REPORT OF RESULTS

VENTURI PROJECT at DS SMITH Reading Mill , Reading, Pennsylvania, USA

Opinion of Consultant

This report provides the comparison of the paper dryness and the steam pressure used for drying before and after the installation of Venturi Paper devices to the system of press felts for PM#1 [DS SMITH Paper Mill, Reading, Pa]. The comparison is made for the same type of paper (grade 23B) at a similar machine speed (2494-2495 fpm before installation versus 2630 fpm after installation). The measurements of the paper dryness using a Kett KJT 270F instrument did not coincide with the measurements of the steam pressure, which along with the other operating conditions were recorded from the paper machine computer.

The reported increase in the paper dryness of more than 4% is based on two measurements before and after the installation of the Venturi Paper devices. For more confidence one could base the comparison using more measurements, but the repeatability of the respective measurements before and after justifies the limited number of the measurements.

The operating conditions were recorded at three different times before and at three different times after the installation of the Venturi Paper devices. In addition, the operating conditions were also recorded during the installation of the Venturi Paper devices. The reduction of the steam pressure from the level of 145 psig to 118 psig is very evident. This significant reduction in the steam pressure is associated with a slight increase in the machine speed. More importantly, the installation of the Venturi Paper has allowed elimination of a vacuum pump in the system.

I cannot access the value of savings in the operating cost (no vacuum pump and reduction of the steam pressure) and the value of increasing the paper dryness. Nevertheless, the reported results are very convincing with respect to the effect of installation on the Venpap devices. Moreover, the methods for obtaining the data pertaining for to comparison is are sound and reasonable.

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1. Introduction and background.

The Venpap project pertains to modernization of the conditioning system of press felts for PM#1 [United Corrstack Paper Mill, Reading, Pa] in order to improve dewatering and reduce production costs. It was developed on the basis of the Venpap Project Concept, Oct 2014.

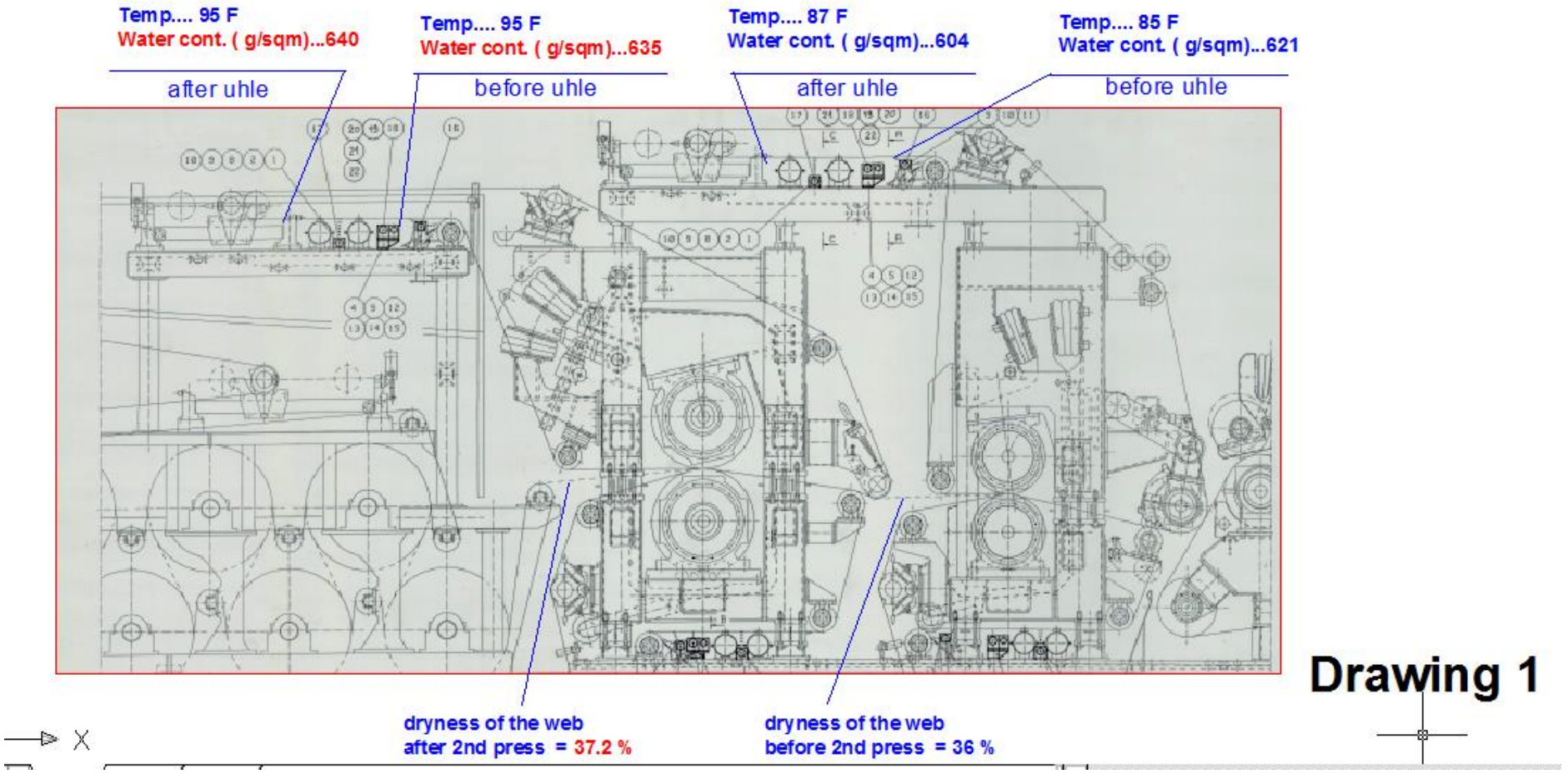
1.1. Situation before implementation of the project:

Machine PM #1 – Fourdinier, total capacity 160,000 st/y, trim width 166 in, corrugating medium/fluting.

The press section comprises 2 presses with 2 top and 2 bottom felts.

A. On Aug 28, 2014 readings from the felts were taken. Readings showed low velocity of the air flow through the top felts to the Uhle Boxes **0.82 m/s and 0.75 m/s** respectively. Deep vacuum (17.5 "Hg) indicates a closed felts structure and a low permeability for air and water penetration. The inhibited air flow through the felts leads to a significantly reduced dwell time and low dewatering

B. The chart below demonstrates the readings obtained following the testing before implementation of the project



Comment: ***As a result of weak conditioning of the top press felts, the web directed to the dryer has a dryness of 37.2% and requires slowing down of the paper machine as well as providing huge amounts of steam to accomplish the required final dryness.***
Please note a very slight increase in dryness (1.2%) on press # 2. Essentially, this means that the top felts do not absorb water and merely transport it.

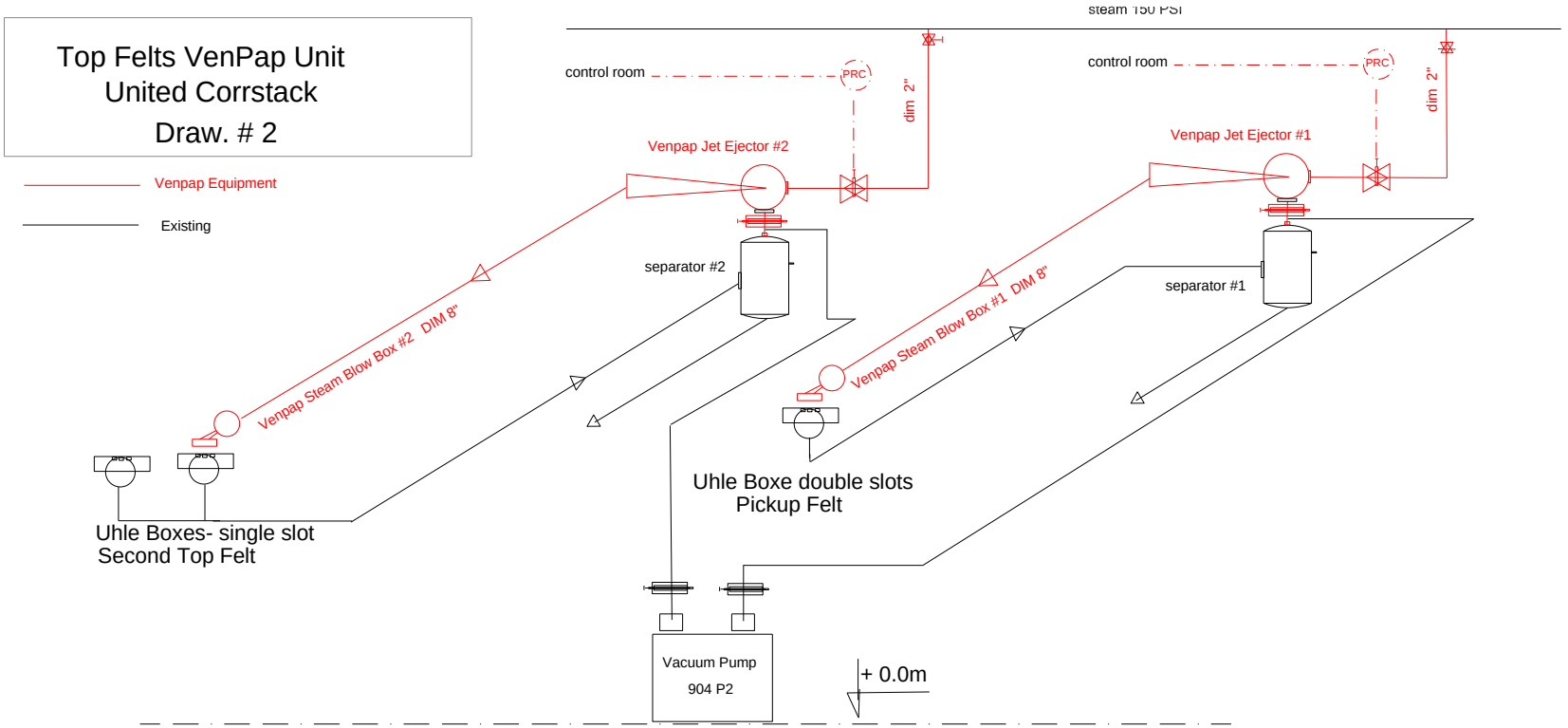
1.2 Status after implementation of the project

The proposed project has allowed a shut down of the vacuum pump using vacuum jet ejectors with simultaneous recirculation of the hot mixture to the top felts conditioning system [Drawing 2]. Through the use of specific superheated mixture of steam and air it was possible to accomplish a total penetration of felts.

Two VenPap Units equipped with a Vacuum Jet Ejectors and a Blow Boxes according to the attached diagram (Draw #2) were installed.

Improvement of the working parameters of Uhle Boxes at top felts:

- Dwell time increased from <0.5 m/s to >3m/s;
- Felts temperature went up to 120 F;
- Speed flow of hot air and steam mixture to Uhle Boxes increased from 0.82m/s to 4 m/s;


Top Felts VenPap Unit
United Corrstack
Draw. # 2
Venpap Equipment
Existing
steam 150 PSI
control room
PRC
dim 2"
Venpap Jet Ejector #2
separator #2
Venpap Steam Blow Box #2 DIM 8"
Uhle Boxes- single slot
Second Top Felt
Uhle Boxe double slots
Pickup Felt
Venpap Steam Blow Box #1 DIM 8"
Venpap Jet Ejector #1
separator #1
Vacuum Pump
904 P2
+ 0.0m

DRAWING 2

2. Statement of assignment

2.1. The aim of the measurements was to determine changes in the dryness of paper for the press section of the paper machine in UC with and without Venturi Paper devices.

2.2. Analysis was performed by comparing dryness of the paper after the presses during production.

2.3. Documented measurements of paper dryness were confirmed by the changes in steam pressure to drying section of paper machine.

2.4. Measurements were performed with instrument Kett KJT 270F - one of the world's most reputable companies in the field of moisture measurement (method NIR). The instrument has been calibrated for paper grade 23B produced in the UC.

2.5. Changes of the steam pressure were taken from the main computer of control room at the paper machine.

3. Statement of expert qualification.

Author: Lucjan Raubic,Venturi Paper,Canada

Lucjan graduated Wrocław University of Science and Technology, Poland, 1980, with a master's degree in the field of chemistry and engineering. He has many years of experience in the field of paper production with the focus on reducing energy consumption. He is an author and presenter of many conferences in Europe and the USA (lately - 2015 TAPPI PaperCon, Atlanta). He is the author of numerous publications in the field of improving paper production processes (Paper Overview - Warsaw, Poland -1995; Paper Technology -London, England- 2003; Appita, Sydney, Au -2014; etc). - Lucjan has several inventions and patents in Europe, Canada and USA.

4. Documents and information considered.

4.1. Measurements (see &6)

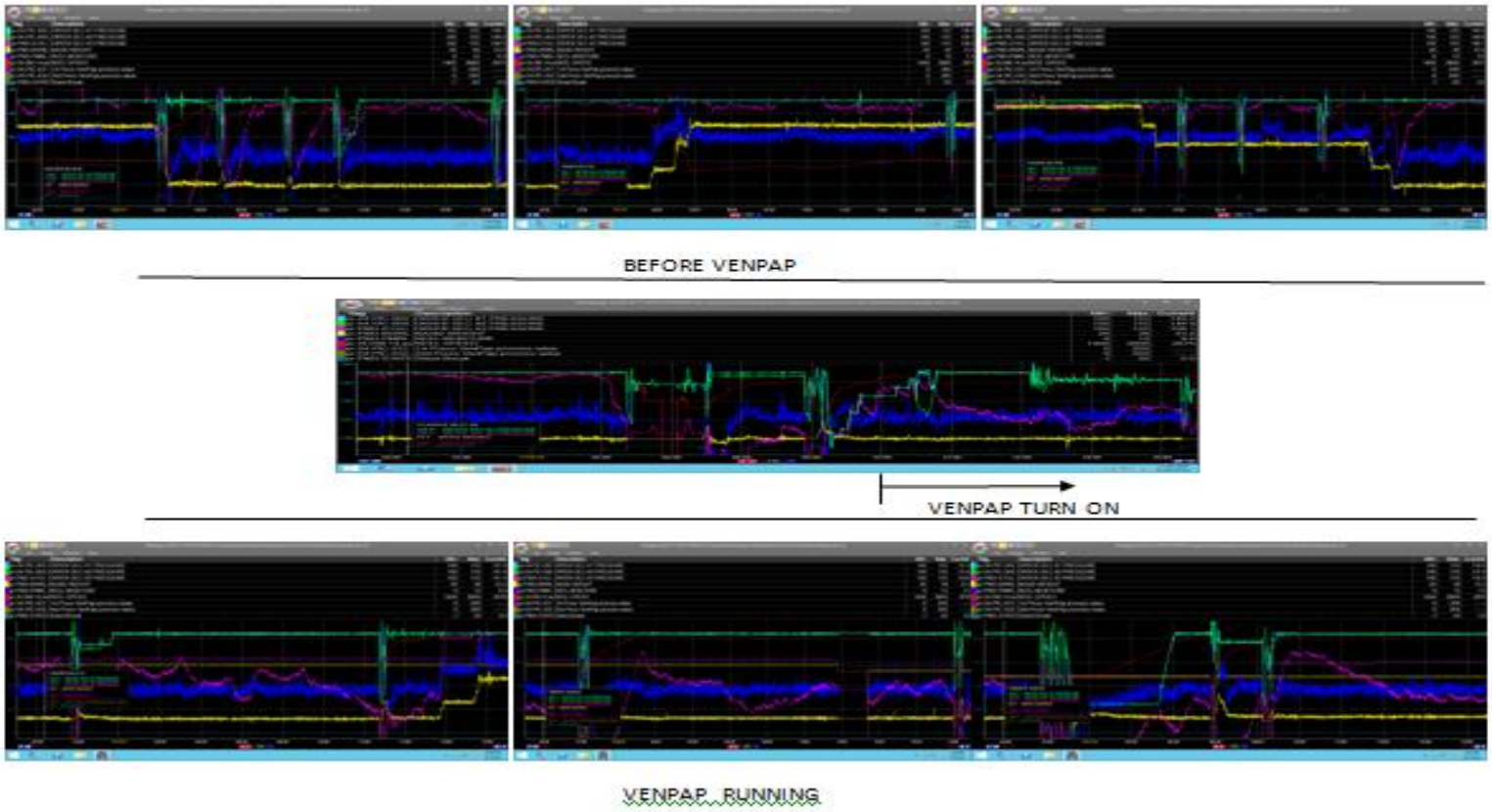
4.1.1. On day 05/20/2015 - dryness of paper 37.4% - 10 weeks before start Venpap
4.1.2. On day 07/13/2015 - dryness of paper 38.2% - 16 hours before start Venpap
4.1.3. On day 07/28/2015 8.15pm – dryness 42.8% - fourteen days after start Venpap
4.1.4. On day 07/29/2015 8.17 am – dryness 42.6% - fifteen days after start Venpap

The mean dryness of the paper web after the second press for grade 23B is:

(37.4 %+ 38.2) /2 =37.8% - without Venpap
(42.8%+42.6%)/2 = 42.70% - with Venpap

4.2. To avoid variance of production conditions, the analysis involves the same grade of paper and the same speed of the paper machine. Comparison was made in the period before turning Venpap on and during operation of the system.

The following are the parameters of the PM for maximum speed that is **2600 fpm to 2635 fpm** and grade of paper **23B** (main product):



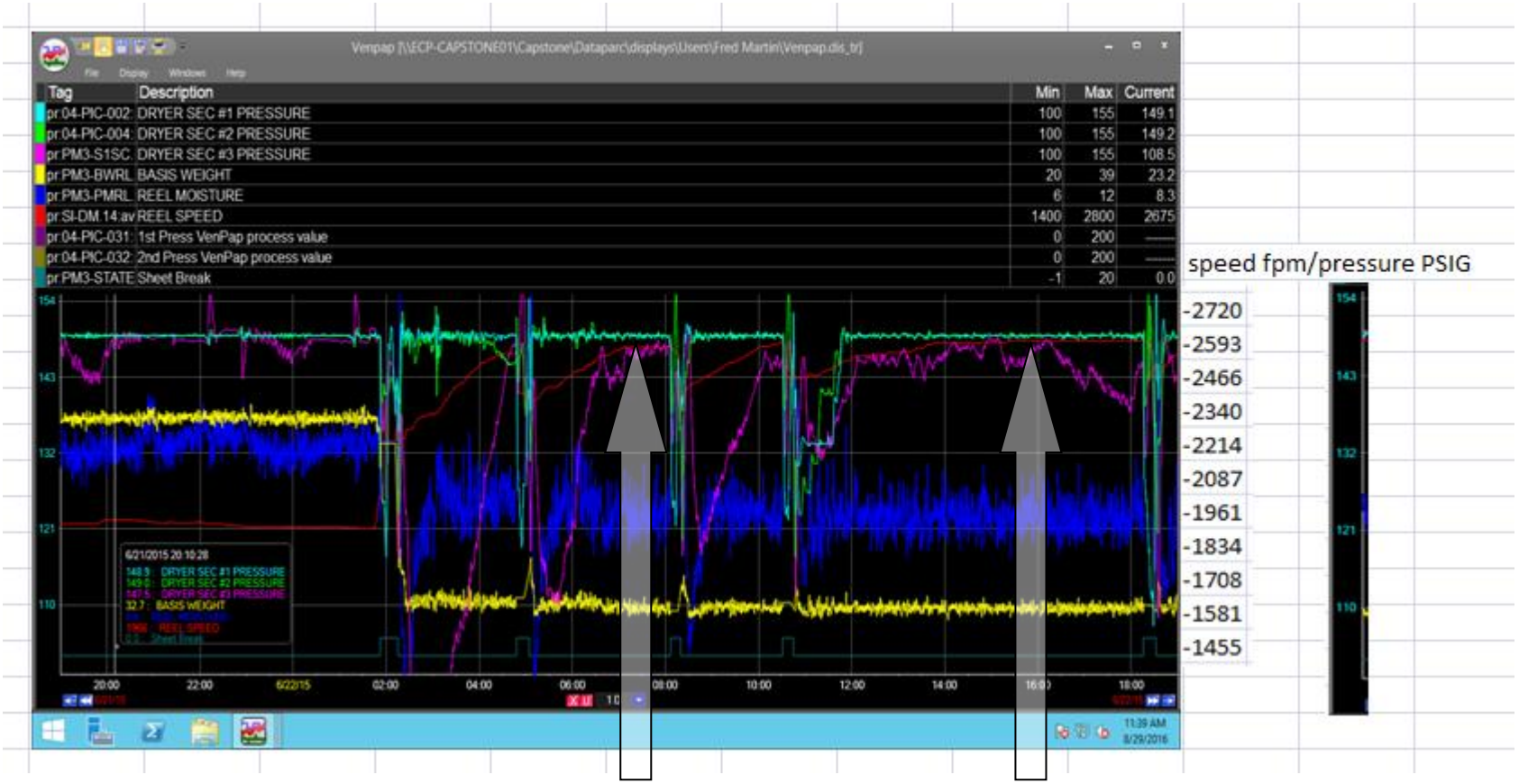
(*) DETAILED DESCRIPTION OF CHARTS see Section 5.

5. Basis for opinion.

5.1. Data recorded by the paper machine computer.

Chart #62115

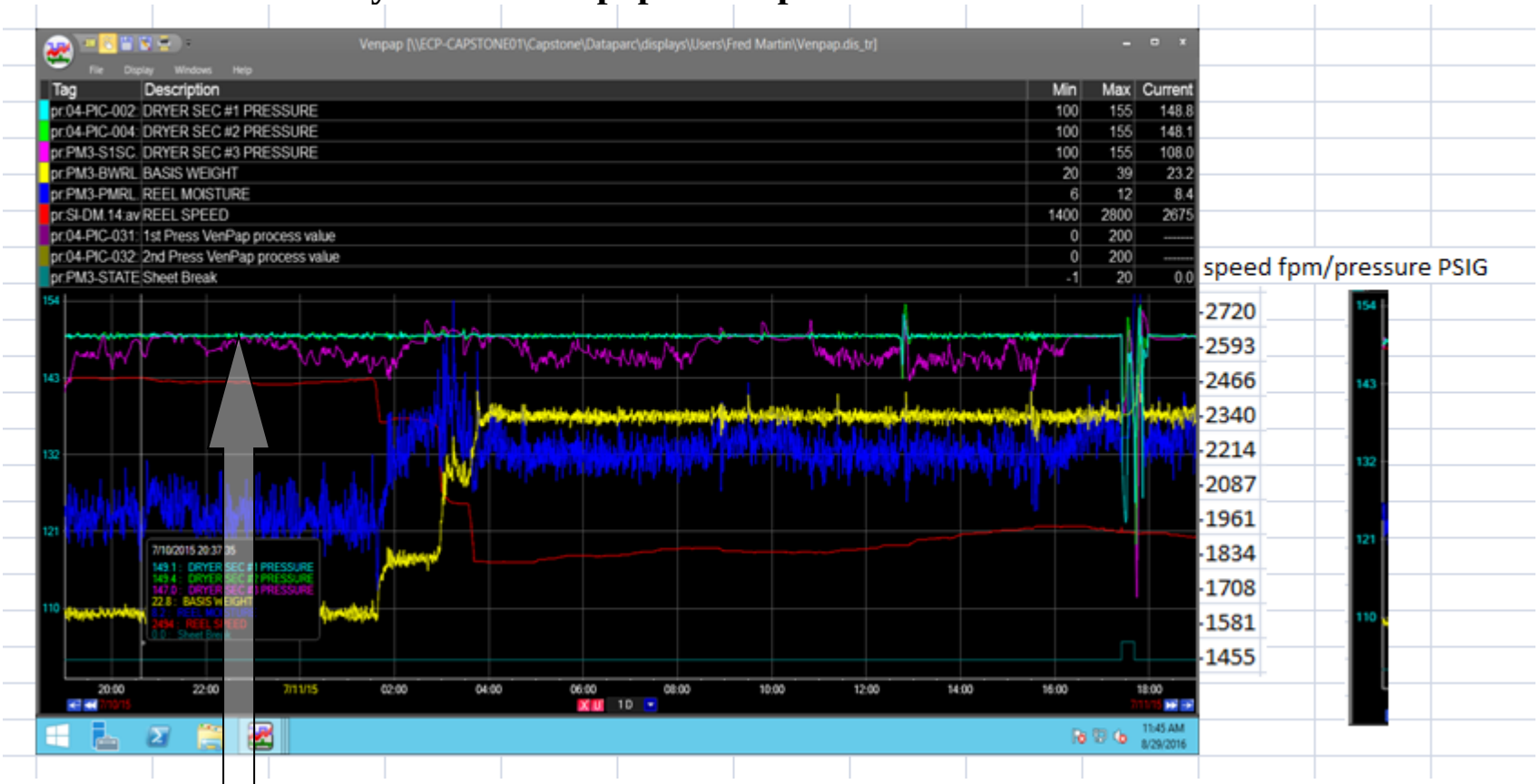
6/21 – 6/22 /2015 - 3 weeks before Venpap launch



Characteristic maximum level of steam pressure [147.5 PSIG] despite the reduced speed of the paper machine [2495 fpm]

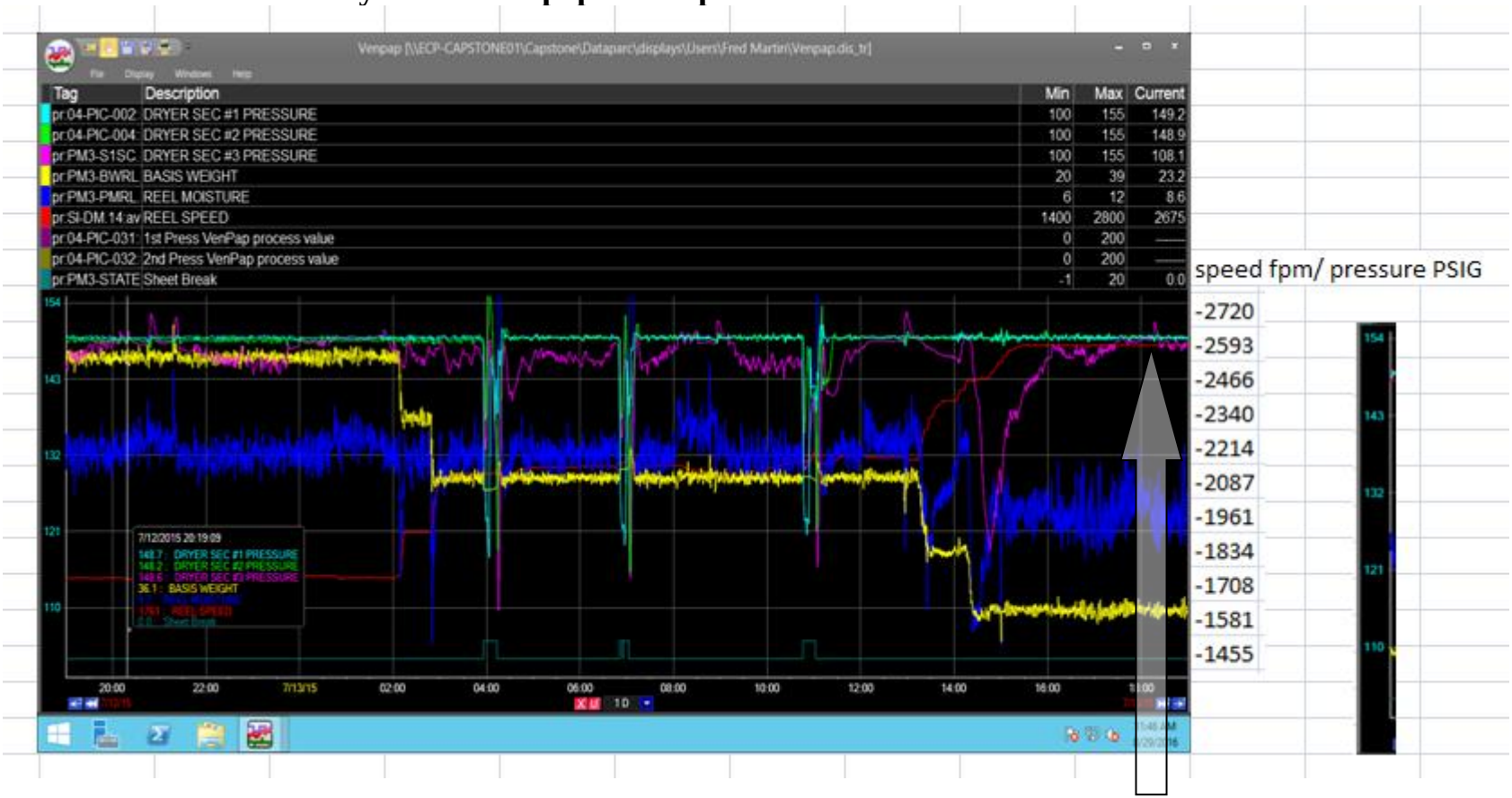
Chart #71015

7/10 – 7/11 /2015 - 3 days before Venpap start up



Characteristic maximum level of steam pressure [147 PSIG] despite the reduced speed of the paper machine [2494 fpm]

Chart #71215
7/12 – 7/13 /2015 - 1 day before Venpap start up



Characteristic maximum level of steam pressure after each start up of production = 149 PSIG

Cart #71315
7/13 – 7/14/2015 - VENPAP START UP @ 7/14/015 at 10am

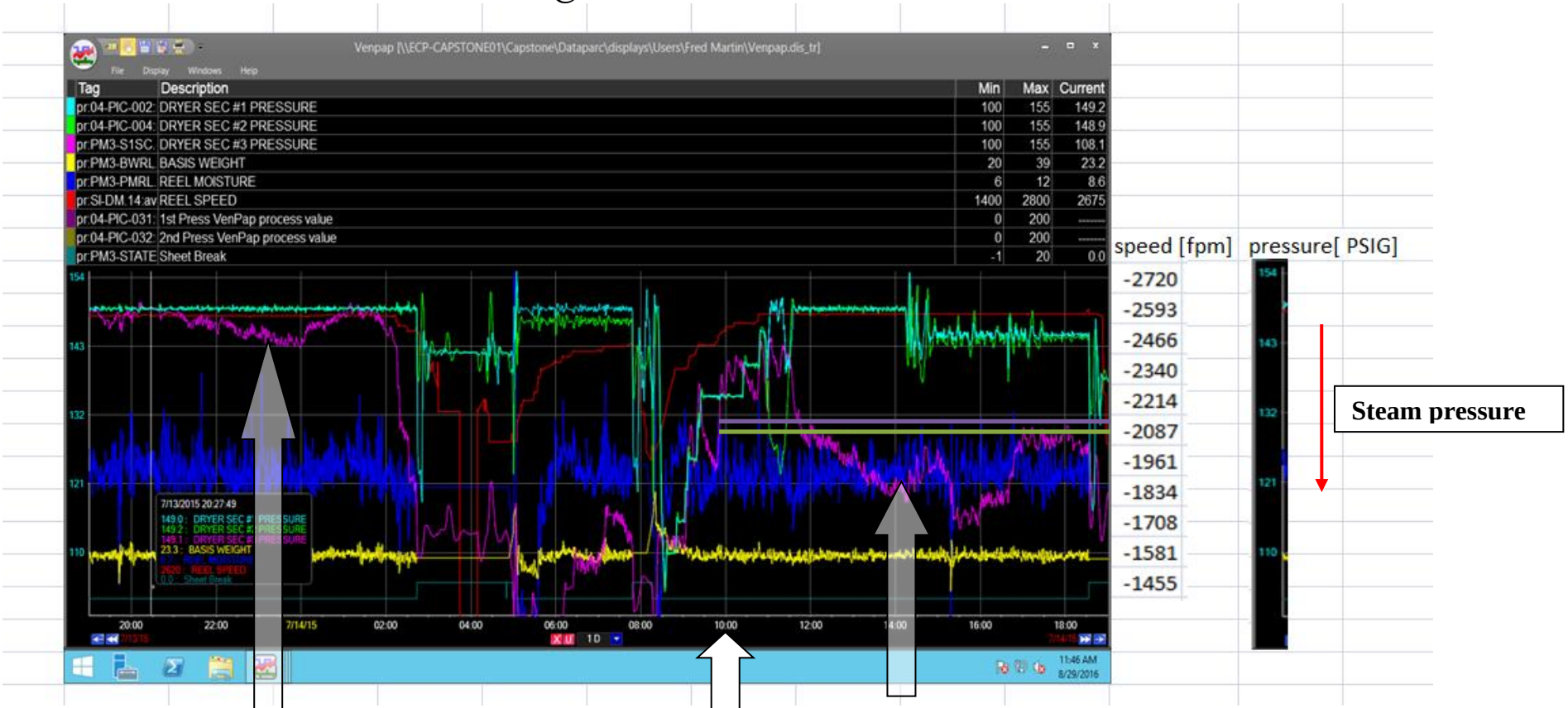
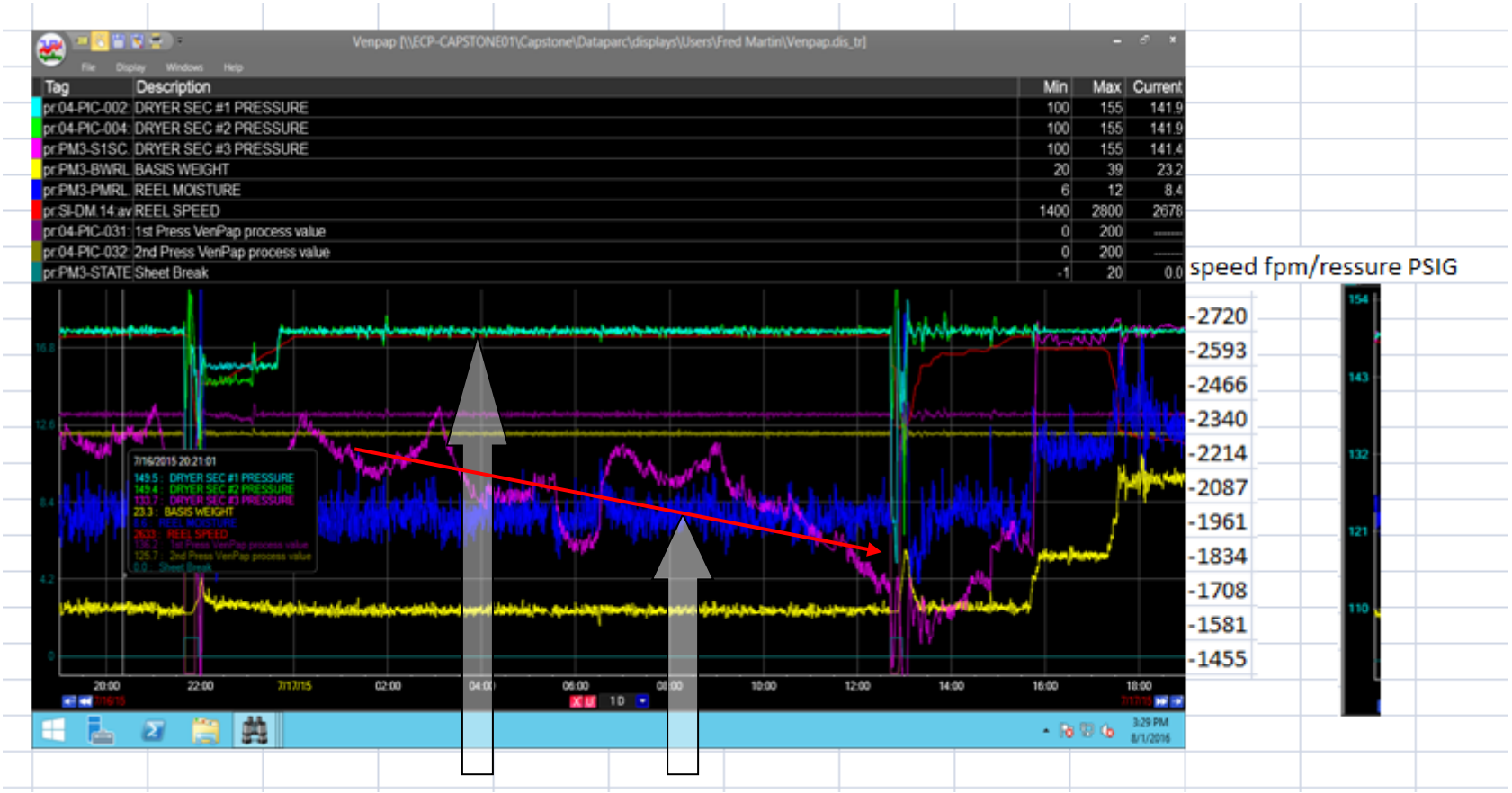


Chart @71615
7/16 – 7/17/2015 - VENPAP RUNNING

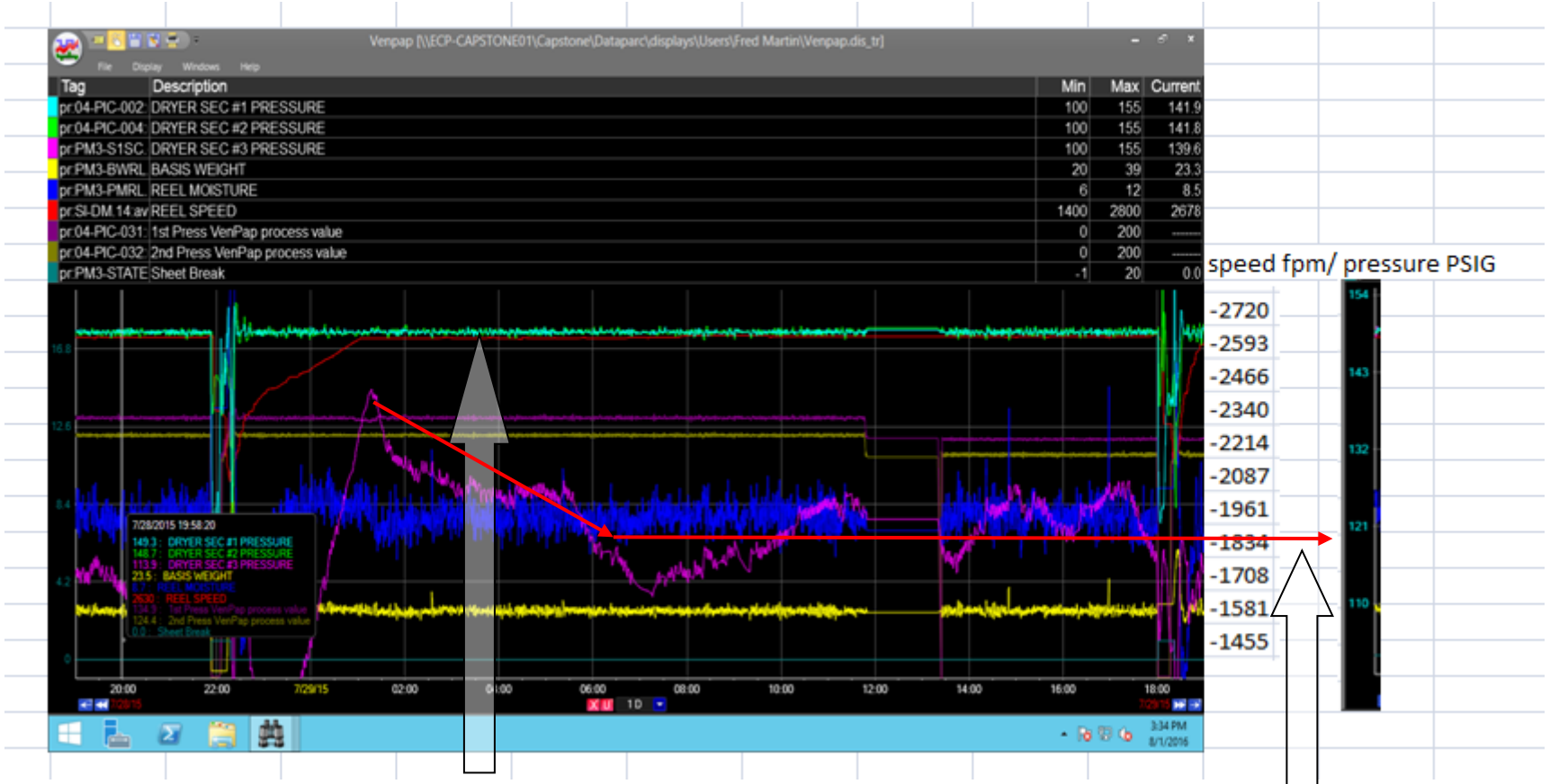


Paper machine speed = 2633 fpm

Characteristic declining trend of steam pressure (pink line) after each start up of production with Venpap

Chart #72815

7/28 – 7/29/2015 - VENPAP RUNNING

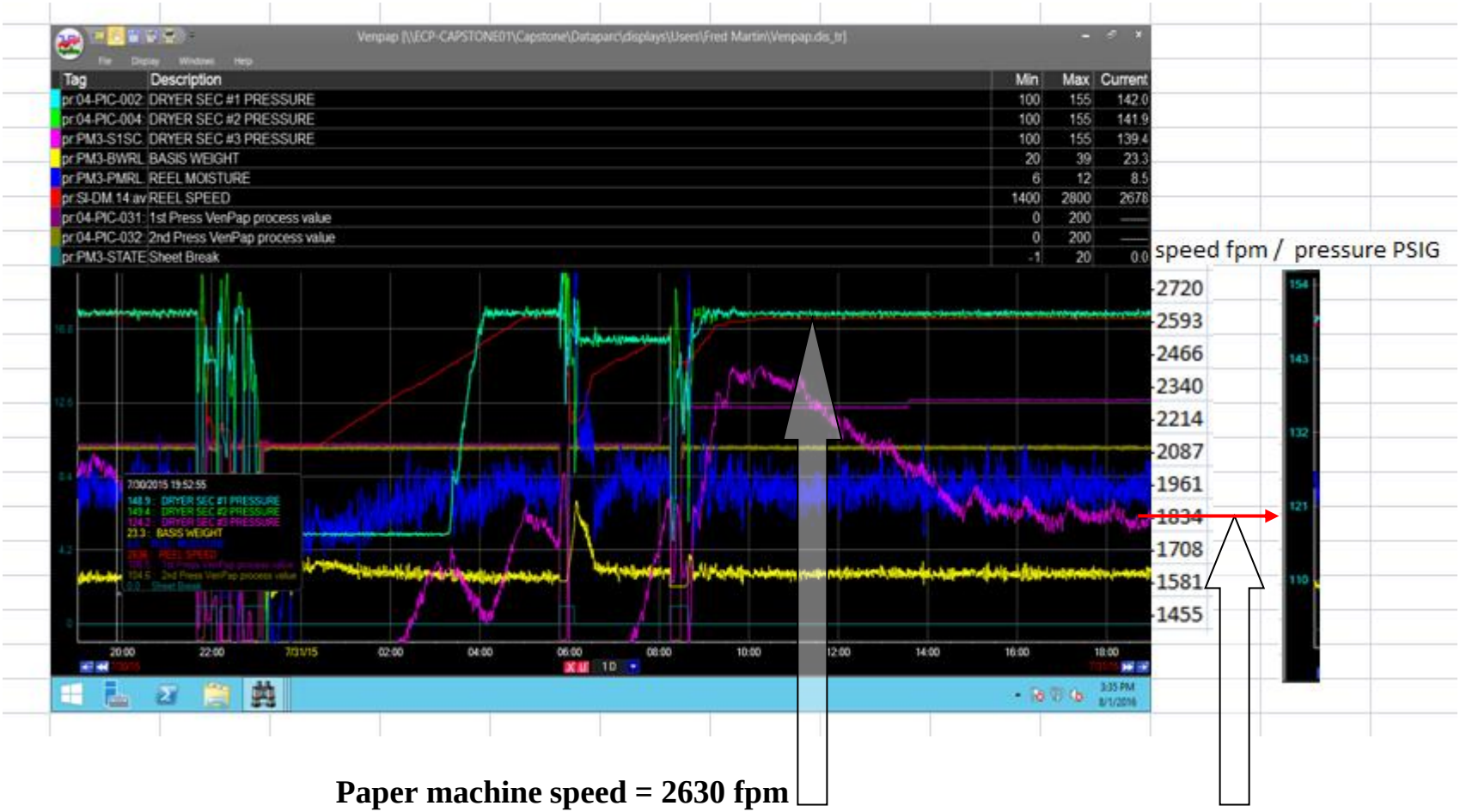


Paper machine speed = 2630 fpm

Average steam pressure to the dryer=118 PSIG

Chart #73015

7/30 – 7/31/2015 - VENPAP RUNNING



Paper machine speed = 2630 fpm

Average steam pressure to the dryer=118 PSIG

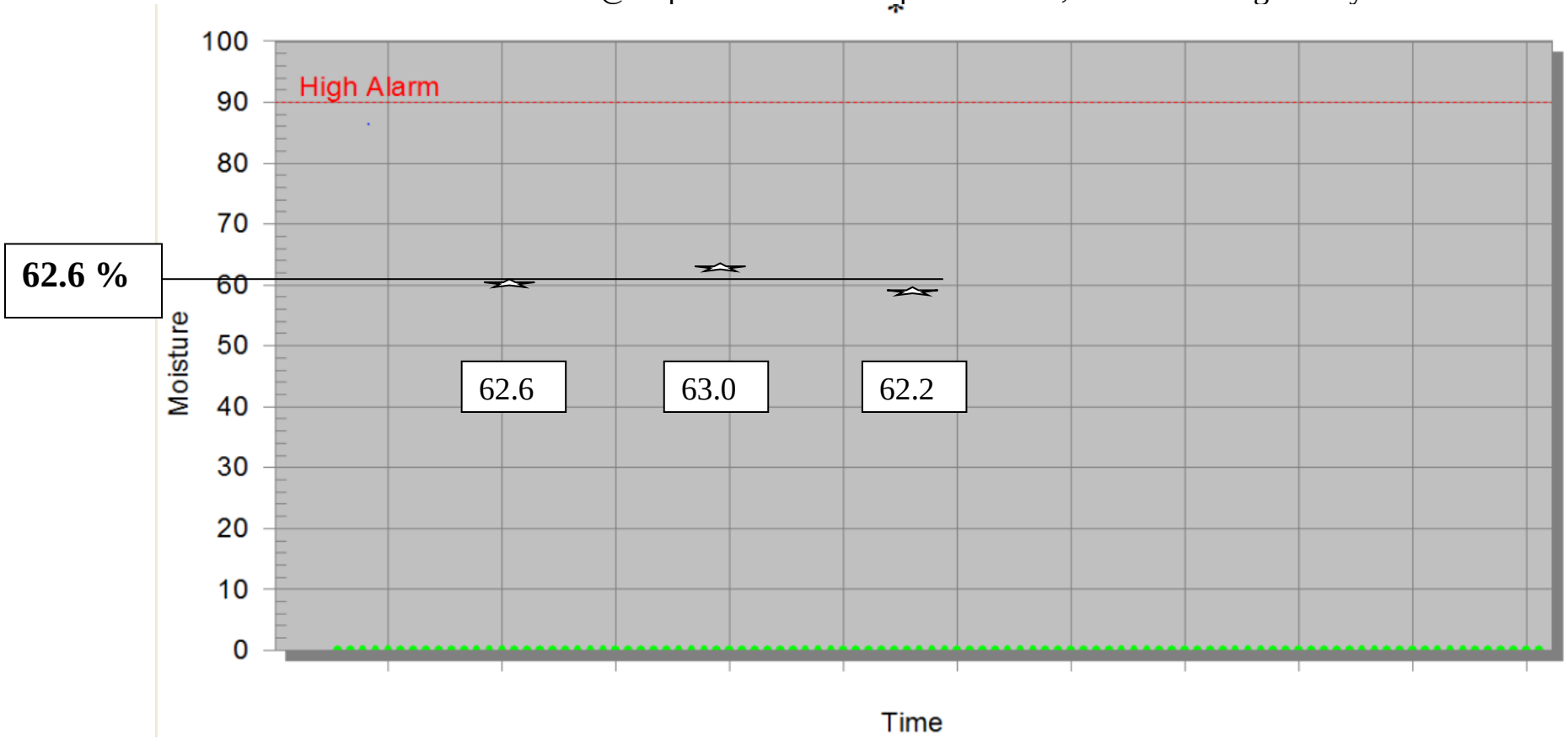
5.2. Measuring device.

Measurements were performed with instrument Kett KJT 270F - one of the world's most reputable companies in the field of moisture measurement (method NIR). The instrument has been calibrated for paper grade 23B.

5.2.1.

United Corrstack Papar Machine, Reading, PA [10 weeks before Venpap launch]

DEV. KETT 270F / Worksheet #052015/ @ Paper moisture after press section, before entering the dryer.

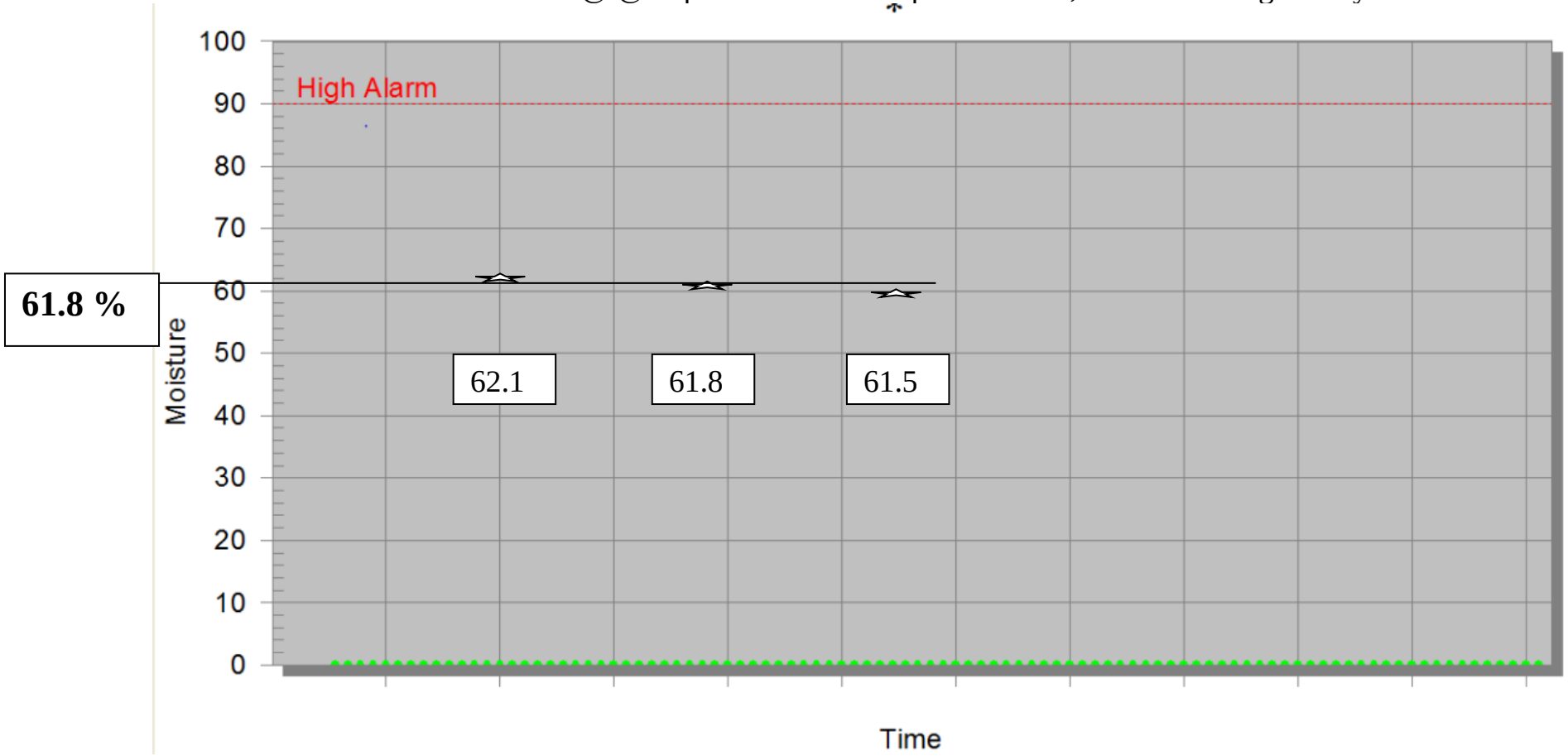


Measurements taken @ 05/20/2015 **@ DRYNESS: 100% – 62.6% = 37.4%**

5.2.2.

Unied Corrstack Papar Machine, Reading, PA [16 hours before start Venpap]

DEV. KETT 270F / Worksheet #071315 @ @ Paper moisture after press section, before entering the dryer.

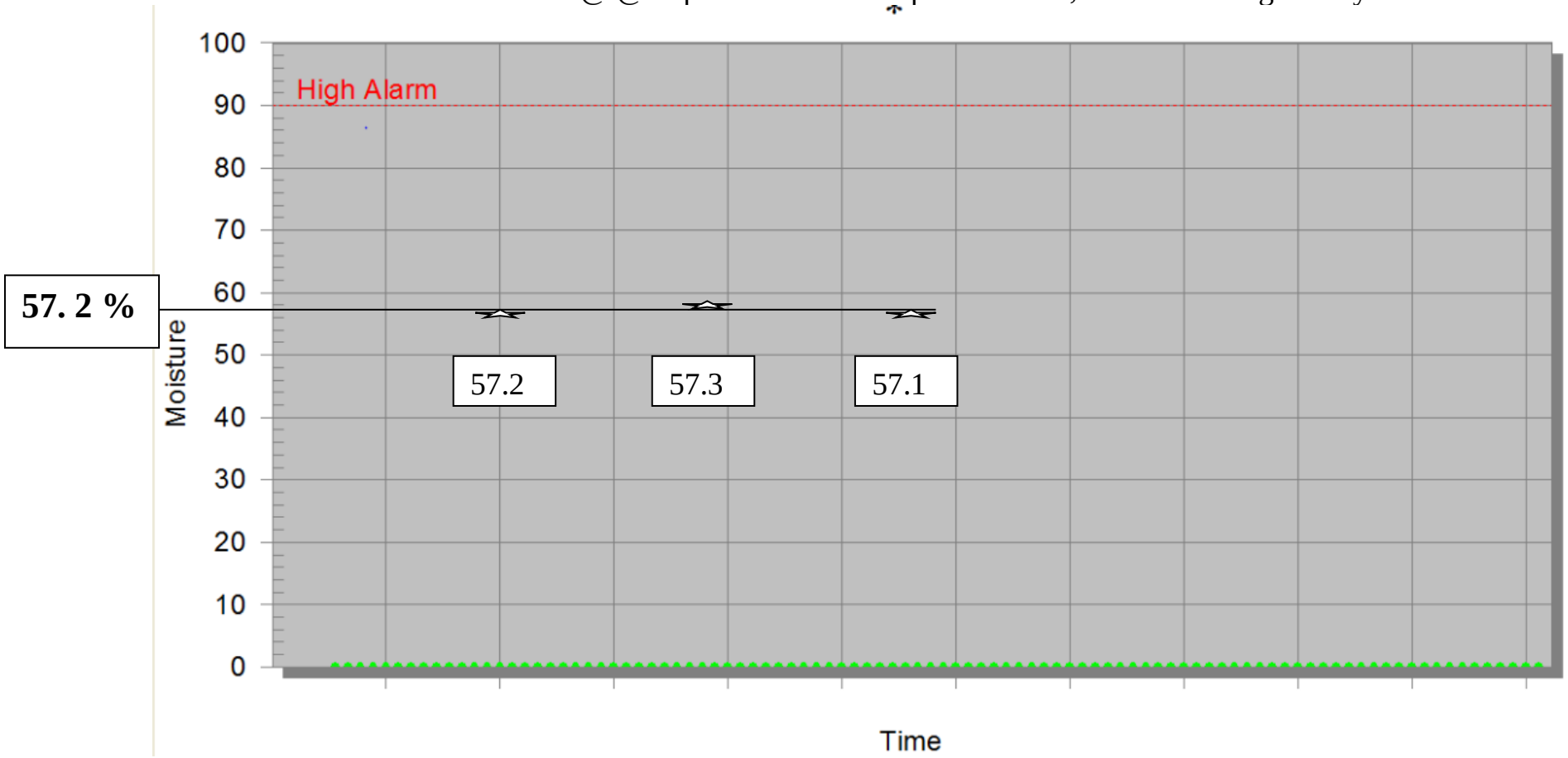


Measurements taken @ 07/13/2015 @ 6.25 pm **@ DRYNESS: 100% – 61.8% = 38.2%**

5.2.3.

Unied Corrstack Paper Machine, Reading, PA [Venpap running for 14 days]

DEV. KETT 270F / Worksheet #072815 @ @ Paper moisture after press section, before entering the dryer.

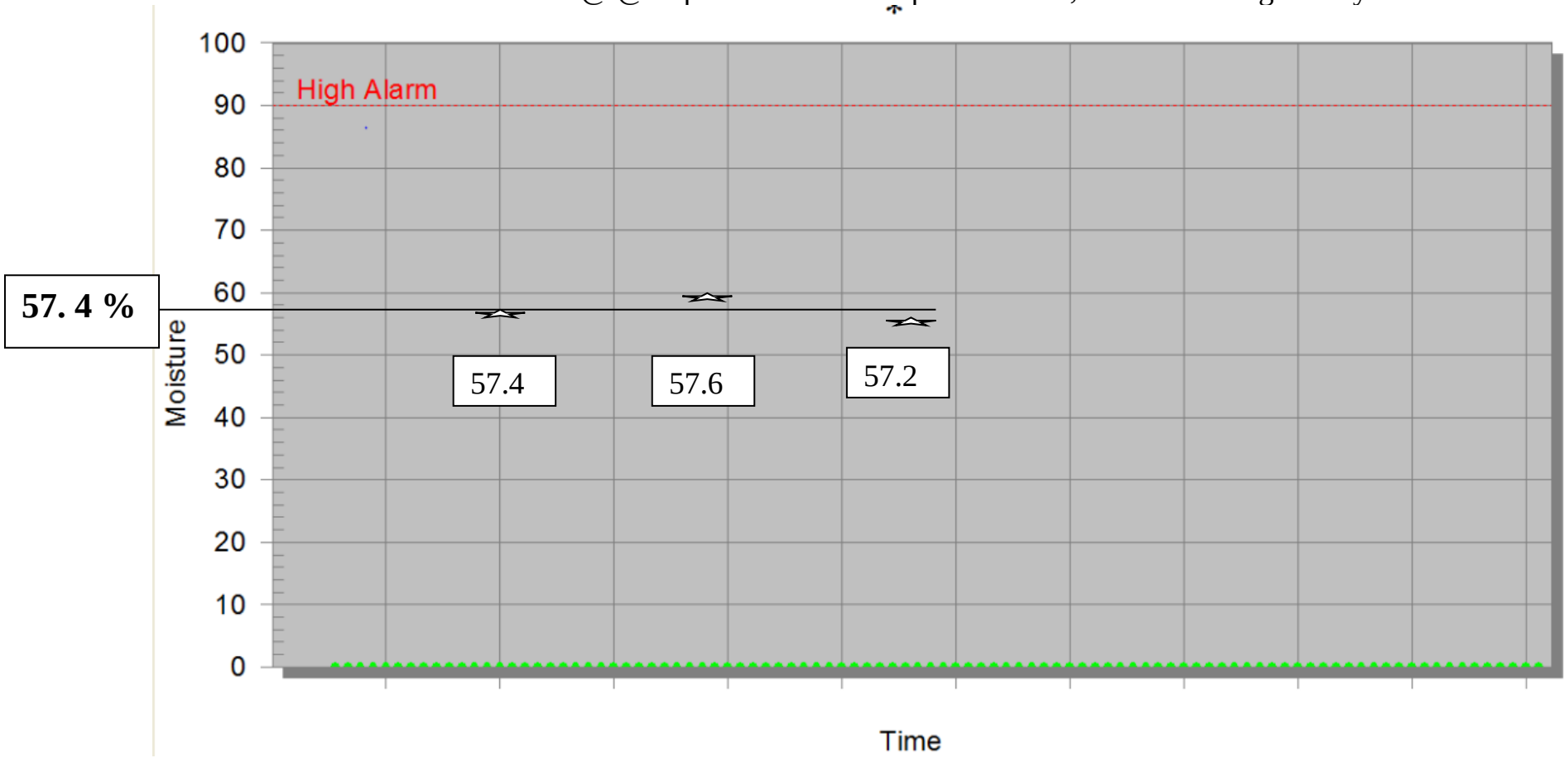


Measurements taken between 8.12-8.19 am @ 07/28/2015 @ **DRYNESS: 100% – 57.2% = 42.8%**

5.2.4.

Unied Corrstack Paper Machine, Reading, PA (Venpap running for 15 days]

DEV. KETT 270F / Worksheet #072915 @ @ Paper moisture after press section, before entering the dryer.



Measurements taken between 8.15-8.20 am @ 07/29/2015 **@ DRYNESS: 100% – 57.4% = 42.6%**

6. Summary

6.1. Average steam pressure to the drying section without Venpap:

145 PSIG

Average steam pressure to the drying section with Venpap:

118 PSIG

The reduction of steam pressure to the dryer section with Venpap Technology:

[(145 PSIG – 118 PSIG)/145 PSIG] x 100% = 18.6% (*)

(*) The above result was achieved in a period of continuous operation Venpap. It should be noted that the Venpap devices allowed the electricity savings in the amount of 400 HP due the exclusion of vacuum pump NASH 904.

6.2. The mean dryness of the paper web after the second press for grade 23B is:

(37.4 %+ 38.2) /2 =37.8% - without Venpap

(42.8%+42.6%)/2 = 42.70% - with Venpap

Improvement of paper dryness after press section with Venpap Technology:

(42.7% – 37.8%) = 4.9%

6.3. Final review

6.3.1. Above analysis and results related to the Venpap Project confirm the achievement of paper dryness improvement above 4%.

6.3.2. Venpap Project challenges one of the most difficult fields of the paper production processes. It is therefore important to emphasize that Venpap significantly improves the characteristics of the press section and thus improves performance of the whole paper machine.