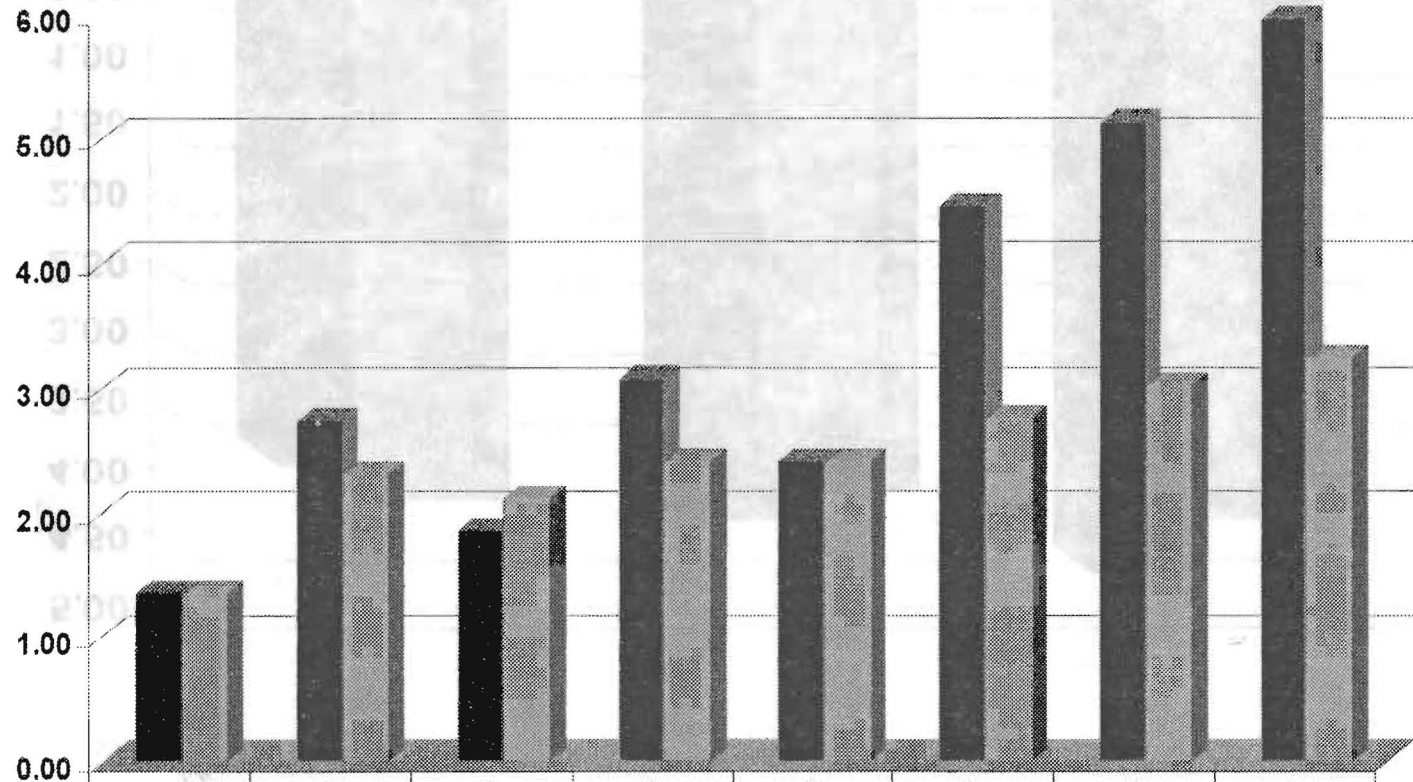
# PULP DRIER ENERGY (Comparison Crop 1998 to 1999)



# Dryer Running Totals FY 2001



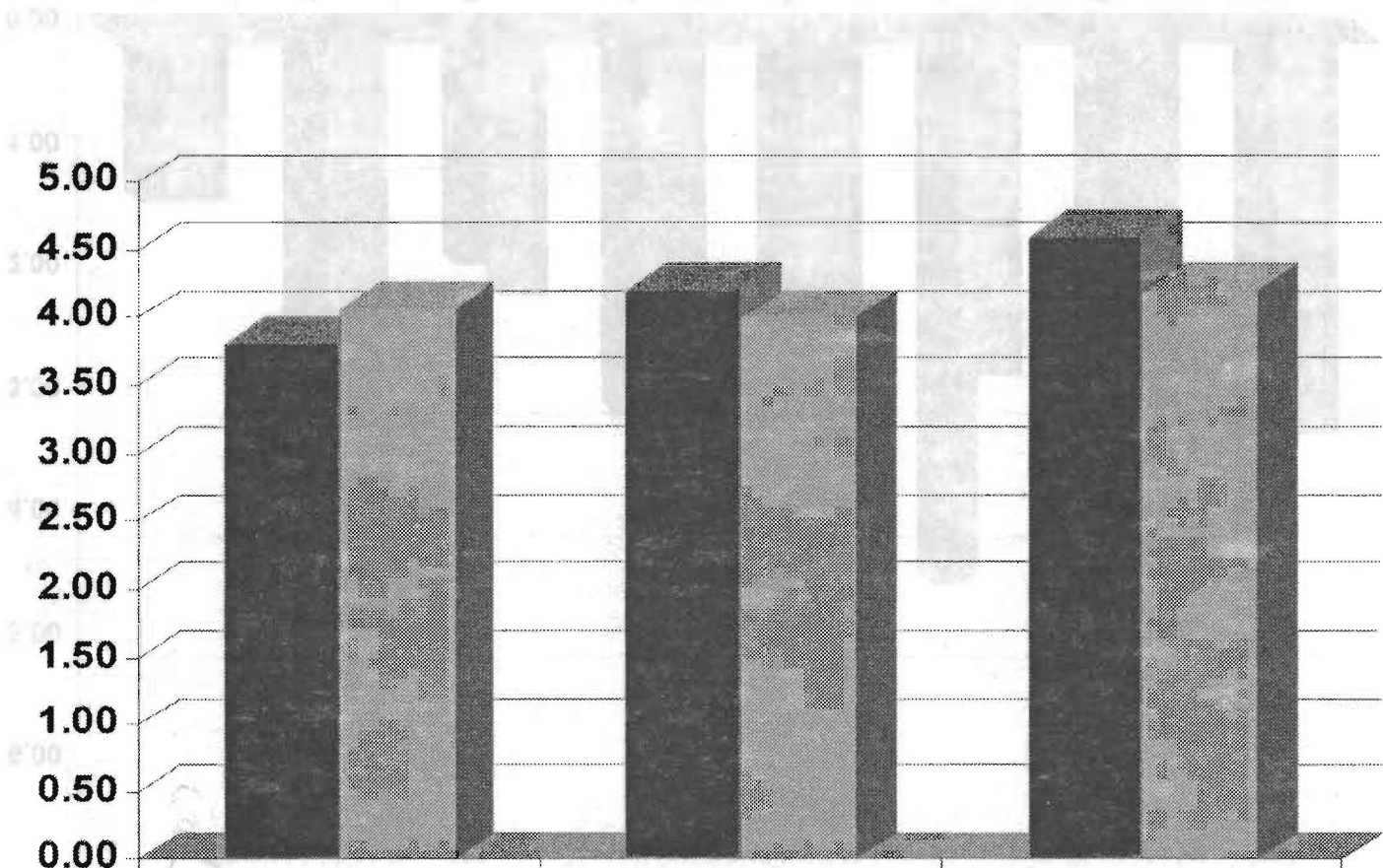
## Pulp Pellets % on Beets FY - 2000



■ Monthly Average	1.36	2.75	1.86	3.08	2.43	4.46	5.14	5.95
■ YTD Average	1.36	2.33	2.13	2.43	2.43	2.77	3.03	3.25

## Pulp Pellets % on Beets FY - 2001

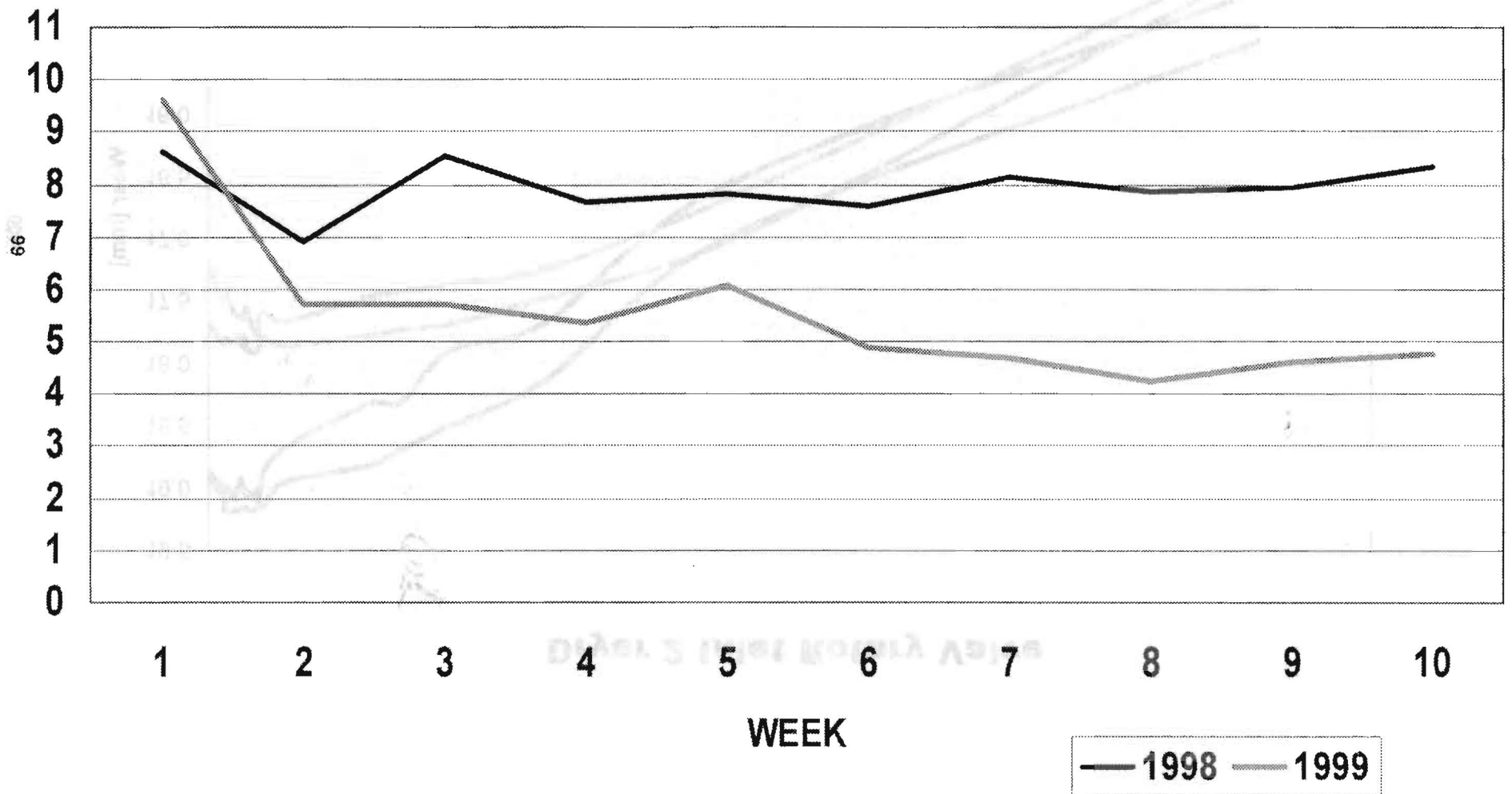
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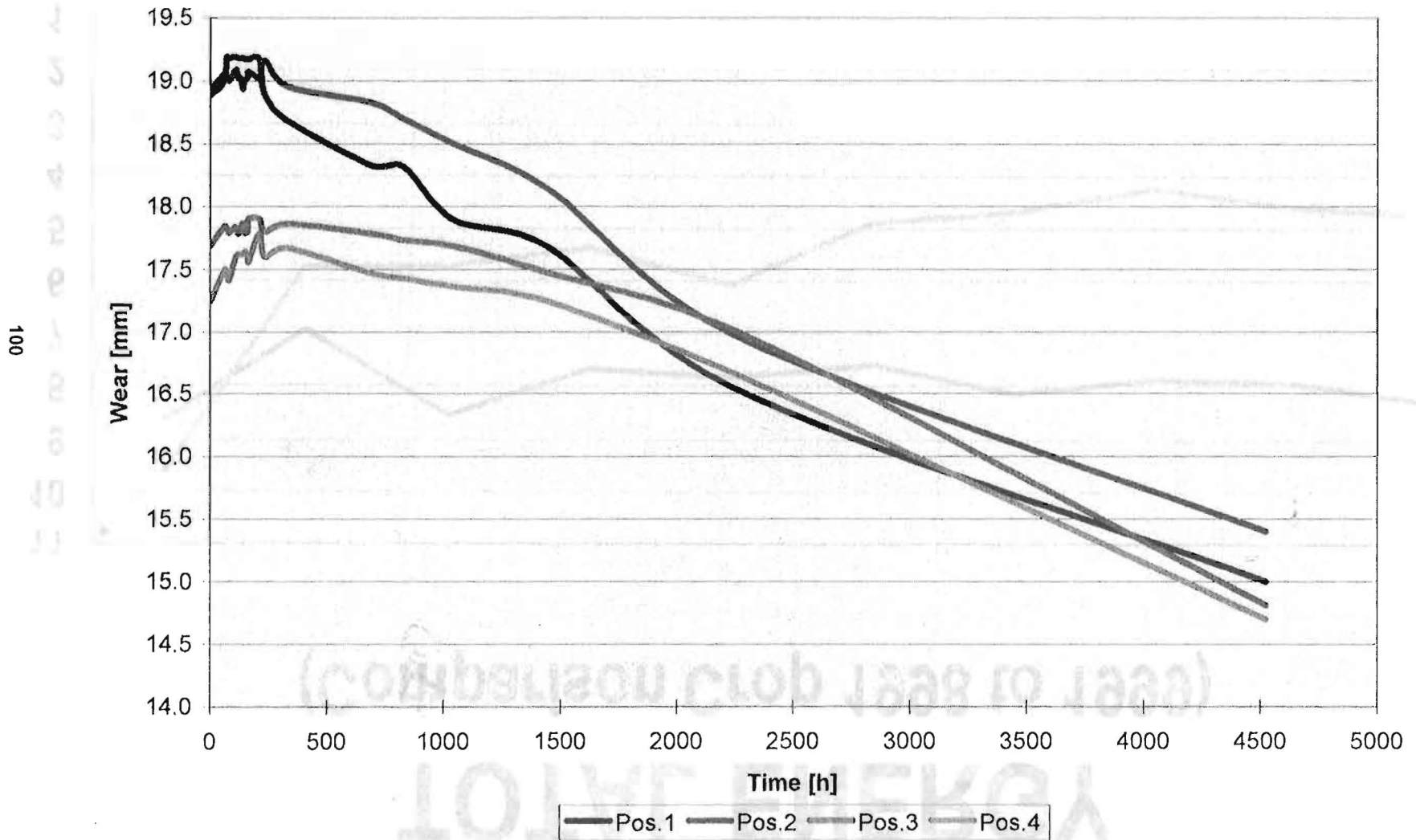
	1	2	3
■ Monthly Avg	3.80	4.20	4.60
■ YTD Avg	4.06	4.00	4.20

# TOTAL ENERGY

## (Comparison Crop 1998 to 1999)



# Dryer 2 Inlet Rotary Valve





## Dryer 2 Outlet Rotary Valve

