Improving Dryer Efficiency

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What Comprises Dryer Efficiency?

- Energy Efficiency
  - Steam utilization
- Drying Efficiency
  - Drying capacity / production
- Operational Efficiency
  - Uptime, breaks, cull losses, etc.

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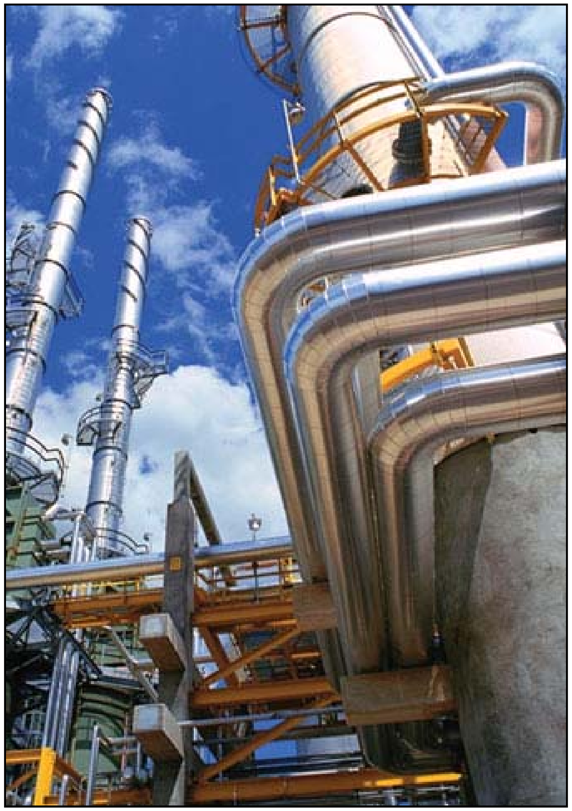
Good Dryer Energy Consumption

- Steam used in dryer cylinders
  - 1.15 to 1.2 lbs steam / lb water evaporated

- Steam used by dryer air systems
  - 0.18 to 0.20 lbs steam / lb water evaporated

- Steam loss from system should be no more than 1 to 3% of total dryer steam consumption.



Rules for Energy Efficient Drying

- Eliminate the system losses
- Utilize flash steam
- Minimize use of high pressure steam
- Don’t heat more air than you must
- Manage the dryer systems

Eliminate Dryer Drainage System Losses

- Use steam to dry paper
- Steam loss locations
  - Differential vent valves to condenser or atmosphere
  - Flash steam loss or poor utilization
  - Dryer discharge to condenser
  - Non-condensable bleeds
  - Steam leaks

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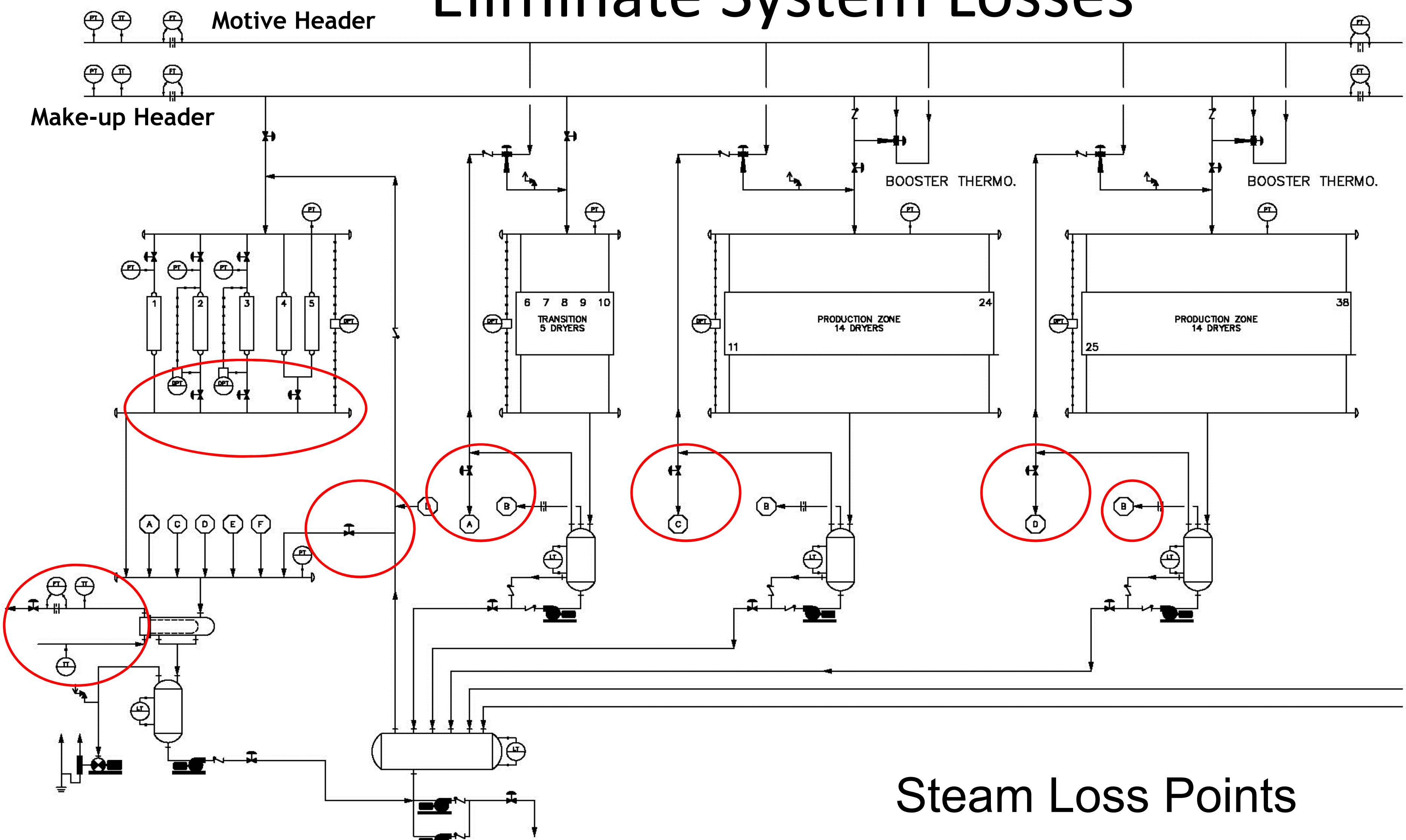
Eliminate System Losses



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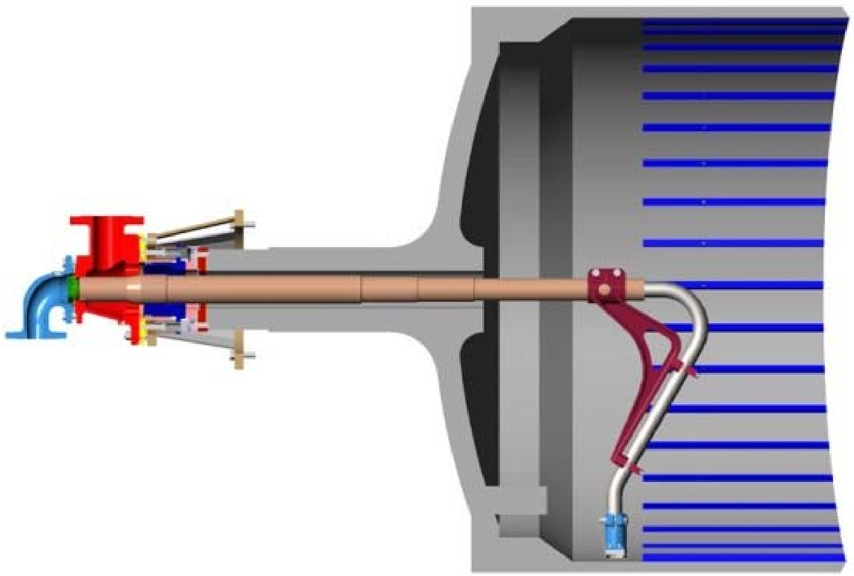
System Venting

- Differential vent valves should be closed for all operating conditions
  - Track valve position in process historian
  - Check valve condition
  - Track condenser energy loss
- Reasons for open vent valves
  - Blow-through rates too high
  - Syphon size / type is incorrect
  - Differential pressures are set too high
  - Operating pressure too low
  - Cascade system balance incorrect
  - Thermocompressor condition poor
  - Thermocompressor sizing poor
  - Thermocompressor is “choked”
  - Undersized piping or tanks



Dryer Discharge to Condenser

- Minimize the number of dryers discharging directly to condenser
- Use stationary syphons in wet end dryers
- Use scoop syphons below rimming speed
- Disconnect bottom unorun dryers
- Add differential control valves

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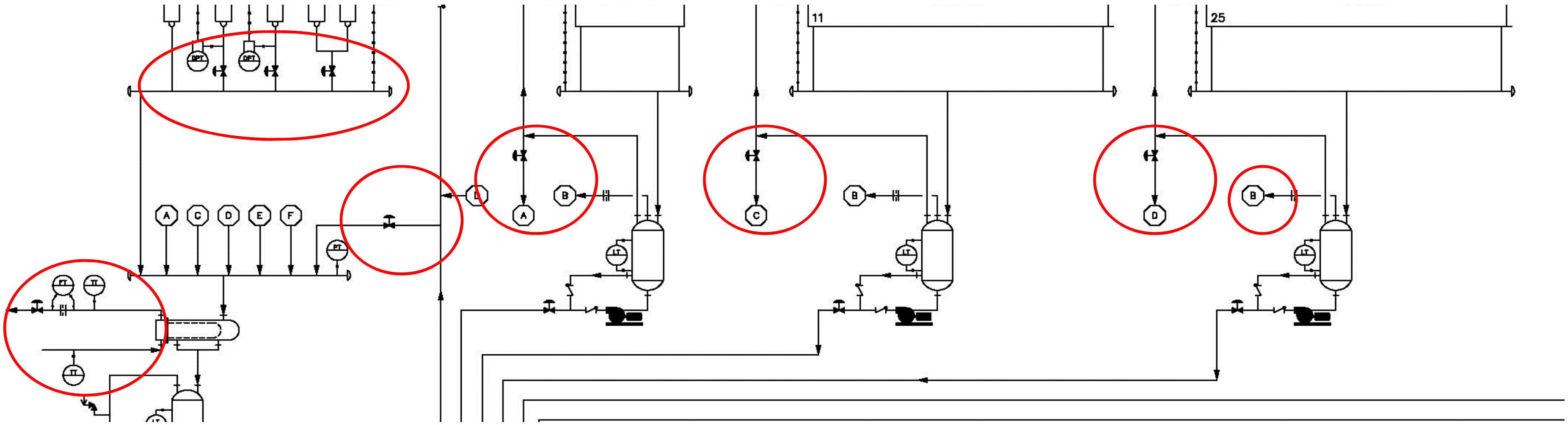
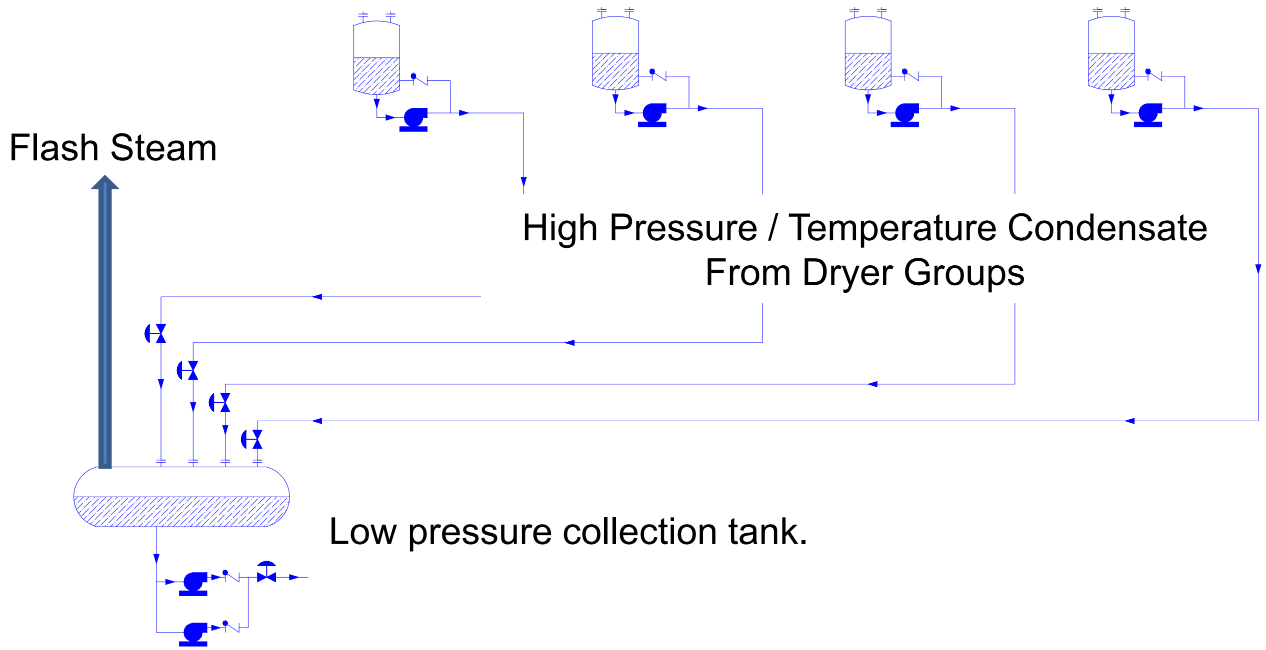
Leaking Valves to Condenser

- Use portable water flow meter to measure water flow and temperature for energy loss calculations
- Install permanent flow meter and temperature probes for on-line energy tracking



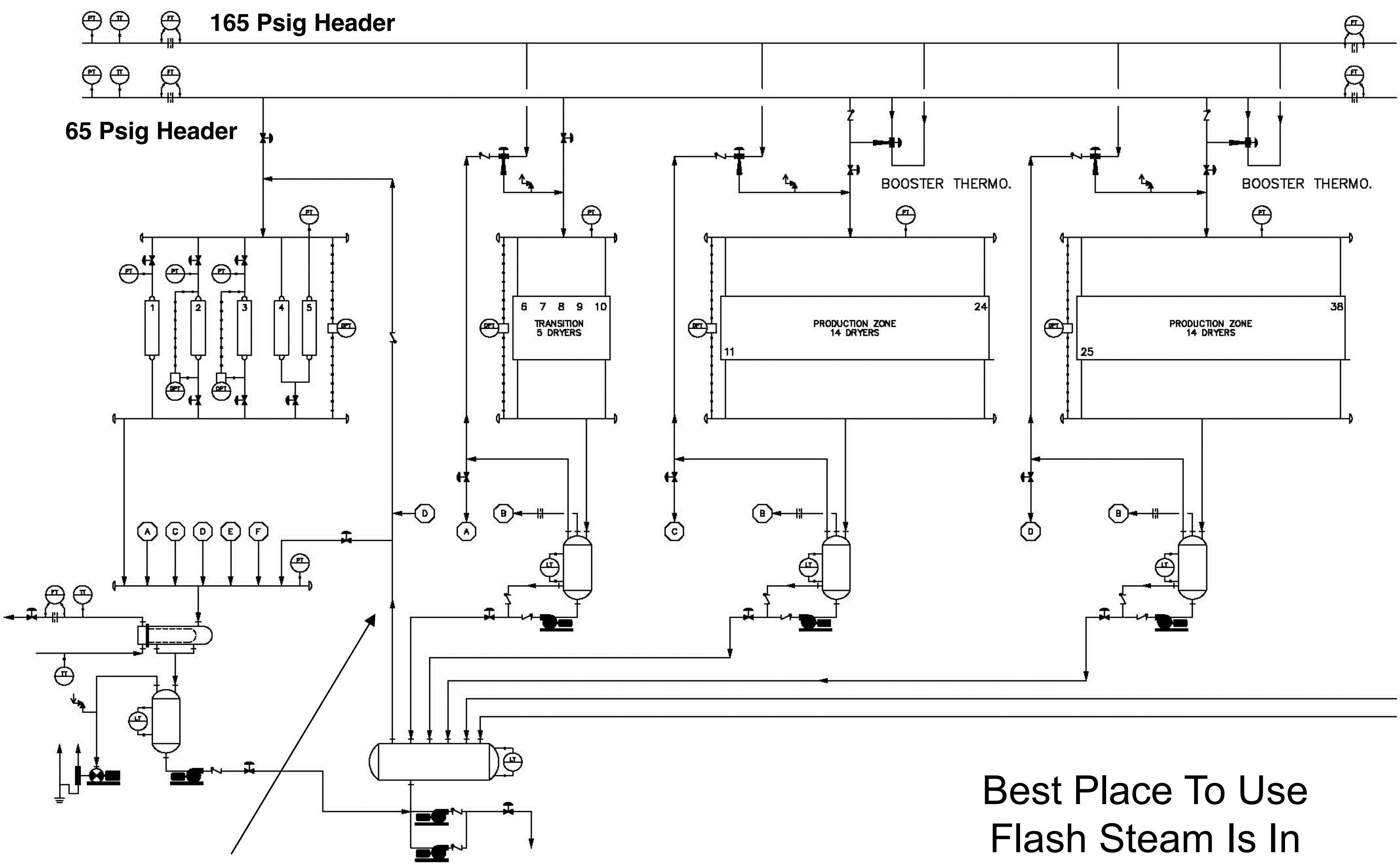
Flash Steam

- Condensate from dryers is at saturation temperature of dryers
- Pressure is reduced through level control valve
- Condensate temperature drops at lower pressure
- Flash steam is created



Flash Steam Uses

Flash Steam Use	Ranking
In low pressure dryers	Best
Pocket ventilation preheat air	Good
Steam shower	Good
Condenser or heat exchanger	Poor
Machine shower water heating	Poor
Machine silo	Poor
Discharge to atmosphere (at the machine or at the boiler)	Unacceptable



Flash Steam Used In Wet End Dryers

Low Temp Condensate Return To Boiler House

Best Place To Use Flash Steam Is In Wet End Dryers

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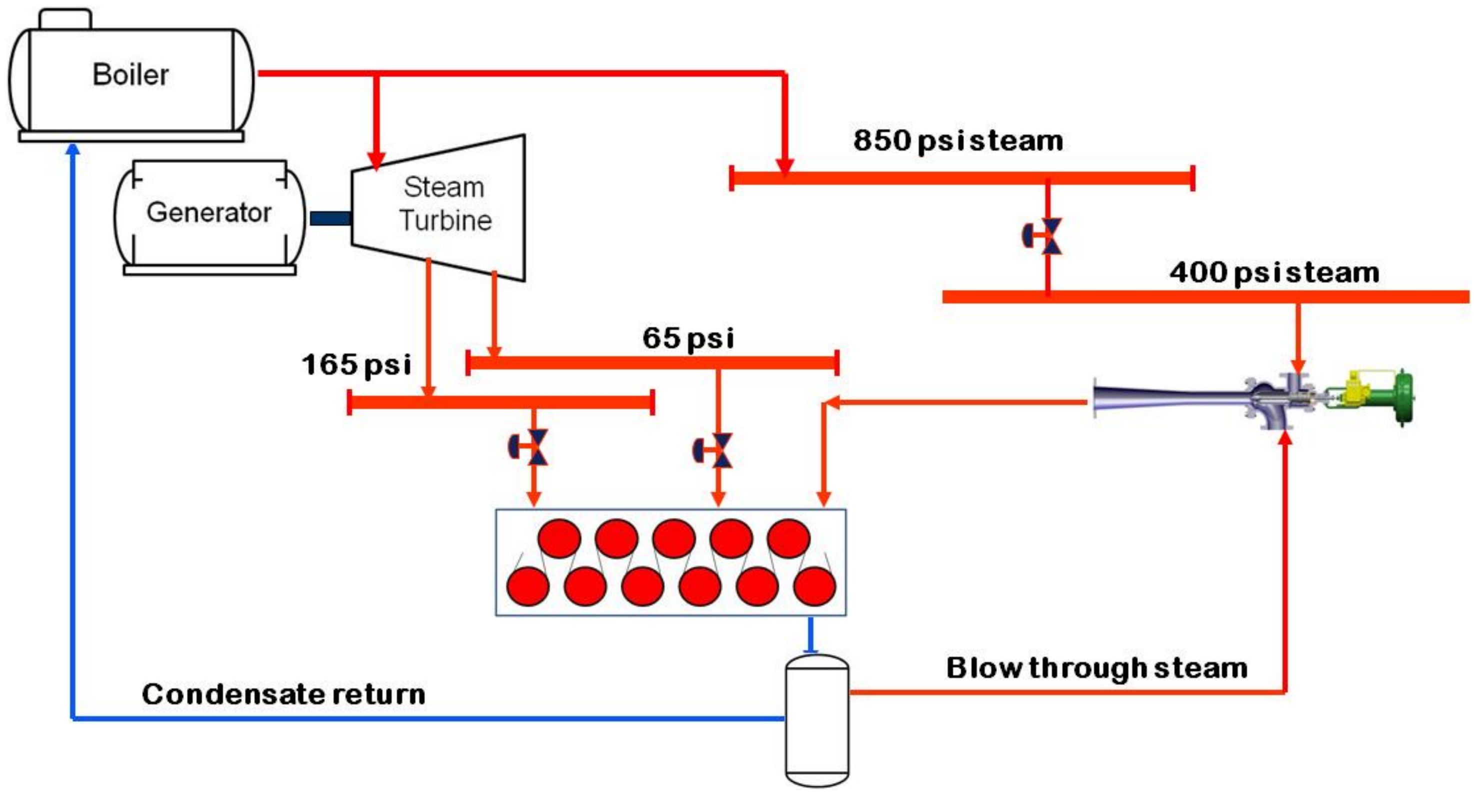
Minimize High-Pressure Steam Use

- Mills often use high-pressure steam to generate electricity
- Shifting dryers from the high-pressure header to the make-up header will result in the generation of more electricity



Methods to Reduce High-Pressure Steam

- Use low pressure steam in wet end dryers
- Switch between low- and high-pressure steam source based on production requirement
- Use booster thermocompressors where appropriate
- Ensure thermocompressors in good condition
- Use high efficiency thermocompressors
- Properly size thermocompressors
- Reduce blow-through steam
- Reduce differential pressure

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Paperboard Machine
Dryer Drainage System Rebuild
Case History

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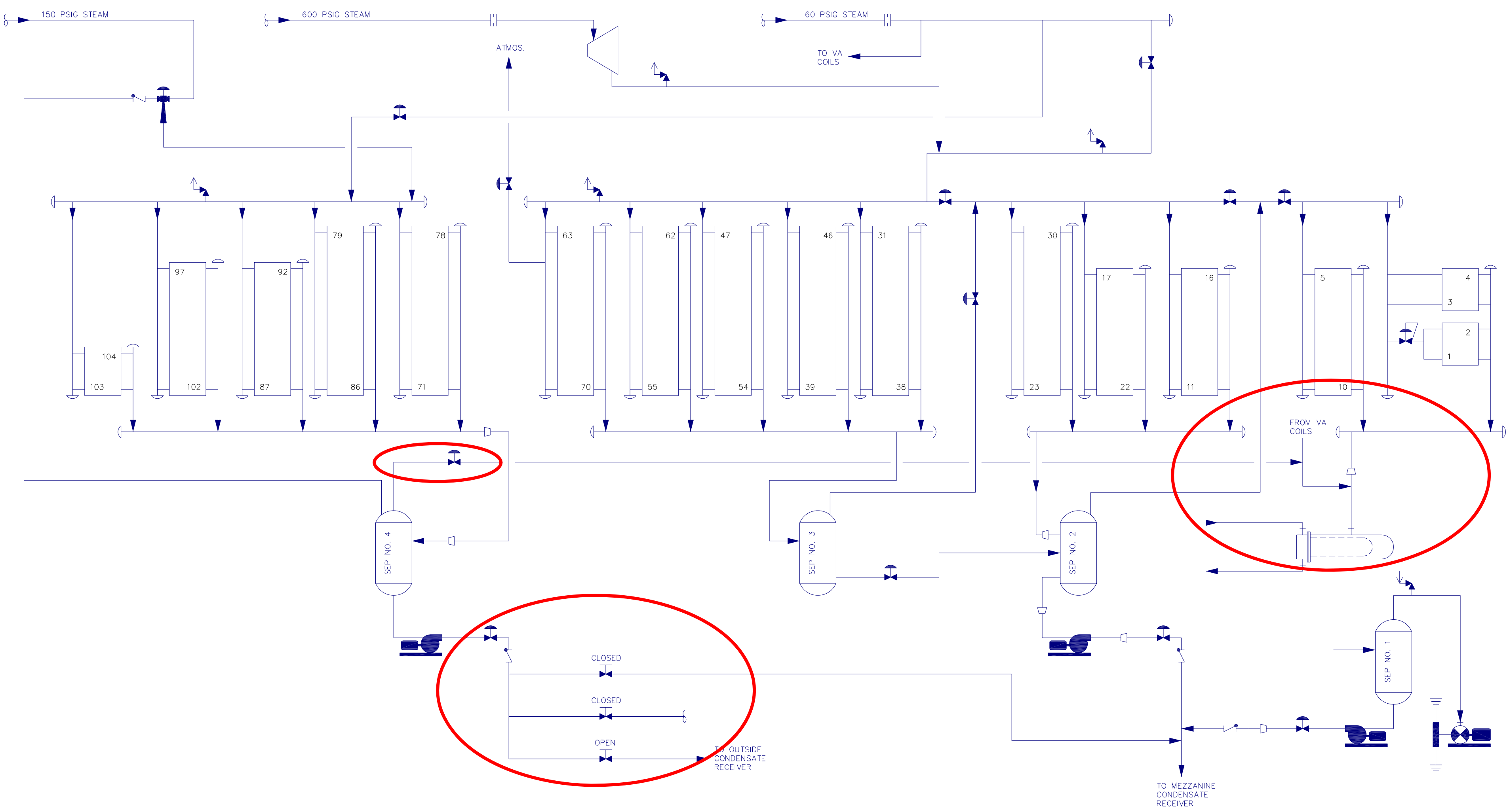
Paperboard Machine Before Upgrade



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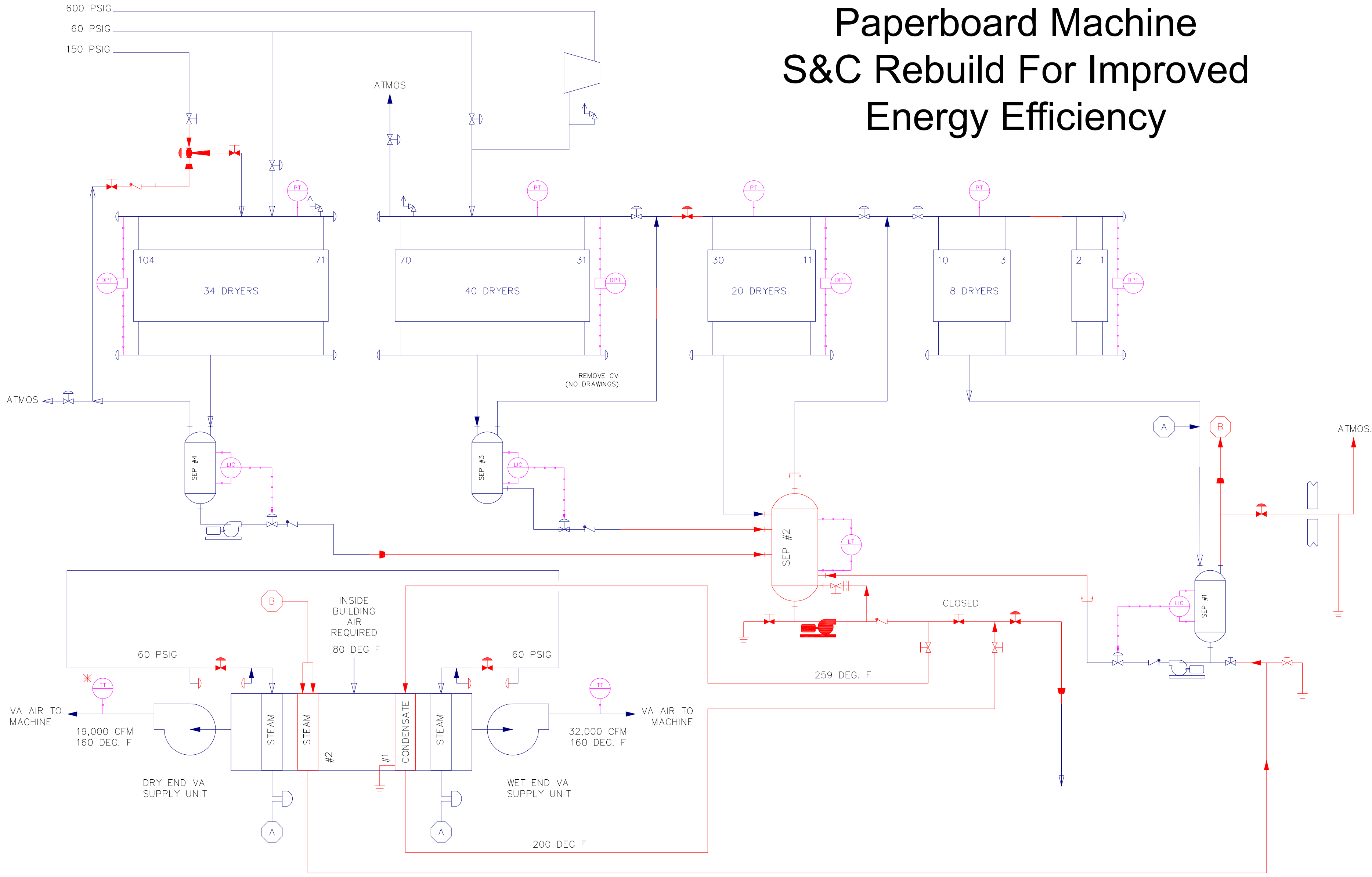
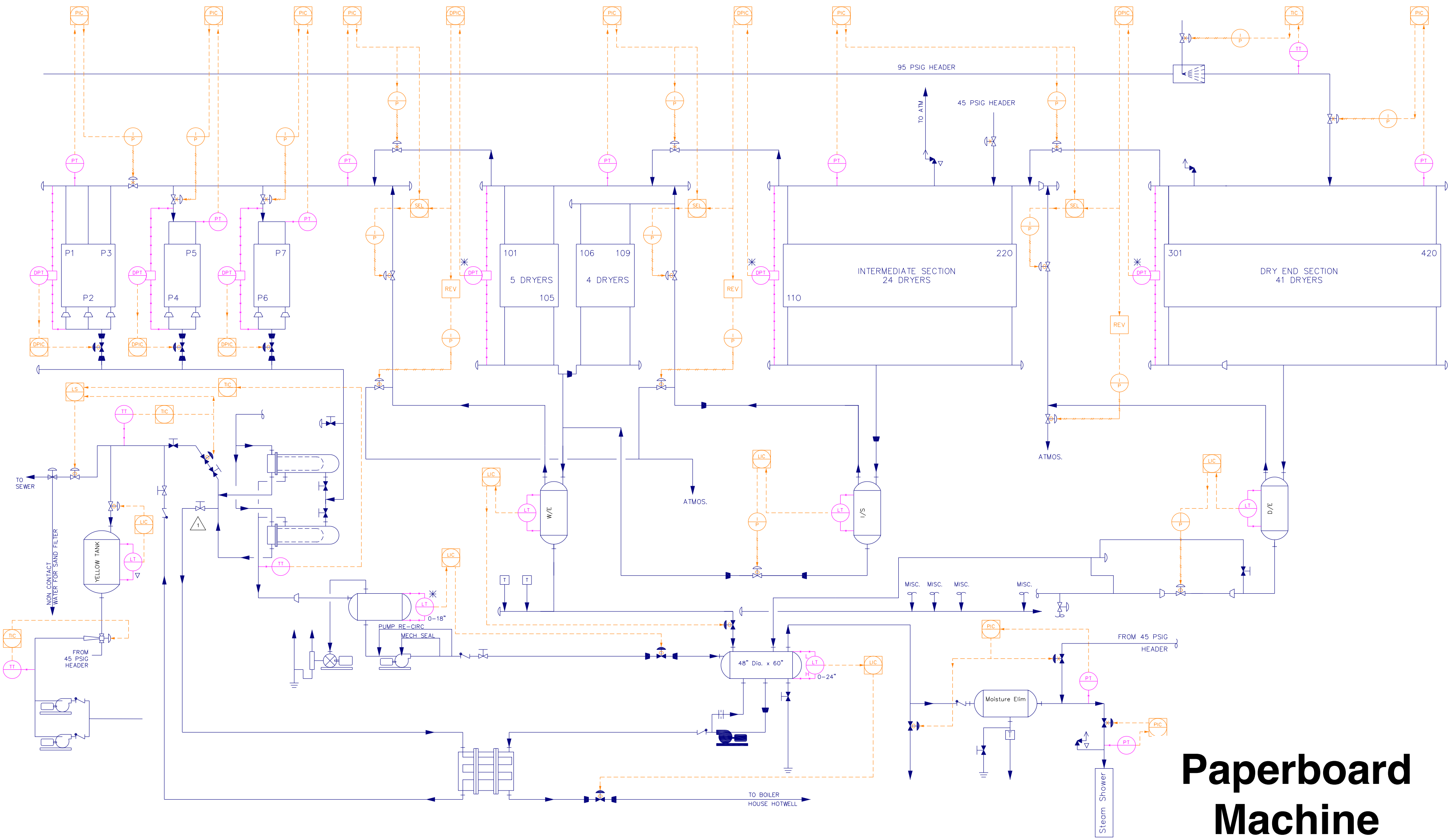
Paperboard Machine S&C Rebuild For Improved Energy Efficiency



Manage the Drying Systems

- The “best” equipment will produce poor results if operated incorrectly
- Control logic should be used to manage the system set points to optimum levels
  - Manage pressures
  - Manage differential pressures
  - Lower differential pressures on breaks
  - Manage the thermocompressors
  - Manage the condenser
  - Manage the hood air systems

Dryer Systems Can Be Complicated



Paperboard Machine

Operator's Responsibilities

- Adjust system pressures as machine conditions change
  - Maximize drying capacity
  - Operate at low pressures on light weights
  - Graduate dryers for quality and runnability
- Adjust differential pressures
- Adjust system so no steam wasted
- Turn down dryer pressures on sheet breaks
- Manage pressures on grade changes
- Make sure thermocompressors operating within range
- Adjust hood and air system temperatures and flows
- Start system up following shutdowns
- Monitor system operation
- Troubleshoot the system

Safe but not optimized settings are often used

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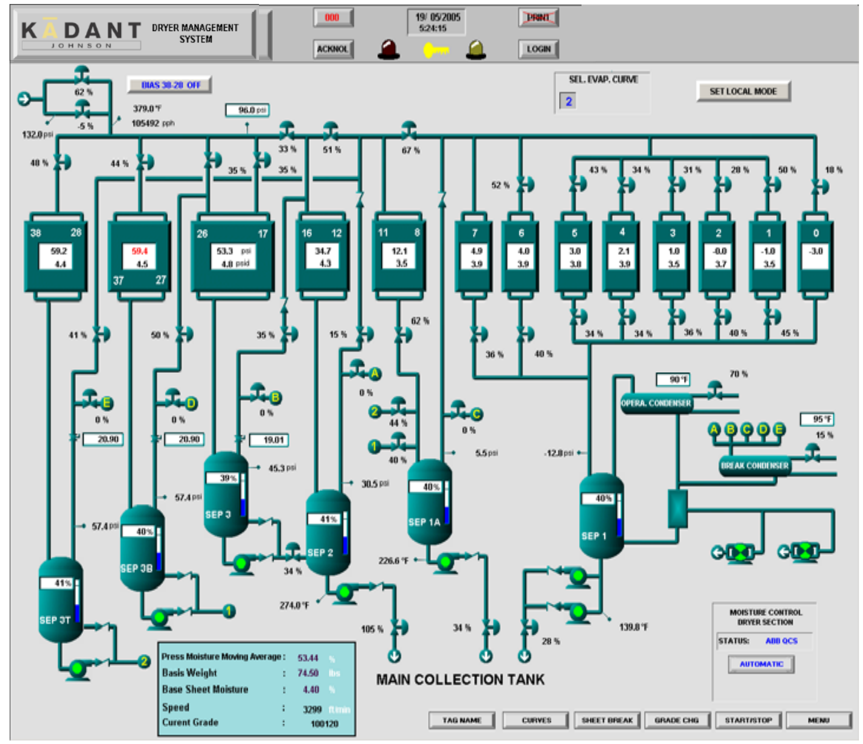
Improved Dryer Control Concept

- Use Supervisory Logic to continuously manage system set points
  - Pressures
  - Differential pressures
  - Sheet break
  - Cascade logic
  - Thermocompressors
  - Start-up



- Incorporate drying and steam systems knowledge to more efficiently operate dryer section

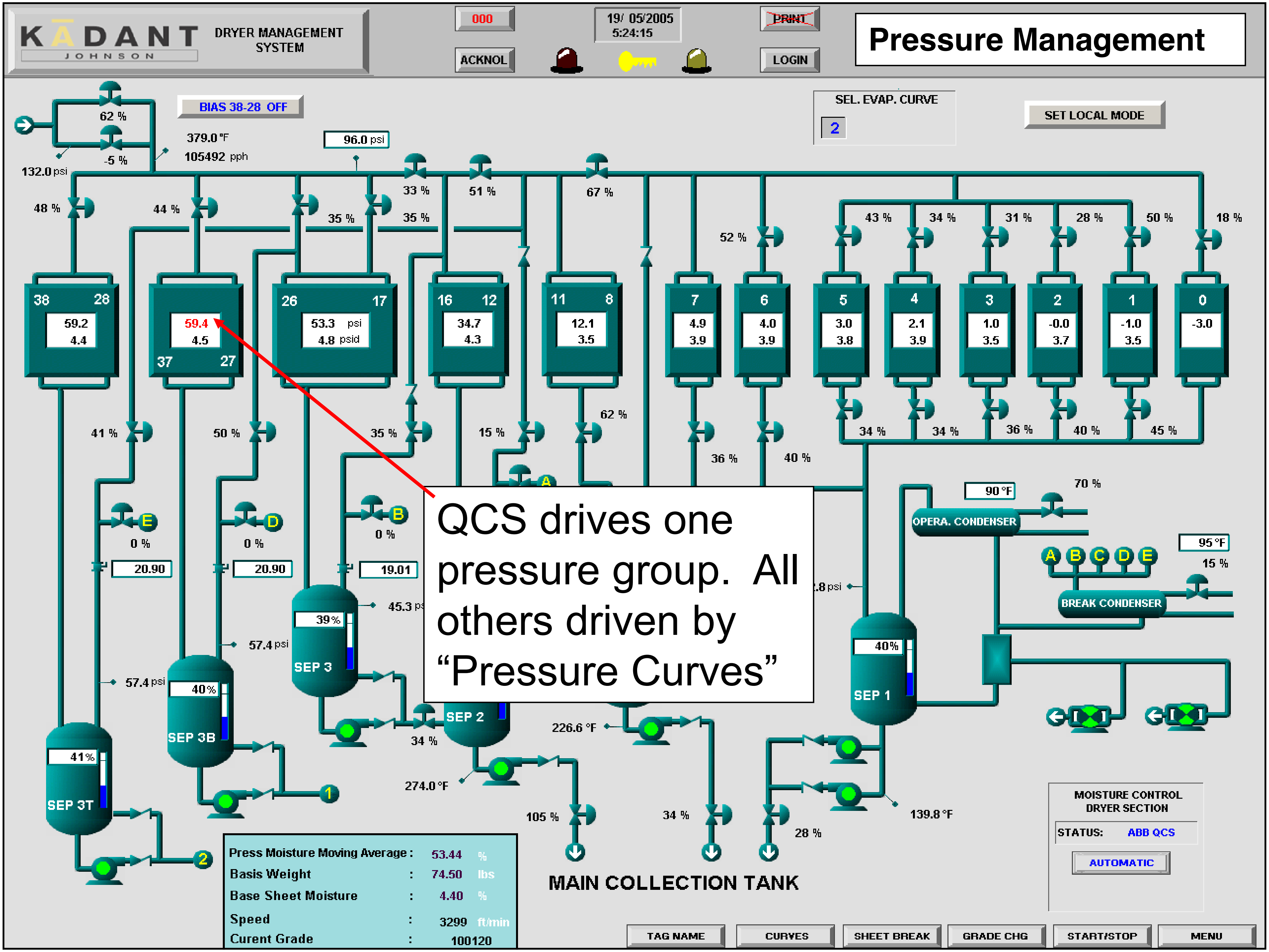
Supervisory Control Features

- Pressure management
- Differential pressure management
- Thermocompressor anti-choke logic
- Sheet break management
- Hood supply air temperature management
- Automatic system start-up
- Press moisture indication
- Dryer grade change logic
- Dryer air flow management

Pressure Management

- Improper Pressure Management
  - Inconsistent dryer operation
  - Maximum drying potential not achieved
  - Inability to operate at low pressures
  - Steam waste
  - Poor MD moisture control
  - Quality concerns such as picking, cockle, ply separation, and curl

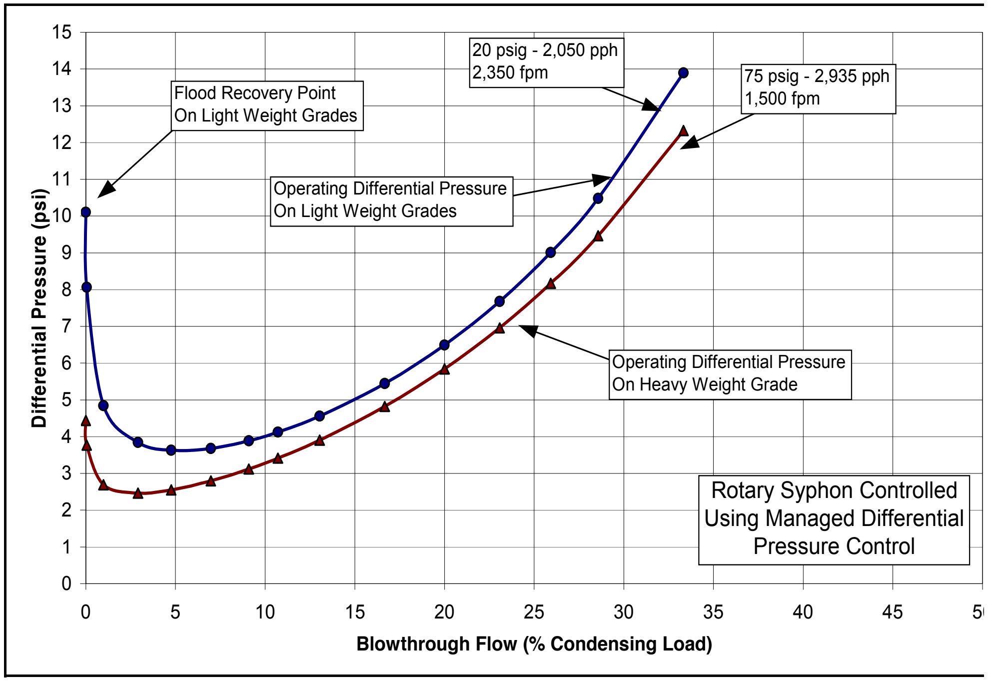
- Solution
  - Automatically set all dryer pressures using predefined pressure curves
  - Curves driven by QCS



QCS drives one pressure group. All others driven by "Pressure Curves"

Differential Pressure Management

- Differential pressures / blow-through flows should change with operating conditions
  - Speed
  - Condensing load
  - Sheet break status
  - Syphon characteristics
- Operators establish "safe" but high set points
  - Dryers will always drain
  - High blow-through flows and steam waste likely



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Managed Differential Pressures

- No need for operators to set differential pressures or blow-through steam flows
- Machine speed, condensing load, and syphon Cv used to calculate and set differential pressure and blow-through flow
- Differential pressures reduced on sheet breaks to prevent waste
- No requirement for blow-through flow transmitters or new instrumentation

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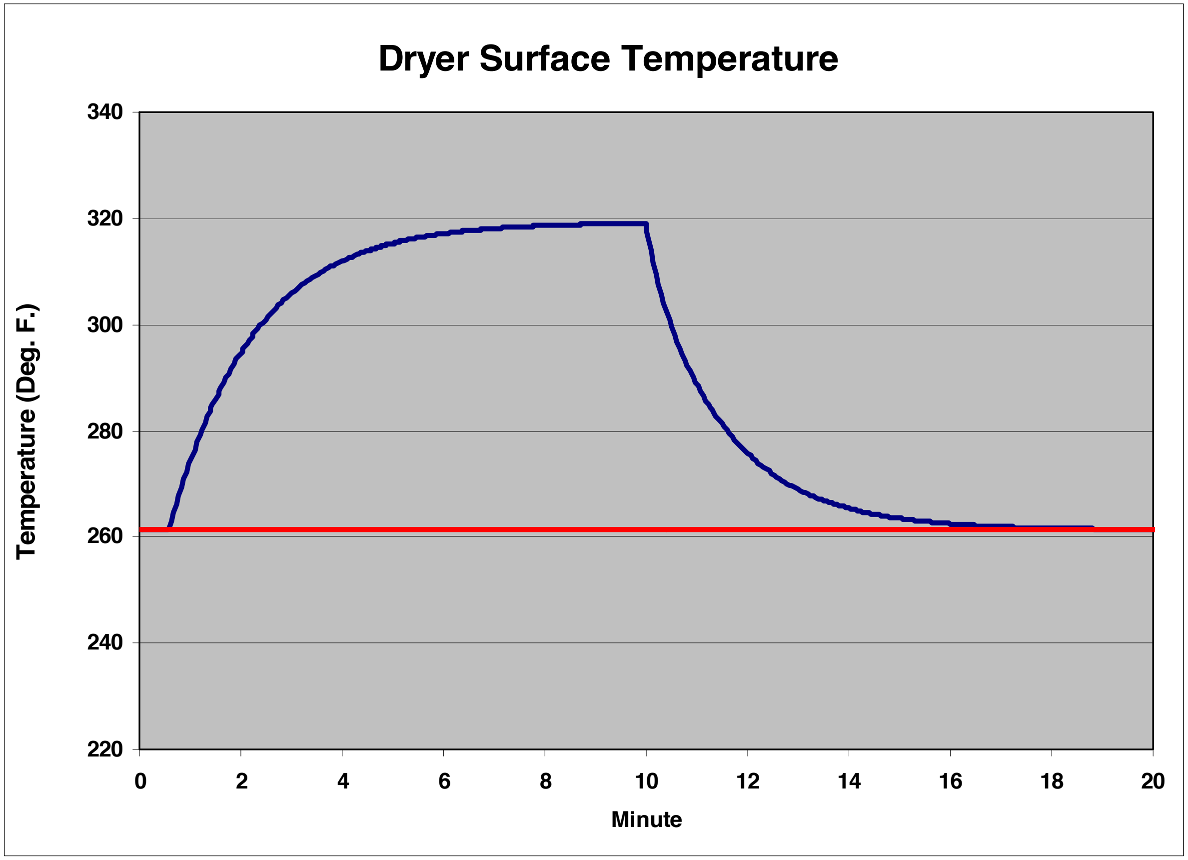
Sheet Break Recovery

- Dryer pressures must be turned down on sheet break to aid tail threading and recovery



Dryer temperature response with no turndown

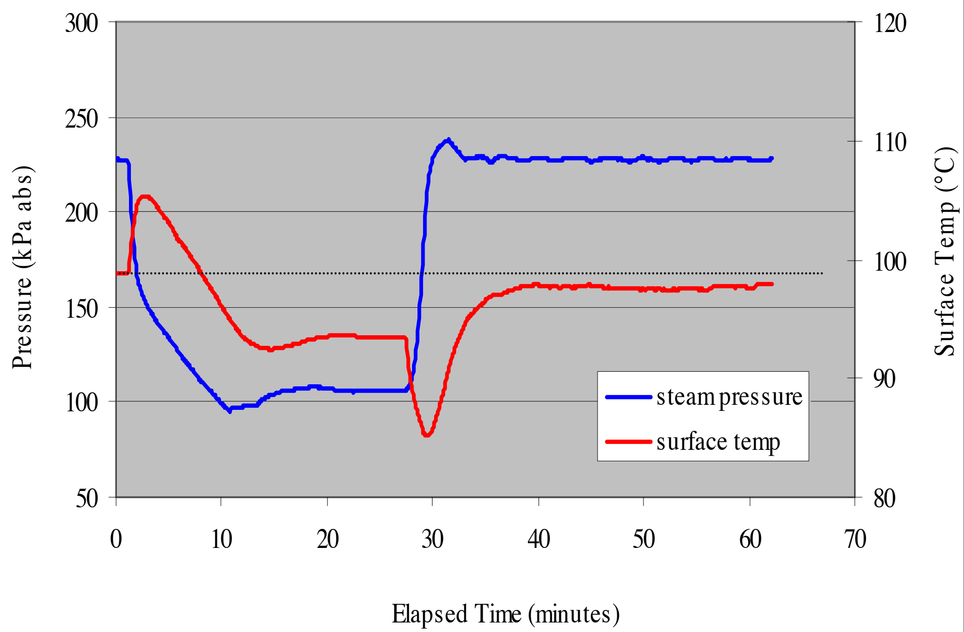
Rapid Break Recovery Objectives

– Tail threading

- Match dryer temperatures to run conditions

– Rapid return to 1st quality moisture

- Turned down too much = wet sheet and possible dryer wraps
- Turned down too little = dry sheet and possible snap offs



Advanced Sheet Break Logic

- Logic configured with online drying model
  - Model calculates heat flow for each dryer
  - Ideal tail threading temperature calculated

- System control logic modified to improve responsiveness
  - Required to obtain rapid temperature response from dryers
  - Thermocompressors and make-up valves temporarily closed off
  - Vent valves temporarily opened

- Mill adjustment allows for fine tuning of logic
  - Adjustment is delta T from ideal tail threading temperature

Minimize Hood Air Heating

- Hood air systems are designed for worst case conditions:
  - Highest production rates
  - Conservative press solids
  - Conservative fan volumes and pressures
  - High supply air temperatures

- Operation of the hood systems should be matched to the drying load
  - Adjust supply temperatures
  - Adjust air volumes

System Start-up

- Typically operators start-up the dryer drainage system manually
  - May follow an established procedure
  - May use operator’s personal experience
  - No measurements taken
- Started up too quickly
  - Bearing failures
  - Steam joint seal damage
  - Equipment damage
  - Insufficient purge of air from system
- Started up too slowly
  - Lost production
  - Time consuming for operators

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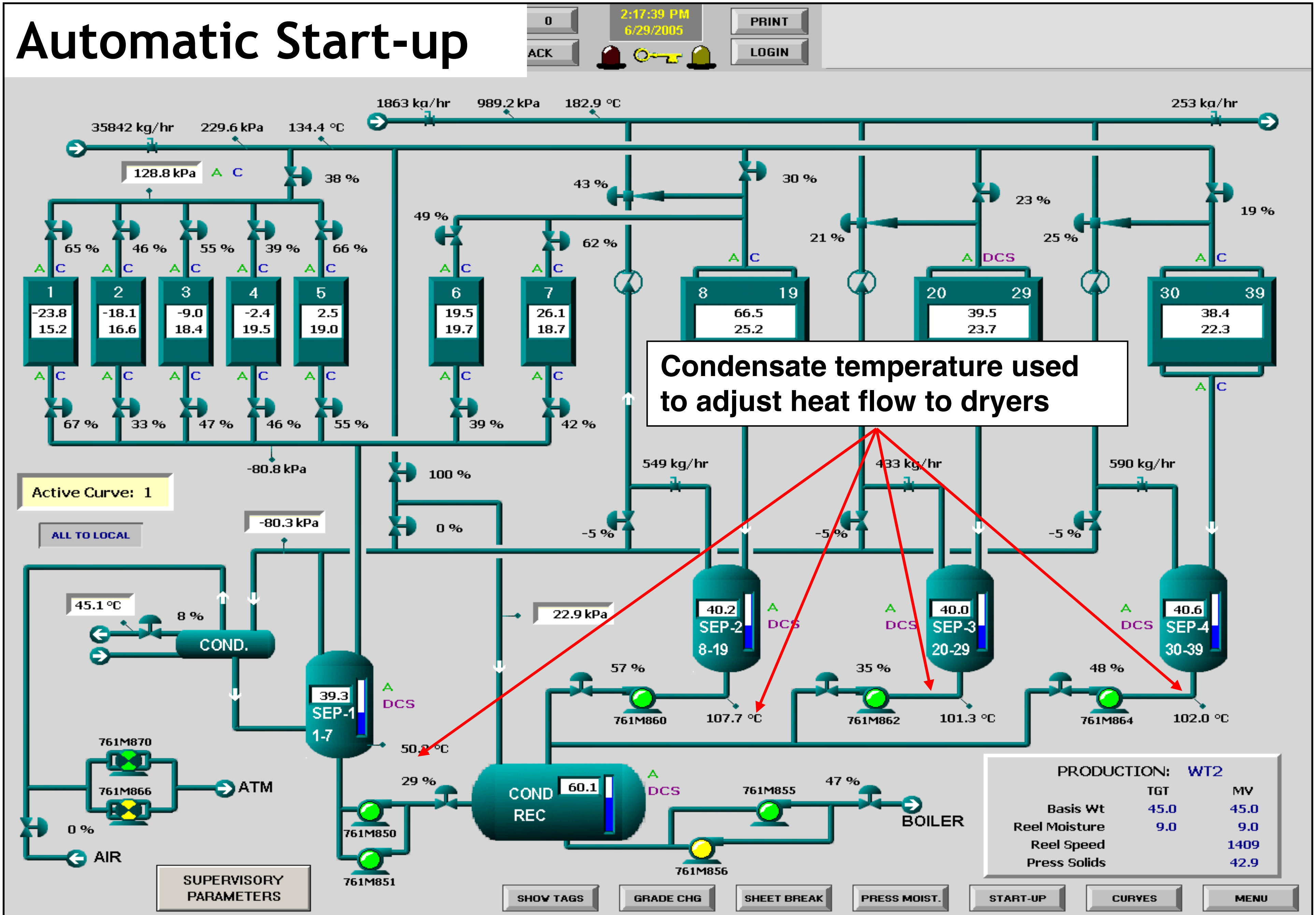
Automatic Start-up



Condensate temperature used to adjust heat flow to dryers

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Benefits of Improved System Control

- Consistency of operation
- Operating range of system
  - Low pressure turndown
  - Maximum production
- Improved system energy efficiency – run and sheet off
- Reduced energy for hood air heating
- Reduced motive steam use (thermocompressors)
- Improved tail threading
- Faster recovery from sheet breaks to 1st quality
- Fewer bearing failures due to poor start-ups
- Faster start-ups
- Ease of operation

Dryer Management System®
Case History

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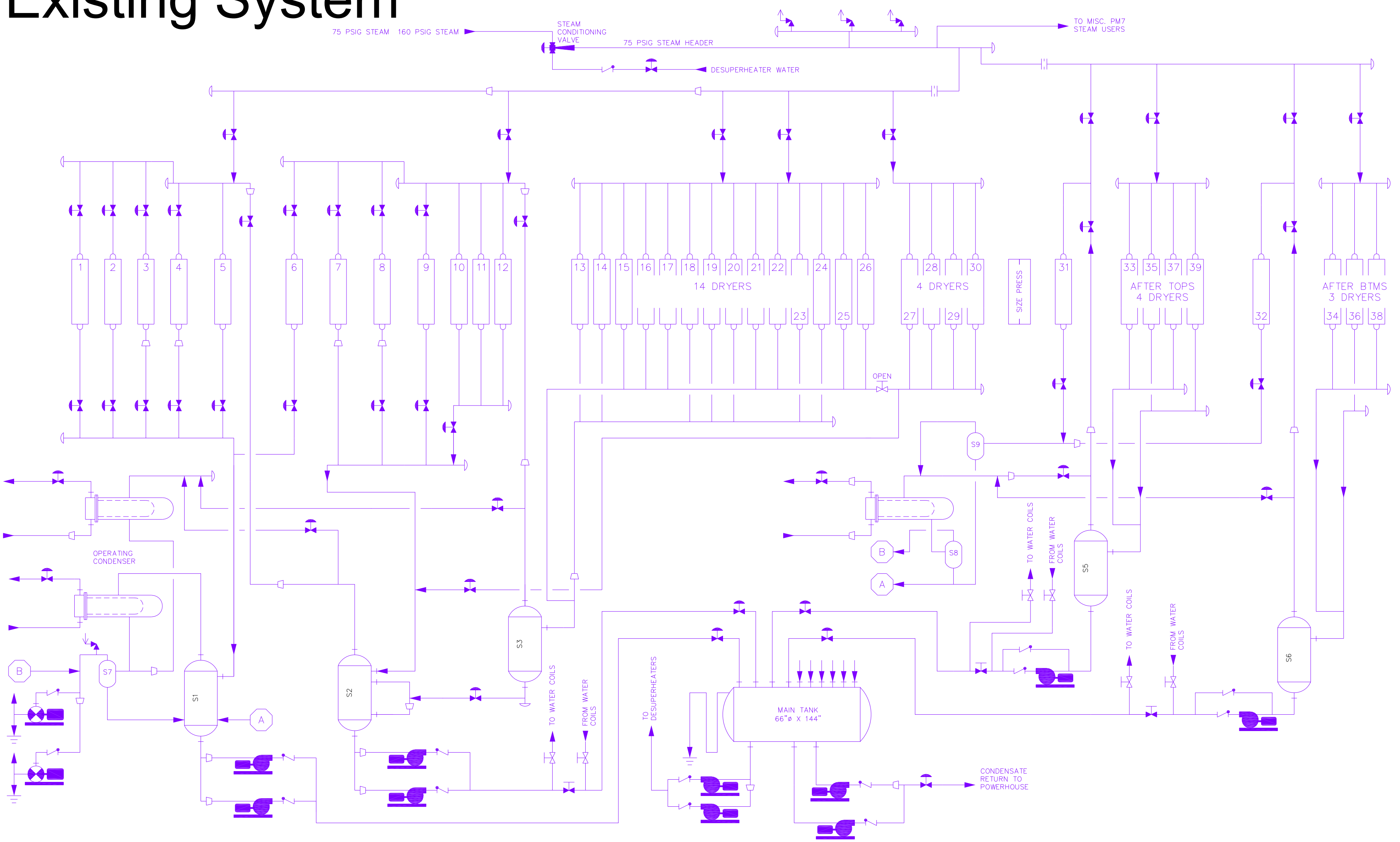
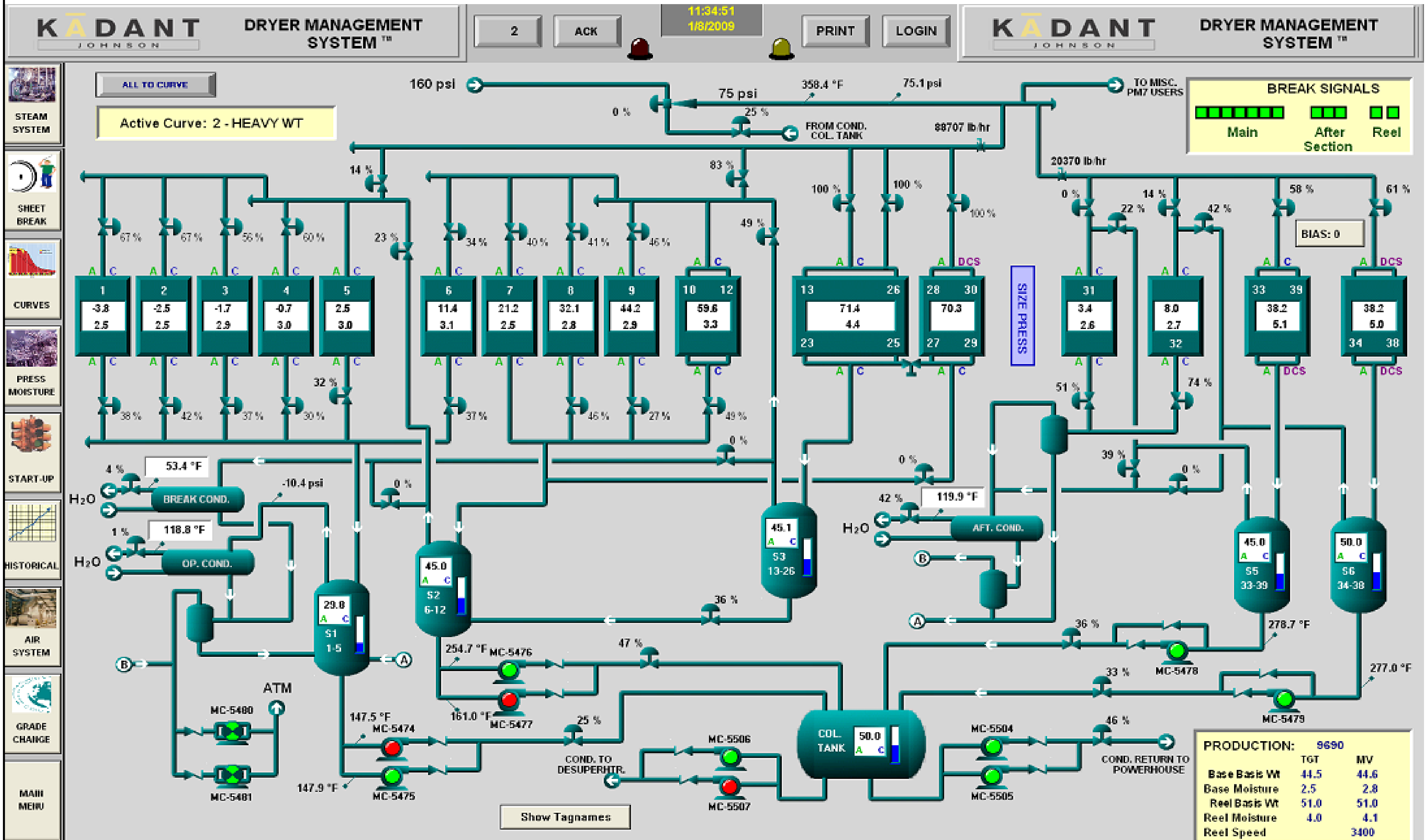
Existing System



System Issues

- Inconsistent operation between shifts
- Drying potential not maximized for heavy weight grades
  - Operators establish pressure bias
- Inability to operate at low pressures consistently
- Steam venting to the condenser
  - Operating and sheet breaks
  - Quantified using mill's PI data
- Dryers at the wrong temperature for tail threading
  - Wet and dry after break were both observed
  - Long recovery times following sheet breaks
- Long grade change time / draw breaks
- Bearing failures due to rapid start-ups
- Poor control of PV temperatures

Main DMS Screen



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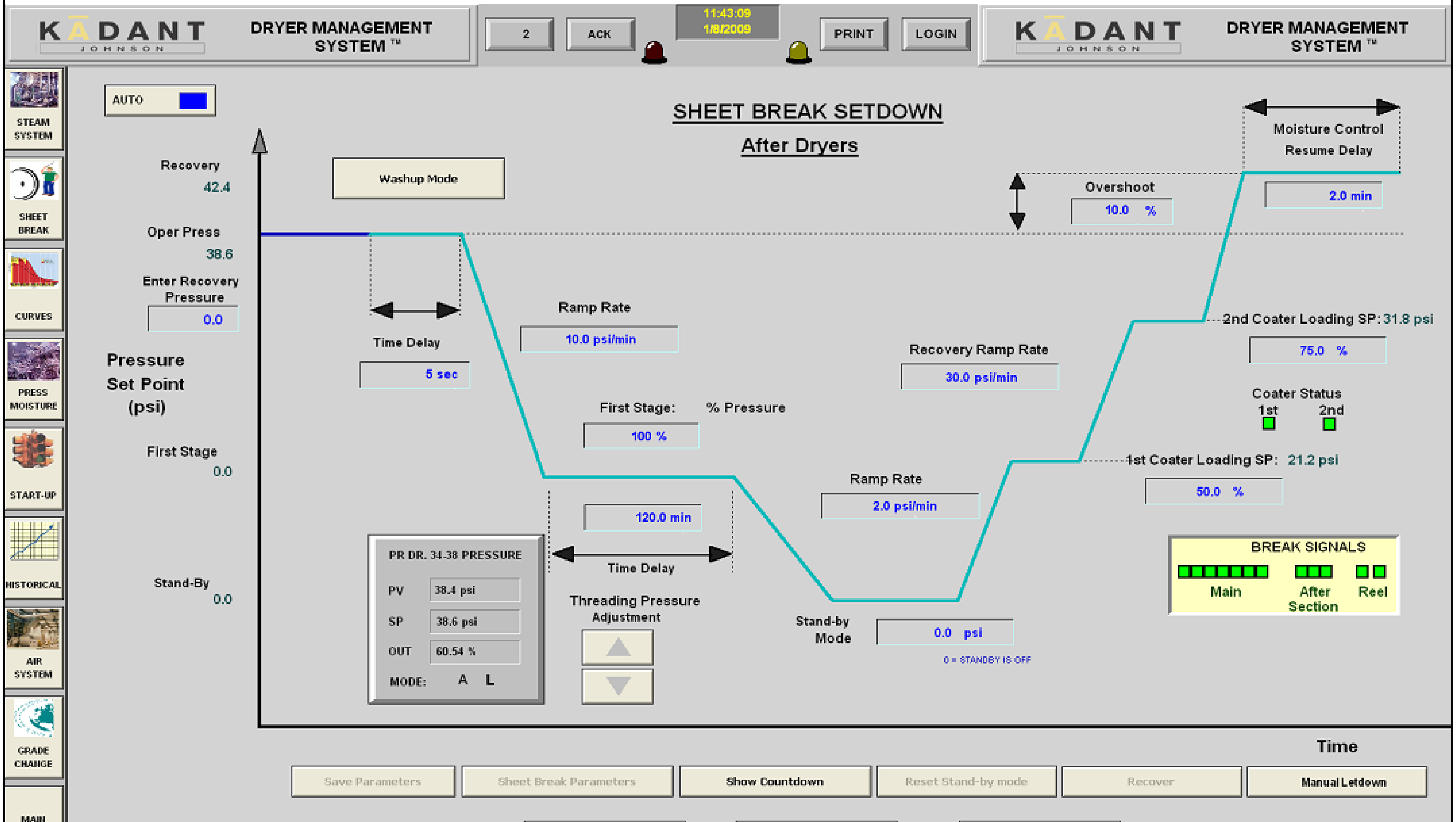
Sheet Break Screen



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Summary of Benefits

(Reduction in break time not included)

Mill PI information before and after DMS installation for comparison

Assumptions / Basis			
Operating Days Per Year:	350		
Uptime Efficiency:	90%		
Steam on Sheet Off:	5%		
Steam Cost:	11.50	$/1000lbs	
Incremental Profit:	150	$/ton	
DMS Benefit	**Steam Savings 1000 lbs/Year**	**Production Increase Ton/Year**	**Profit Improvement $/Year**
Reduce Venting Sheet-On	7882		$ 90,643
Reduce Venting Sheet-Off	309		$ 3,554
Maximize production on Dryer Limited Grades		1250	$ 187,500
Air System Energy Savings	11440		$ 131,560
Total			$ 413,257

Less Tangible Benefits

- The dryer operation is more consistent
  - Process variability created by each crew/operator adjusting parameters based on preference or habits
- Operator interface clear and concise
- Better alarms for system problems
- No bearing race failures since installation

Summary

- Design the system to operate with a minimum of steam waste
- Use supervisory logic to manage the system at optimum levels