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RF NOTE 106

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STUDY OF TRANSIENT OCCURRENCE IN THE AC LINE SUPPLY AT NSCL

Contents

A. Introduction, or "Why Bother Conducting This Study?"

The purpose of this study was to determine the level of transient noise on the power line supplied to the Laboratory and what level of protection is needed. (Electromagnetic inteference (EMI) and radio-frequency interference (RFI) was not addressed in this study.)

This study is crucial because of the threat of equipment damage that transients present. For optimum equipment usage, the power line must constantly remain at 120V and 60Hz. However, as the study shows, this is not the case. If the voltage or phase varies, the sensitive equipment in the Lab could be degraded.

Another more insidious problem is sudden voltage changes. Surges (a spike of increased voltage) and sags (a spike of decreased voltage) can change values of digital signals, blow fuses, weaken components, or even kill a piece of equipment altogether. Depending upon the equipment and its design, there is a possibility of equipment damage when the power level is above 120V. Power One, a power supply company, cites equipment damage beginning at 140V-145V. And in one instance during this study, two computers were knocked off-line by a voltage sag.

Two modes of protection are available against transients: MOVs (metal oxide varistors) and solid state transient absorbers. (Circuit breakers and fuses won't protect against transients because of the speed of the event.) At the Laboratory, only the K800 RF balcony and ECR are protected. We use Psytronics solid state transient absorbers because MOVs are self-sacrificing and must be periodically replaced, while transient absorbers are not self-sacrificing and thus are expected to last longer.

B. Study Procedure

It is very unlikely that the line frequency will change, because 60Hz is a national standard and our power generator has protecting circuits that shut off unless 60Hz is emitted. Therefore, the study concentrated on measuring voltage events. A voltage event is a rapid, radical change in voltage from the normal value.

To record the voltage events, we plugged a Drantz 620 transient recorder into the line outlet in various parts of the building, moving it from room to room over a period of 34 2/3 days (832 hours). The unit recorded the time of day, magnitude, and duration of the events.

As shown in Figures 1-6, the study began at about 3:30 p.m. March 13, 1987 and ended at 8 a.m. April 16, 1987. Surges and sags were measured against a 122V-124V median.[1]

C. Results & Conclusions

Four events were recorded, all in unprotected areas:

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1. It is interesting to note that there were some gradual changes in the line voltage over the month.

1. 24V sag at 100V lasting 0.42 seconds, 11:02 a.m. Saturday, March 14 in the RF shop. (Two computers in the computer room were knocked off-line by this event.)
2. Instantaneous 217.2V surge reaching 339.2V, 10:12 a.m. Wednesday, March 18 on the K500 RF balcony.
3. 4.2V sag at 118.4V lasting 9 seconds, 8:21 a.m. Saturday, April 4 in the welding shop.
4. 3.8V sag at 118.4V lasting 0.25 seconds, 11:39 p.m. Sunday, April 5 in the welding shop.

The following conclusions may be made from this data:

* The transients were recorded at an average of once every 6.1 days, or about once a week. (See Table 1.)
* There is little or no correlation between transient occurrence and time of day or day of the week. Therefore, transients are random events and do not appear to be induced by noise created when work is being done.
* Since a sag recorded in the RF shop affected computers in the computer room, it is clear that transients reach all unprotected devices in the building.
* No transients were recorded in protected areas, which were monitored during 29% of the study duration.

D. Recommendation

As cited earlier, equipment damage has been documented as beginning at 140V-145V. During the study, a voltage surge reaching 339.2V was recorded, as was a voltage sag that effectively "unplugged" some equipment.

Therefore, to avoid intermittant equipment failures, it is a worthwhile investment for the laboratory to install transient absorbers on power panels which feed equipment used for measurement, detection, and control. As stated earlier, transient absorbers are preferable over MOVs because transient absorbers last longer. They cost $500-$800 per power panel.

The other option is to procure an uninterruptable power system for the Laboratory for $1,000 per kilowatt. This is not economical.

Figure 1: March 13-20

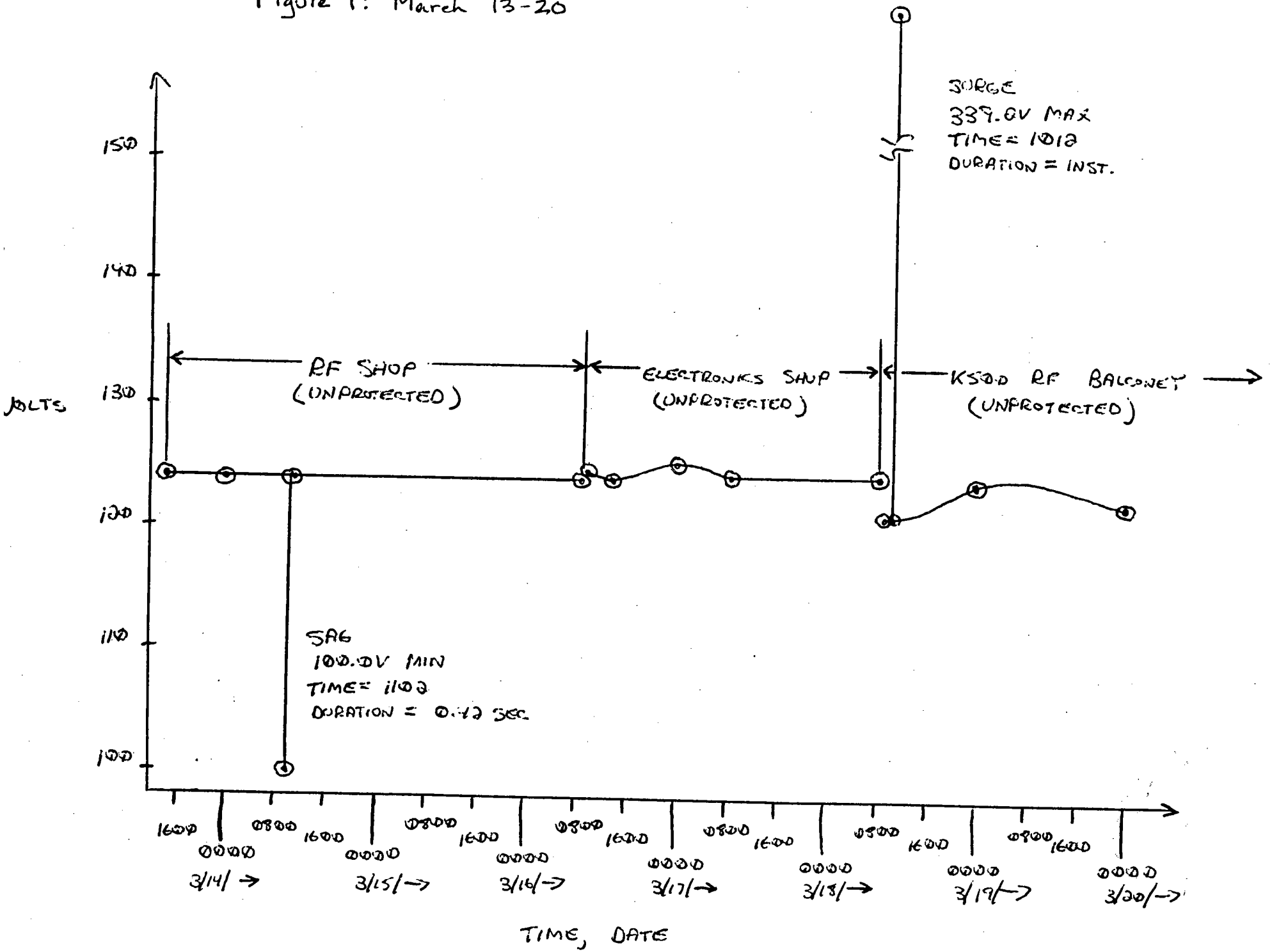

Figure 2: March 20-26

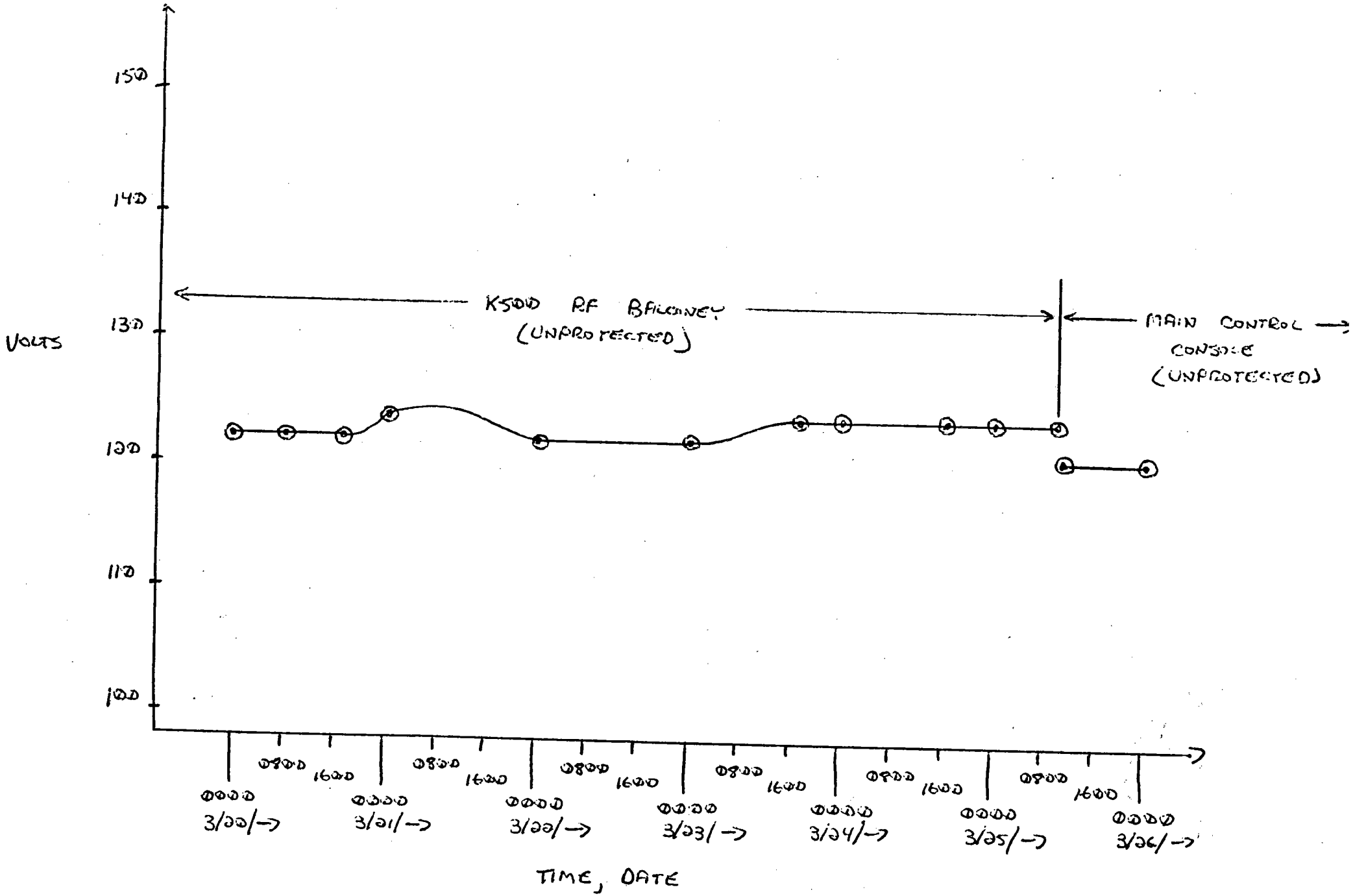

Figure 3: March 26 - April 1

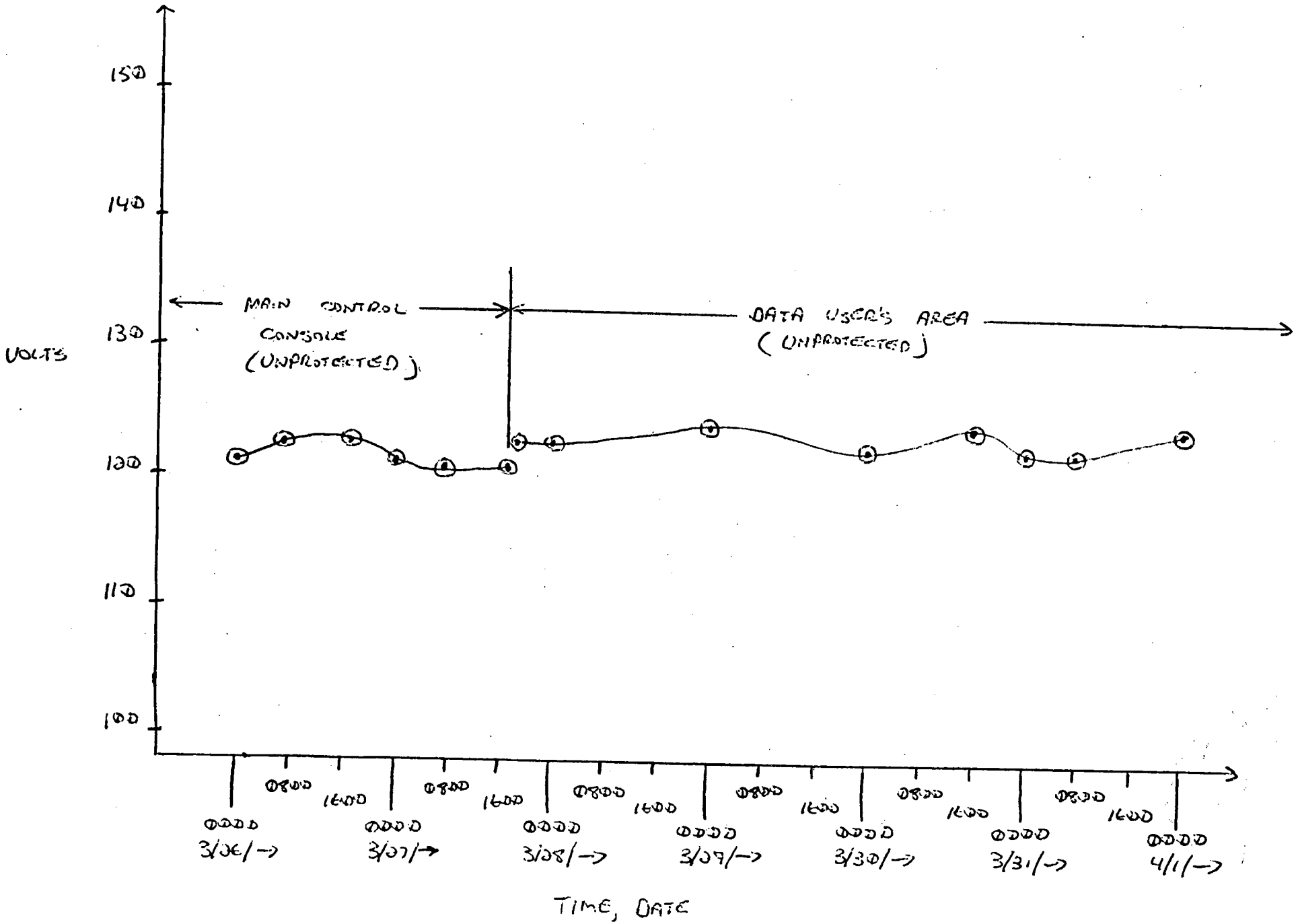

Figure 4: April 1 - 7

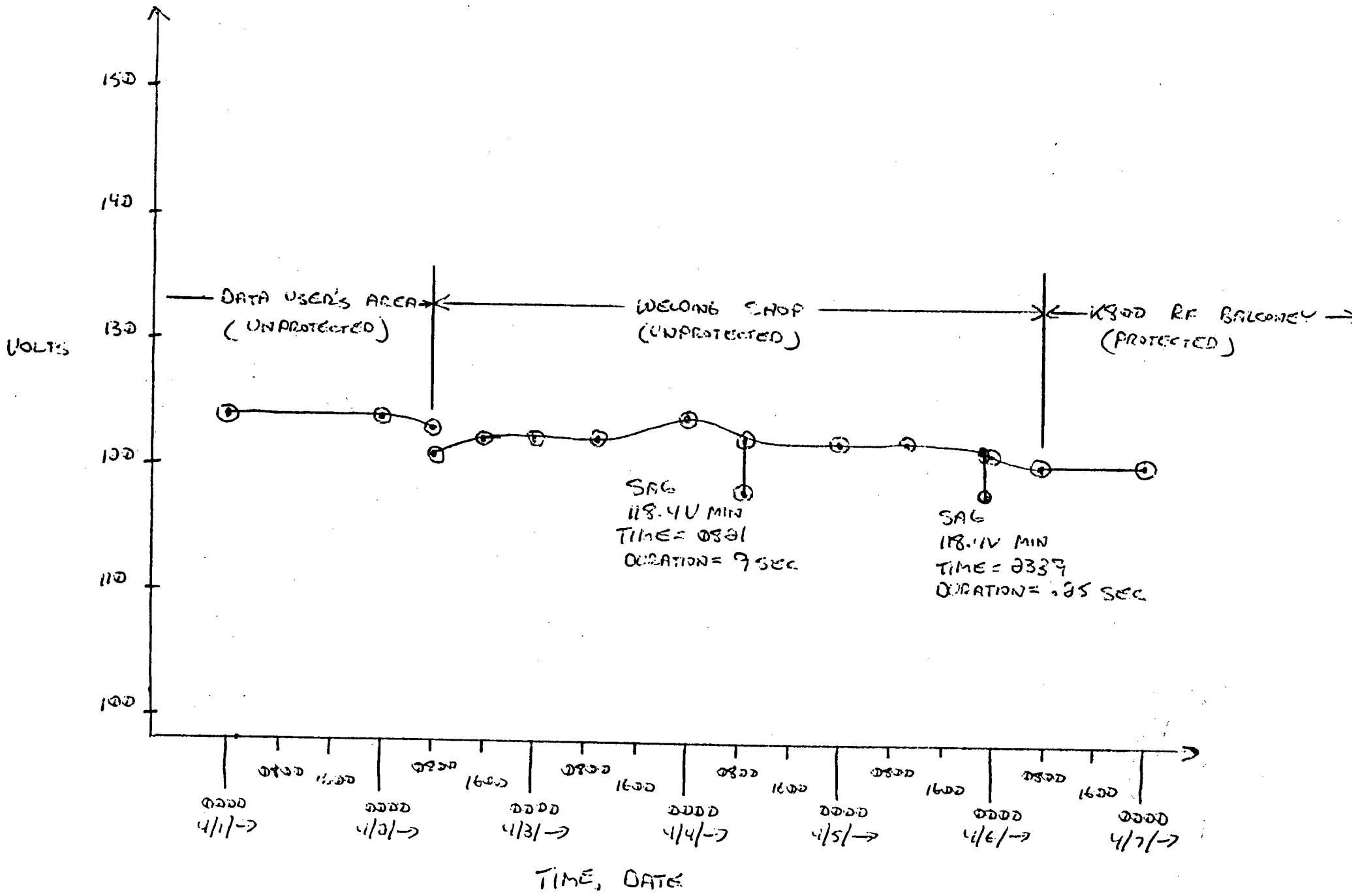

Figure 5: April 7-13

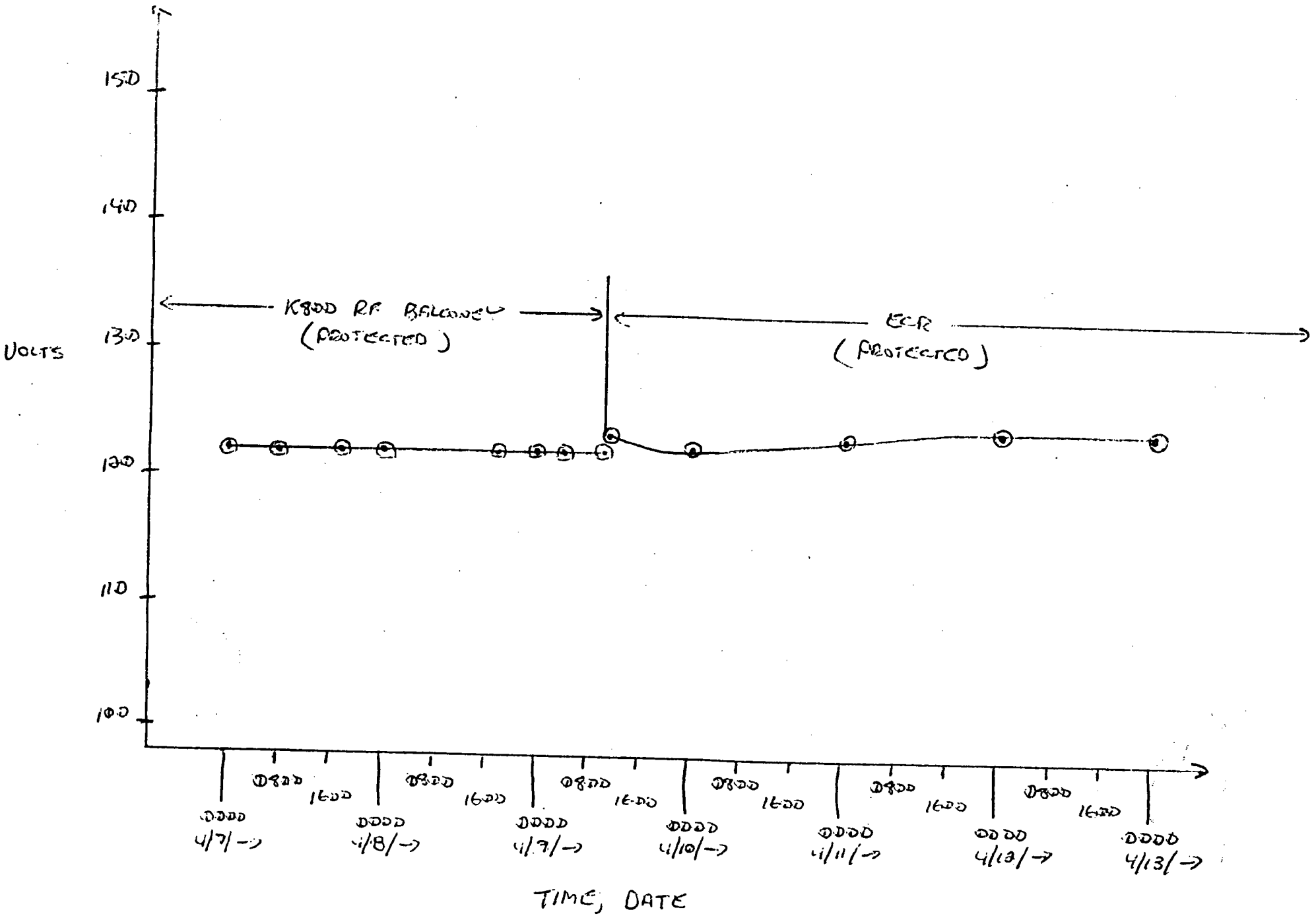

Figure 6: April 13 - 16

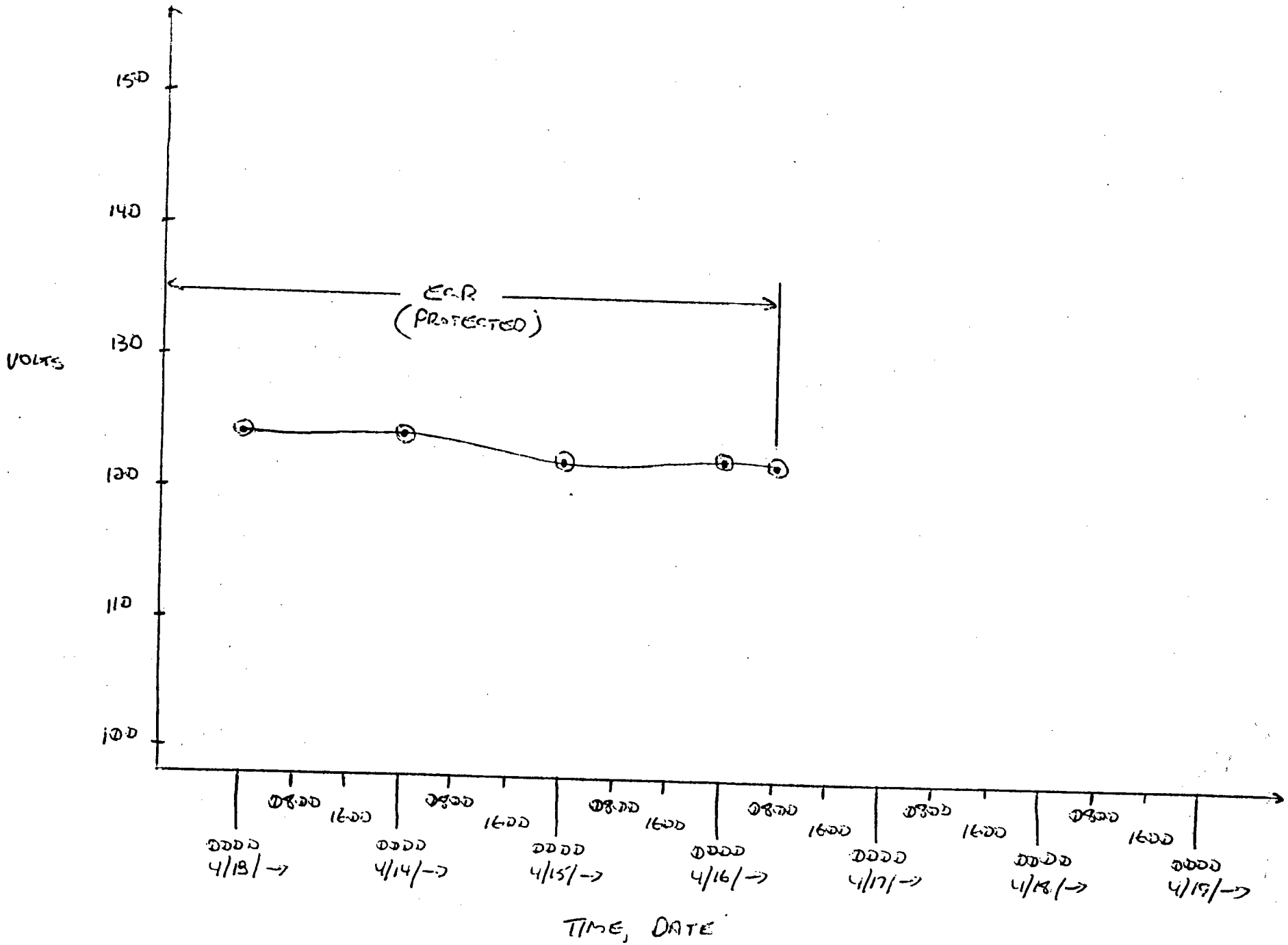

TABLE 1

Frequency and Location of Event Occurrence

Location	Hours Monitored	Events
1. RF Shop	64.833	1
2. Electronics Shop	47.567	0
3. K500 RF Balcony	169.667	1
4. Main Control Console	55.067	0
5. Data Users' Area	158.733	0
6. Welding Shop	95.767	2
7. K800 RF Balcony	74.417	0
8. ECR	165.467	0

Hours monitored (unprotected) = 591.634
Hours monitored (protected) = 239.884

TOTAL = 831.518

EVENTS = 4

Mean time between events (hours/event) = 147.909 hours

≈ 6.1 days