ACTION PLAN # 1A, 1B

TITLE: Auxillary Feed Pumps Overspeed Trips

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TITLE: AUXILIARY FEED PUMPS OVERSPEED TRIPS

REPORT BY: Dan Wilczynski, Chuck Rupp   Plan No.: 1A and 1B

DATE PREPARED: 6/24/85

This report has been prepared in accordance with the "Guidelines to Follow When Troubleshooting or Performing Investigative Actions into the Root Causes Surrounding the June 9, 1985, Reactor Trip," Rev. 4. These guidelines were developed in response to Confirmatory Action Letter 85-05.

I. INTRODUCTION

On Sunday, June 9, 1985, normal feedwater flow to the steam generators was interrupted. The reactor was automatically shutdown and reactor heat was removed via steaming through the main steam safeties and the atmospheric vent valves. The water level in the steam generators was decreasing and at 1:41:03 a Steam and Feedwater Rupture Control System (SFRCS) full trip was initiated on Channel 1 due to a low water level in Steam Generator #1 (SG #1). This SFRCS actuation attempted to initiate auxiliary feedwater flow by opening the steam supply valve, MS 106, from SG #1 to auxiliary feedwater pump turbine (AFPT) #1. Five seconds after the initial SFRCS (1:41:08) the reactor operator inadvertently initiated an SFRCS low pressure trip on both channels and both steam generators. This low pressure trip of SFRCS is intended to respond to a steam line break or other equipment failure resulting in depressurizing a steam generator. The manual low pressure SFRCS trip initiated the following, as designed:

1. Sent a close signal to MS 106 (which was partially open at the time) and MS 107 (which was closed at the time).

2. Sent a close signal to AF 608 and AF 599, containment isolation valves on auxiliary feedwater path to steam generator #1 and #2, respectively.

3. Sent an open signal to MS 106A (steam supply for AFPT #1 from steam generator #2) and MS 107A (steam supply for AFPT #2 from steam generator #1) in an attempt to operate both AFPTs on opposite SGs.

4. Sent an open signal to auxiliary feed pump discharge valves AF 3869 and AF 3871.

5. Sent a close signal to auxiliary feed pump discharge valves AF 3870 and AF 3872.

Each AFPT tripped on overspeed (4500 RPM) approximately 25 seconds after initial roll.

This report documents the review of data from previous unit trips, the 6/9/85 trip, AFPT testing, and other utility overspeed trips to determine possible causes of the overspeed trips which occurred at Davis-Besse on 6/9/85. Based on this review, this report presents hypothesized causes of the observed overspeed.

Based on review of currently available information, we conclude that the most likely hypothesis of those considered is introduction of water slugs into the AFPTs causing overspeed. Based on discussions with Terry Turbine, water slugs flash as they pass through the turbine inlet nozzles resulting in acceleration of the turbine rotor. (It appears that introduction of excessive amounts of water may slow down the turbine.)

Although introduction of water slugs is judged to be the major cause of the observed overspeed, other factors may have contributed and will be further investigated. These other factors include:

1) AFPT governor problems
2) "Double start" due to switchover of steam supply for AFPT #1.
3) Pump discharge flow was through the minimum recirculation path only.

II. <u>SUMMARY OF DATA</u>

In order to determine possible causes of the overspeed trips on 6/9/85, the following data were collected and analyzed. A summary of the analysis for the 6/9/85 plant trip and several previous trips is provided.

For each plant trip and surveillance test, the specific sequence of events was reviewed with particular attention to the following parameters.

- AFPT speed vs. time
- AFP flow and discharge pressure
- Steam generator pressure and level
- Specific valve line-ups

Figure 1 and Attachment 1 provide a summary of pertinent steam and feedwater system features associated with the AFPTs (for reference).

A. <u>June 9, 1985 Plant Trip Summary</u>

During the June 9, 1985 trip transient, the following sequence of events regarding auxiliary feedwater flow initiation occurred:

- Steam flow was initially provided to AFPT #1 via the normal path through MS 106 and turbine speed began increasing. This was initiated by a steam generator low level trip in the SFRCS at 1:41:03. Steam flow to AFPT #2 was not immediately initiated since a low level condition did not exist in SG #2 at this time.

- As a result of an operator initiated low steam header pressure SFRCS trip (1:41:08), the steam supply to AFPT #1 was switched to SG #2 through MS 106A. The SFRCS also initiated steam flow through the MS 107A flow path from SG #1 to AFPT #2.

- The low pressure SFRCS trip resulted in switching the discharge path from the auxiliary feedwater pumps (AF 3870 closed, and AF 3869 and 3871 opened) and AF 599 and AF 608 were closed. The net result of these actions was to isolate the feedwater discharge path of both auxiliary feedwater pumps leaving only the minimum recirculation path available.

The speed characteristics are shown on Figures 2 and 3 of Attachment 2. A review of the speed vs. time characteristics for AFPT #1 shows the typical characteristics of several oscillations prior to reaching rated speed but the final oscillation was uncontrolled and increased turbine speed to the overspeed trip setpoint.

A review of the speed characteristics for AFPT #2 shows an uncharacteristic leveling off at approximately 2500 RPM for about eight (8) seconds from which point turbine speed quickly increases to above 4100 RPM, decreases slightly and then continues to increase to the overspeed trip setpoint. The pause at 2500 RPM could be due to excessive water induction into the turbine.

B. Past Plant Trips and Surveillance/Testing Data

Based on our evaluation of previous plant trips and surveillance testing, we have the following observations:

1) The AFPT speed vs. time characteristic is relatively uniform for each trip (See Attachment 2).

2) The specific steam supply and feedwater flowpath configuration encountered during the 6/9/85 trip transient has not previously been duplicated.

3) No previous testing had been performed to simulate a "quick start" using only the cross connects (MS 106A and MS 107A) for steam supply to the AFPTs.

The similarities and differences for each of the previous trips and tests compared to the 6/9/85 event are described below with particular attention to the hypothesis judged most likely to have caused the overspeed condition.

1. March 2, 1984 Plant Trip

A review of the trip data indicates that a SFRCS low pressure trip was initiated during the event due to a stuck open Main Steam Safety Valve. This SFRCS initiation closed

the steam supply valve (MS 107) from SG #2 to AFPT #2 and opened the cross connect valve MS 107A to supply steam to AFPT #2 from SG #1. This switch of steam supply occurred 21 seconds (12:37:55) after both AFPTs had been started via MS 106 and MS 107. A review of the speed vs. time characteristics (see Figures 4 and 5 of Attachment 2), show that AFPT #2 experienced a decrease of approximately 1000 RPM at sixteen (16) seconds after the SFRCS low pressure trip. This speed decrease may be attributed to excessive water being picked up from the MS 107A line and being carried to the turbine.

The following differences between the 3/2/84 event and the 6/9/85 event assist in explaining why the AFPTs reached the overspeed trip setpoint on 6/9/85 but not on 3/2/84.

- On 3/2/84, since MS 107 was open and heating the line, opening MS 107A introduced only 250' of cold piping, thereby reducing the amount of water introduced to the turbine.

- On 3/2/84, additional water may have been introduced by opening MS 107A because the steam lines were not drained periodically at this time.

- On 3/2/84, since AFPT #2 was pumping approximately 1000 GPM, if a slug of water occurred from opening of MS 107A, there would have been more resistance to a speed increase as compared to the 6/9/85 event when only a min-recirc flow path was available.

- On 3/2/84, both AFPTs had the Woodward PG-PL governors installed.

2. <u>January 15, 1985 Plant Trip</u>

This event initiated a SFRCS trip on low SG level which, due to valve control changes made during the 1984 refueling outage, opened all four steam supply valves to the AFPTs. Also, AFPT #2 had the new PGG governor installed during the 1984 refueling outage. The speed characteristics are shown on Figures 6 and 7 of Attachment 2.

The following differences between the 1/15/85 event and the 6/9/85 event assist in explaining why both turbines tripped on overspeed on 6/9/85 but not on 1/15/85.

- On 1/15/85, due to the pipe configuration, initial steam flow to both turbines would have been via the normal flow paths, MS 106 and MS 107. Therefore, initial heating of the respective lengths (360' and 125') may have occurred prior to steam flow through the cross connects resulting in less total mass of

water introduced to the AFPTs than postulated for the 6/9/85 event.

- On 1/15/85, both pumps had a flow path other than minimum recirculation available, therefore, speed increases would be accompanied by corresponding flow increases, thus maintaining loading on the pump. This flow path was not available on 6/9/85.

3. <u>March 21, 1985 Plant Trip</u>

This event initiated a SFRCS trip on low SG level that resulted in all four steam supply valves opening at the same time.

The speed characteristics are shown on Figures 8 and 9 of Attachment 2. A review of the speed characteristics for AFPT #1 show the typical characteristics consistently seen on AFPT #1 (i.e., several oscillations prior to reaching rated speed).

The following differences between the 3/21/85 event and the 6/9/85 event assist in explaining why both turbines tripped on overspeed on 6/9/85 but not on 3/21/85.

- On 3/21/85, due to pipe configuration, initial steam flow to both turbines would have been via the normal flow path, MS 106 and MS 107. Therefore, initial heating of the respective lengths (360' and 125') would have been done prior to steam flow through the cross connects resulting in less total mass of water introduced to the AFPTs than is postulated to have formed during the 6/9/85 event.

- On 3/21/85, both pumps had a flow path available other than the minimum recirculation, therefore, any speed increase would be accompanied by a corresponding flow increase, thus maintaining loading on the pump. This flow path was not available on 6/9/85.

A review of the speed vs. time characteristics show that AFPT #2 indicates a constant rate of acceleration until approximately 35 seconds after initial roll at which time there was an 800 RPM decrease in 2 seconds followed by an 1800 RPM increase in 3 seconds. This oscillation may be due to slugs of water.

4. <u>April 12, 1985 Testing</u>

After the change-out of the speed setting bushing from a 30 second rated bushing to a 15 second rated bushing on AFPT #2 governor, two quick start tests were performed to verify operability. This changeout was performed to ensure flow was provided by AFPT #2 within 40 seconds as required by

Technical Specifications. These tests were run on the normal steam supply path via MS 107 and with the pump discharge valves closed (i.e., min-recirc path open). Less than 24 hours prior to these two (2) tests some additional testing was done on this same turbine using the same valve line-ups. This prior testing was performed for trouble-shooting. Due to the prior testing, the steam lines may not have been cooled to ambient conditions prior to the two (2) operability tests being run. The speed characteristics are shown in Figures 10 and 11 of Attachment 2.

A review of the speed vs. time characteristics shows that the first run exhibited speed increases which appear to be a series of step changes rather than a constant acceleration to rated speed. The second run (performed immediately after the first) shows a constant rate of acceleration to rated speed. This is attributed to the fact that the steam lines were already heated, therefore, there would have been less condensation.

5. June 2, 1985 Plant Trip

This event initiated a SFRCS actuation on low SG level. Both AFPTs were supplied steam from their respective steam generators via MS 106 and MS 107.

The speed characteristics are shown on Figures 12 and 13 of Attachment 2. A review of the speed characteristics for AFPT #1 shows the typical characteristics consistently seen on AFPT #1 (i.e., several oscillations prior to reaching rated speed).

A review of the speed vs. time characteristics for AFPT #2 shows a fairly steady increase to rated speed but the speed continues past the high speed setpoint (3710 RPM) to approximately 4000 RPM for about three (3) seconds. The turbine then decreased speed and controlled at the high speed setpoint. During the initial increase to rated speed, the speed increases are seen as step changes rather than a straight line. These step changes, and the increase to approximately 4000 RPM, may be attributable to water slugs.

The following differences between the 6/2/85 event and the 6/9/85 event assist in explaining why both AFPTs reached the overspeed trip setpoint on 6/9/85 but not on 6/2/85.

- Both AFPTs were running on the normal steam supply paths via MS 106 and MS 107, therefore, there could be less condensation reaching the turbines.

- Both pumps had a discharge path available other than the minimum recirculation path, therefore, any speed increase would be accompanied by a corresponding flow increase, thus maintaining loading on the pump. This flow path was not available on 6/9/85.

6. June 9, 1985 Testing (Post Trip)

After the plant trip, a quick start test was performed on each of the AFPTs. These tests were run on the normal supply paths via MS 106 and MS 107. Both pumps discharge valves were closed such that only minimum recirculation flow was provided. These tests were run approximately ten (10) hours after the AFPTs had been shut down, therefore, the lines were still warm and the amount of condensation would be less than expected for ambient temperature lines.

The speed characteristics are shown on Figures 14 and 15 of Attachment 2. A review of each speed vs. time characteristic shows a constant acceleration to rated speed. AFPT #1 does not exhibit oscillations seen at other times. The "smoothness" of these graphs may be attributable to the fact that minimal condensation would be expected since the lines were already heated.

C. Modifications

1. During the 1984 refueling outage, the #2 AFPT governor was changed out from a Woodward PG-PL governor to a Woodward PGG governor. The new governor was supplied with 7 lb/in buffer springs and a 30 second speed setting bushing. Prior to startup from the 1984 refueling outage, the 7 lb/in buffer springs were changed to 26 lb/in buffer springs by a Woodward Governor representative. The speed setting bushing was changed from a 30 second bushing to a 15 second bushing on 4/12/85 to ensure that AFPT #2 could reach rated speed and deliver flow to the steam generators in less than 40 seconds as required by Technical Specifications.

2. During the 1984 refueling outage, the control logic for the steam supply valves to the AFPTs was changed to allow all four valves (MS 106, 106A, 107 and 107A) to open simultaneously. After the 3/21/85 plant trip, the change was revised so that MS 106A and MS 107A would open only on a SFRCS low pressure trip. This revision was made based on the hanger damage found prior to the 3/21/85 trip. This was considered a prudent action, the hanger damage was potentially attributable to water slugs.

D. Maintenance History

The maintenance work done excluding oil replacement since the 1984 refueling outage for AFPT 1-1 is as follows:

1. Replacement of governor control motor (6-2-85), MWO# 1-85-1876-03.

   NOTE: Investigations are currently underway to determine cause of motor failure.

2. Adjustment of governor slip clutch (6-2-85), MWO# 1-85-1878-00.

3. Replacement of low speed stop roll pin (6-2-85), MWO# 1-85-1878-01.

The maintenance work done excluding oil replacement since the 1984 refueling outage for AFPT 1-2 is as follows:

1. Changeout of speed setting bushing (4-12-85), MWO# 2-83-0136-11 (See Modification Item C.1. above).

A review of these maintenance records does not reveal any evidence that could support the overspeed trips of 6/9/85.

E. Investigation of Overspeed Trip Problems at Other Utilities

Various resources have been used to determine if other utilities have experienced overspeed trips of the AFPTs.

NPRDS had only one overspeed trip reported. This occurrence was the result of the failure of a Woodward Governor ramp generator. A ramp generator is not incorporated in the design of either the PG-PL or PGG governor.

"Nuclear Power Experience" reported a total of 10 overspeed trips which are summarized below:

1. Four (4) AFPT overspeeds were reported due to condensation in the line.

2. One (1) overspeed was reported due to a "double start" (i.e., interruption and re-introduction of steam supply when the turbine is already rolling).

3. One (1) loss of suction overspeed was reported (i.e., pump loses suction pressure which effectively reduces pump loading).

4. Four (4) overspeed trips due to governor problems as listed below:

- Low oil level in governor
- Mechanical misadjustments
- Failed speed sensor (applicable to electronic EG governor only)
- Apparent governor valve sticking

The final source of information was the Nuclear Network System. One (1) response was received which indicated the possibility of turbine overspeed due to water in the steam lines.

III. CHANGE ANALYSIS

The differences associated with the 6/9/85 trip compared to previous trips and actuations are listed below (conditions listed below existed only on 6/9/85 trip).

1. Both auxiliary feedwater containment isolation valves (AF 599 and 608) were closed when overspeed occurred. Pump flow was limited to the min-recirc flow.

2. Both AFPTs were running solely on the cross connect steam supply valves (MS 106A and 107A) at the time of the overspeed trips.

3. AFP #1 was started on steam from MS 106 but then was switched to steam from MS 106A.

These differences are discussed in more detail in Section II, Summary of Data.

IV. HYPOTHESIZED CAUSES OF OVERSPEED

From the above data and from discussions with the turbine vendor, Terry Turbine (Ken Wheeler); MPR Associates Inc. (Phil Hildebrandt, Bob Fink, and Tim Clarke); the following list of possible causes of overspeed was developed.

A. Water slugs in steam piping to the turbine due to residual condensation or rapid condensation of steam while heating long, cold steam supply path to AFPTs

This hypothesis is judged to be a viable description of the cause of the observed AFPT overspeed trips. Terry Turbine indicates that the introduction of water slugs which flash through the nozzles may result in an overspeed condition.

The piping between the steam isolation valves (MS 106, 106A, 107, 107A) and the AFPTs is at a temperature near ambient conditions. When the isolation valves are opened, steam at about 500° to 550°F is introduced.

Steam will be condensed in these lines during initial steam introduction and line heating. Preliminary calculations indicate that several hundred pounds of water may be formed in these lines. This condensate is expected to form water slugs, parti-

cularly in the long, approximately horizontal crossover lines downstream of MS 106A or MS 107A.

It is noted that damage to pipe hanger supports on these lines has been experienced previously, apparently due to transient operational loads. Steam flow loads would not be expected to result in hanger damage. Water slug formation or water hammer may produce these loads. (Investigation of the pipe hanger support problem was in process prior to the 6/9/85 event.)

The design for the AFPTs is a single stage turbine configured similar to a bucket type "water wheel". This design is considered susceptible to increased speed excursions when water slugs are introduced. Analyses are currently being performed to confirm this hypothesis.

B. <u>AFPT 1-1 rolling on steam from MS 106 prior to receiving steam flow from crossover ("Double Start")</u>

This mechanism may be a contributor to the overspeed trip on AFPT #1, however, it is not considered likely. Discussions with Terry Turbine, as well as another utility, indicate that if the turbine is rolling, and steam flow is stopped and restarted, the turbine may overspeed. This is because the speed setting bushing (the internal piece that controls the acceleration to rated speed) is ineffective due to the prior rotation of the turbine which has increased the governor oil pressure to its operating pressure. Since the governor oil pressure is established and controlling, loss or reduction in steam flow results in the governor valve opening in an attempt to increase steam flow. When full steam pressure and flow is reestablished, the governor valve is open further than necessary and cannot close quickly enough, resulting in an overspeed condition.

This sequence may have occurred for AFPT #1 as a result of initial roll of the turbine on steam from MS 106 followed by closure of MS 106 coincident with opening of MS 106A. However, examination of the trip event sequence suggests that steam flow would not have been interrupted during switchover from MS 106 to MS 106A as the steam source.

Although considered unlikely, this hypothesis will be tested.

C. <u>Sudden decrease in pump load due to sudden flow reduction when discharge flow is abruptly stopped at the closed valves AF 599 and 608</u>

This hypothesis, although viable, is judged unlikely to have caused an overspeed trip because discharge piping is assured to be full at all times thereby causing the pumps to operate at min-recirc conditions until the discharge valves are open.

It is noted that pump operation on min-recirc only may be a contributing factor to the overspeed because of the decreased pump load.

D. Governor problems (low oil level, improper settings, etc.), including governor valve and linkage

AFPT #1 has the previously used Woodward PG-PL governor which has experienced speed control oscillation problems, AFPT #2 has the new Woodward type PGG governor design which was installed during the 1984 refueling outage which has not indicated any oscillation problems.

Neither governor apparently could respond to prevent the cause of the turbine overspeed. However, it is not considered that failure or malfunction of the governors was the cause based on the following:

1. The speed vs. time characteristics for the trip indicate that the governors were controlling speed as designed during the initial turbine acceleration.

2. Post trip testing shows proper operation of both governors.

3. The governor on AFP #1 is a PG-PL model with external Bodine motor for remote speed setting, while the AFPT #2 has a new PGG model with an internal motor for remote speed setting. It is considered unlikely that both of these governors would fail at the same time in a manner capable of causing an overspeed trip on the turbines.

4. The governor valve was free to move during the trip as evidenced by the initial decrease in speed after both AFPTs began to roll.

Prior to installation, an engineering evaluation was performed on the PGG governor, which concluded that this governor should be functionally similar to the PG-PL governor. However, since we have limited experience with the PGG governor (installed during 1984 refueling outage), we plan to further evaluate whether problems with this governor could have contributed to the overspeed.

E. Loss of pump suction source, resulting in no pump load

This is not considered a viable hypothesis, since the control room alarm printer shows no evidence of low pump suction pressure prior to the overspeed. Also, the 1 psig pressure switch on the pump suctions did not close the steam supply valves. Further, there was no decrease in discharge pressure as would be expected if the suction pressure were lost.

DVW:CER:lrh

ATTACHMENT 1

Steam Supply Piping Layout to AFPTs

Figure 1 presents a schematic representation of the steam supply piping to the Auxiliary Feed Pump Turbines.

The piping configuration downstream of the 4 steam supply isolation valves are described in more detail below.

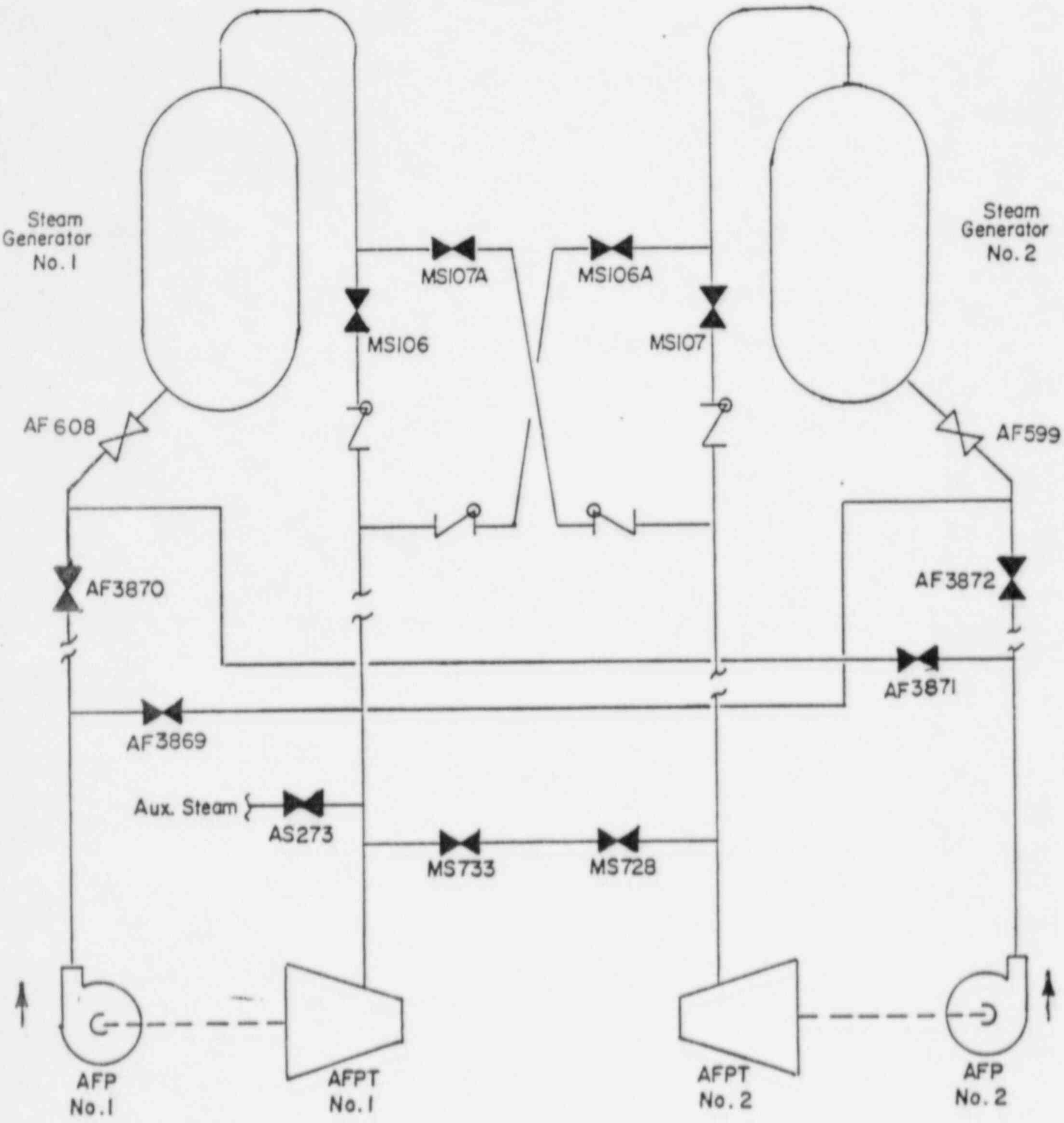
1. MS 106 (SG #1 feed to AFPT #1) - The pipe length of this run is approximately 360 feet. Immediately downstream of MS 106 is a downhill run. The length of the pipe run has several vertical drops interrupted by horizontal runs. Total vertical drop is from elevation 623' to elevation 565'. Any condensation is expected to become entrapped in the steam flow or be carried as small slugs.

2. MS 106A (SG #2 feed to AFPT #1) - The pipe length of this run is approximately 650 feet. Immediately downstream of MS 106A is a 290 foot length of essentially horizontal pipe. After the steam/water has traversed the initial length of pipe, it ties into the length of pipe described in item 1 above, which is immediately downstream of MS 106. The 280 foot length of horizontal pipe could allow large water slugs to form prior to entering the downhill run.

3. MS 107 (SG #2 feed to AFPT #2) - The pipe length of this run is approximately 125 feet. Immediately downstream of MS 107 is a downhill run. The total length of the pipe run has an almost continual downhill flow (i.e., very few long lengths of horizontal pipe) dropping from elevation 623' to elevation 565'. Any condensation is expected to become entrapped in the steam flow or be carried as small slugs.

4. MS 107A (SG #1 feed to AFPT #2) - The pipe length of this run is approximately 375 feet. Immediately downstream of MS 107A is a 250 foot length of essentially horizontal pipe except for a 7 foot rise near the end of the run. After the rise is a short horizontal run and then the steam supply line has a 14 foot drop and is tied to the steam supply pipe described in item 3 above, immediately downstream of MS 107. The rise, after a long horizontal run, will enable water slugs to form at the bottom of the rise and be carried downstream after filling the pipe.

Figure 1



SCHEMATIC REPRESENTATION OF
AUXILIARY FEED PUMP TURBINE STEAM PIPING SYSTEM

AUX FEED PUMP 1-1 SPEED DATA
JUNE 9, 1985 - TRIP

DATA POINT	TIME	AFP 1-1 SPEED (S008)
1	01:41:06	37.9
2	01:41:07	435.9
3	01:41:08	807.1
4	01:41:09	948.7
5	01:41:10	1415.1
6	01:41:11	1793.7
7	01:41:12	2240.5
8	01:41:13	2472.5
9	01:41:14	1703.3
10	01:41:15	NO DATA
11	01:41:16	1793.7
12	01:41:17	2675.2
13	01:41:18	3290.6
14	01:41:19	2211.2
15	01:41:20	3471.3
16	01:41:21	2404.2
17	01:41:22	3801.0
18	01:41:23	4352.9
19	01:41:24	4616.6
20	01:41:25	3315.0
21	01:41:26	1915.8
22	01:41:27	1322.3
23	01:41:28	1024.4

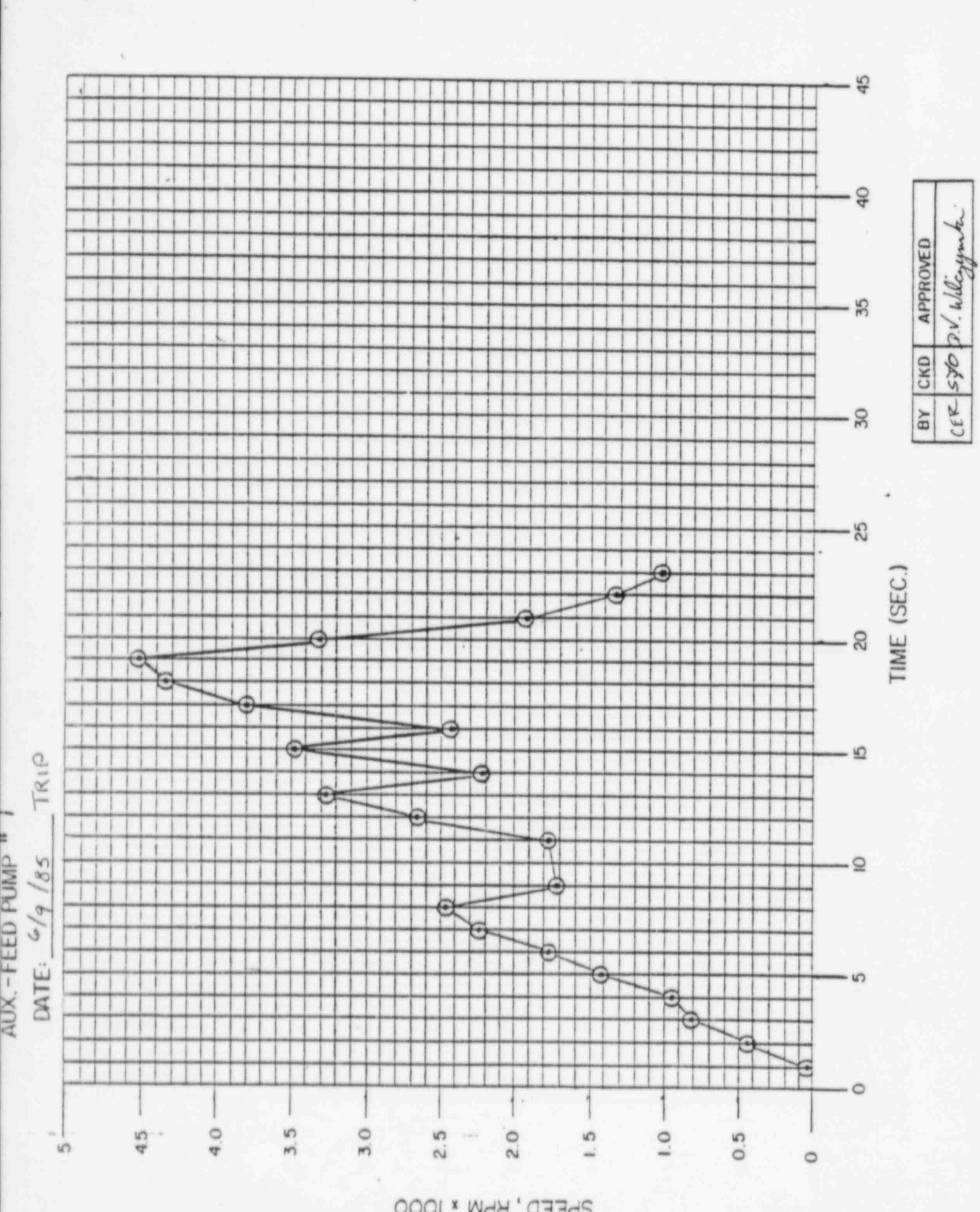

AUX.-FEED PUMP # 1
DATE: 6/9/85 TRIP
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
BY
CKD
APPROVED

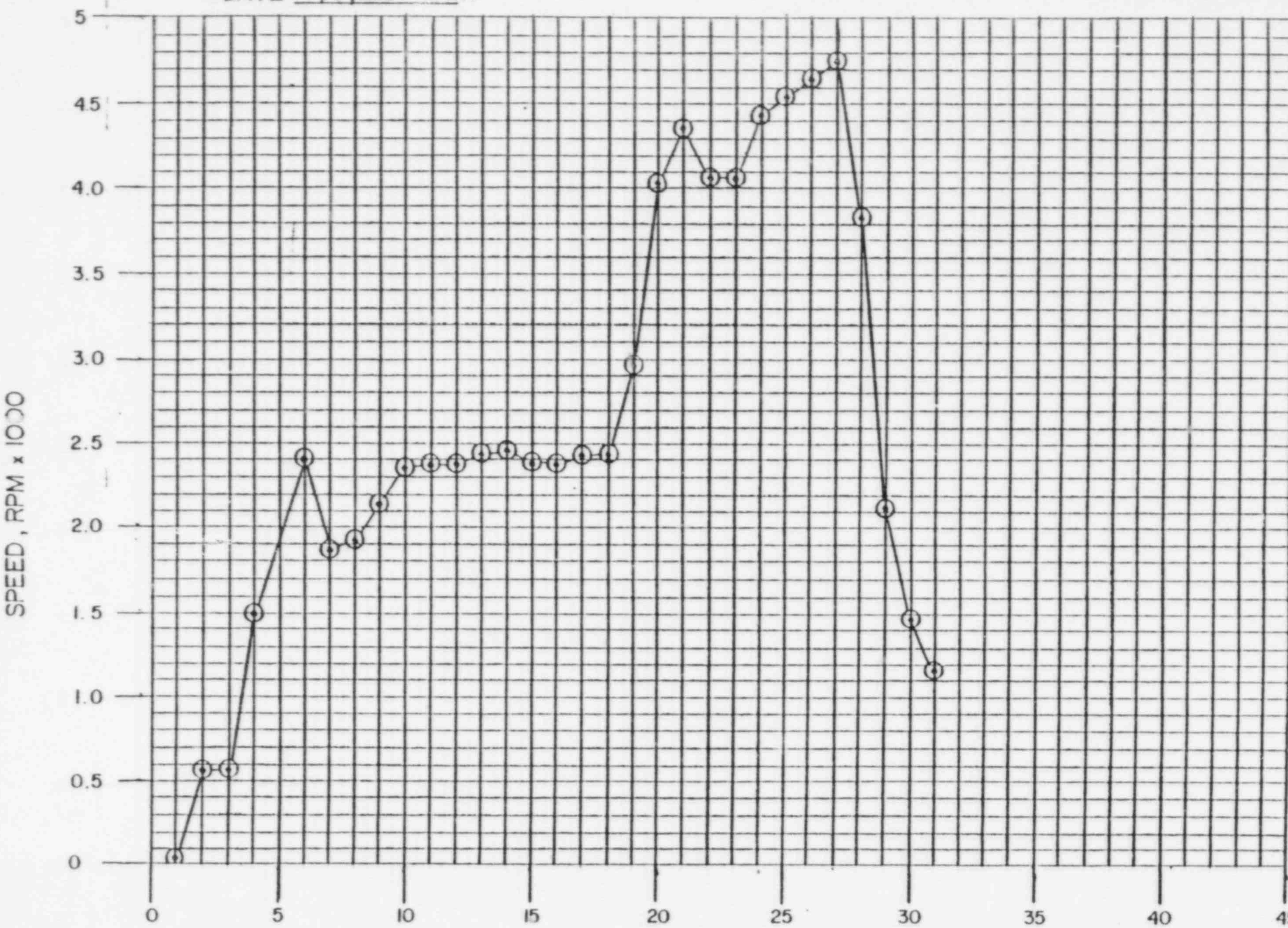
Figure 2

AUX FEED PUMP 1-2 SPEED DATA
JUNE 9, 1985 - TRIP

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	01:41:11	35.4
2	01:41:12	565.3
3	01:41:13	570.2
4	01:41:14	1500.6
5	01:41:15	NO DATA
6	01:41:16	2399.3
7	01:41:17	1766.8
8	01:41:18	1923.1
9	01:41:19	2152.6
10	01:41:20	2355.3
11	01:41:21	2389.5
12	01:41:22	2391.9
13	01:41:23	2438.3
14	01:41:24	2460.3
15	01:41:25	2396.8
16	01:41:26	2379.7
17	01:41:27	2428.6
18	01:41:28	2433.5
19	01:41:29	2987.8
20	01:41:30	4118.4
21	01:41:31	4362.6
22	01:41:32	4172.2
23	01:41:33	4162.4
24	01:41:34	4418.8
25	01:41:35	4540.9
26	01:41:36	4655.7
27	01:41:37	4748.5
28	01:41:38	3820.5
29	01:41:39	2120.9
30	01:41:40	1476.2
31	01:41:41	1175.8

AUX.-FEED PUMP # 2

DATE: 6/9/85 TRIP



BY	CKD	APPROVED
CEZ	SJO	D.V. Wilczynski

Figure 3

AUX FEED PUMP 1-1 SPEED DATA
MARCH 2, 1984

DATA POINT	TIME	AFP 1-1 SPEED (S008)
1	12:37:39	18.3
2	12:37:40	40.3
3	12:37:41	330.9
4	12:37:42	1605.6
5	12:37:43	1310.1
6	12:37:44	NO DATA
7	12:37:45	NO DATA
8	12:37:46	787.5
9	12:37:47	768.0
10	12:37:48	1070.8
11	12:37:49	NO DATA
12	12:37:50	1549.4
13	12:37:51	1483.5
14	12:37:52	1459.1
15	12:37:53	1415.1
16	12:37:54	1400.5
17	12:37:55	1383.4
18	12:37:56	1381.0
19	12:37:57	1371.2
20	12:37:58	1373.6
21	12:37:59	1363.9
22	12:38:00	1359.0
23	12:38:01	NO DATA
24	12:38:02	NO DATA
25	12:38:03	2057.4
26	12:38:04	2318.7
27	12:38:05	2372.4
28	12:38:06	NO DATA
29	12:38:07	2636.1
30	12:38:08	2782.7
31	12:38:09	2929.2
32	12:38:10	NO DATA
33	12:38:11	3229.5
34	12:38:12	NO DATA
35	12:38:13	NO DATA
36	12:38:14	NO DATA
37	12:38:15	3612.9
38	12:38:16	3483.5
39	12:38:17	NO DATA
40	12:38:18	NO DATA
41	12:38:19	NO DATA
42	12:38:20	3564.1
43	12:38:21	3615.4
44	12:38:22	3649.6
45	12:38:23	3664.2

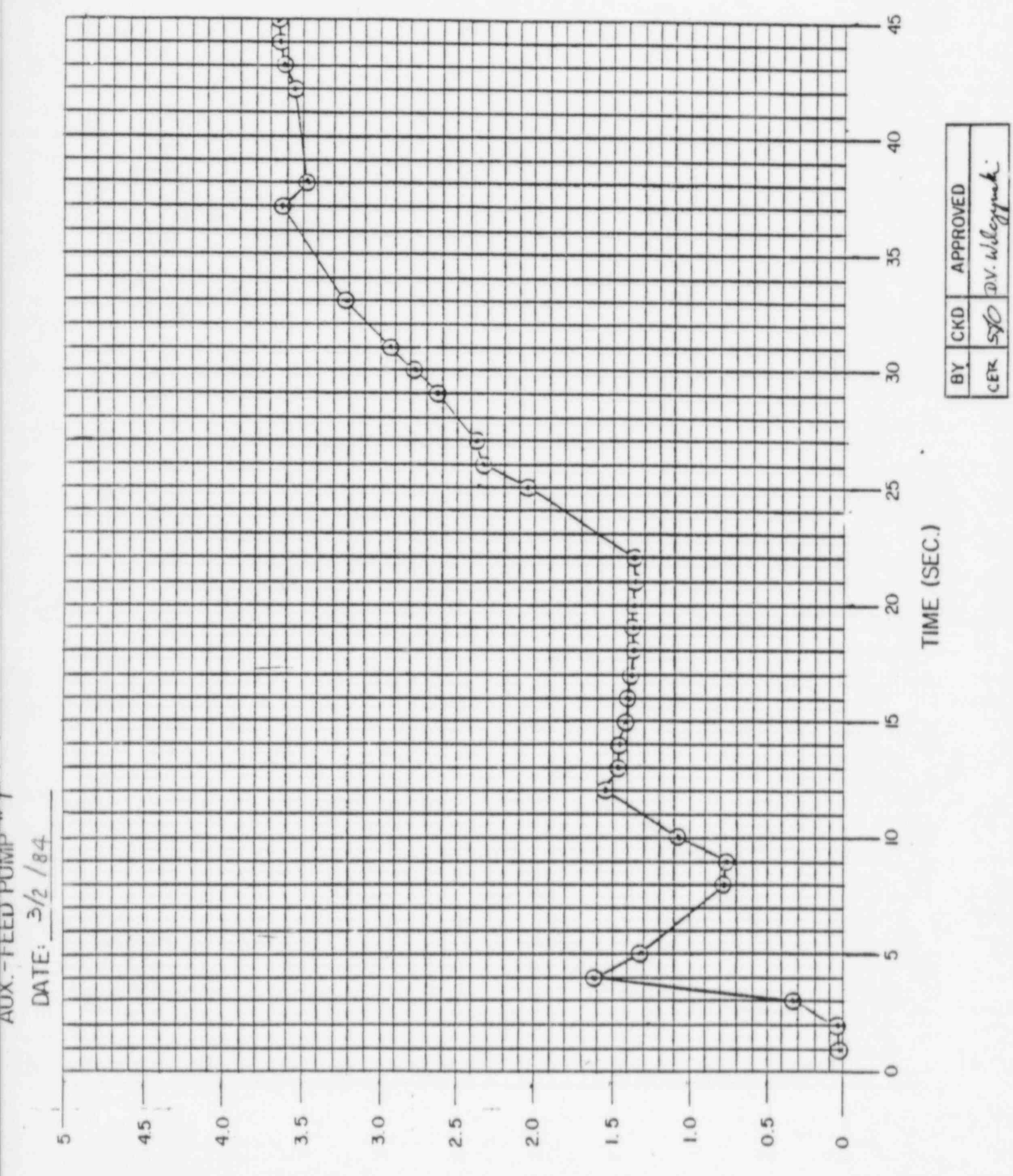

AUX.-FEED PUMP
DATE: 3/2/84
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
BY
CKD
APPROVED
CETR

Figure 4

AUX FEED PUMP 1-2 SPEED DATA
MARCH 2, 1984

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	12:37:39	23.2
2	12:37:40	25.6
3	12:37:41	155.1
4	12:37:42	431.0
5	12:37:43	1935.3
6	12:37:44	NO DATA
7	12:37:45	NO DATA
8	12:37:46	1363.9
9	12:37:47	1666.7
10	12:37:48	1947.5
11	12:37:49	NO DATA
12	12:37:50	2267.4
13	12:37:51	2443.2
14	12:37:52	2489.6
15	12:37:53	2584.9
16	12:37:54	2731.4
17	12:37:55	2853.5
18	12:37:56	2948.7
19	12:37:57	3041.5
20	12:37:58	3078.1
21	12:37:59	3207.6
22	12:38:00	3256.4
23	12:38:01	NO DATA
24	12:38:02	NO DATA
25	12:38:03	3334.6
26	12:38:04	3385.8
27	12:38:05	3407.8
28	12:38:06	NO DATA
29	12:38:07	3451.8
30	12:38:08	3424.9
31	12:38:09	3488.4
32	12:38:10	NO DATA
33	12:38:11	2304.0
34	12:38:12	NO DATA
35	12:38:13	NO DATA
36	12:38:14	NO DATA
37	12:38:15	3105.0
38	12:38:16	3078.1
39	12:38:17	NO DATA
40	12:38:18	NO DATA
41	12:38:19	NO DATA
42	12:38:20	3327.2
43	12:38:21	3368.7
44	12:38:22	3412.7
45	12:38:23	3495.7

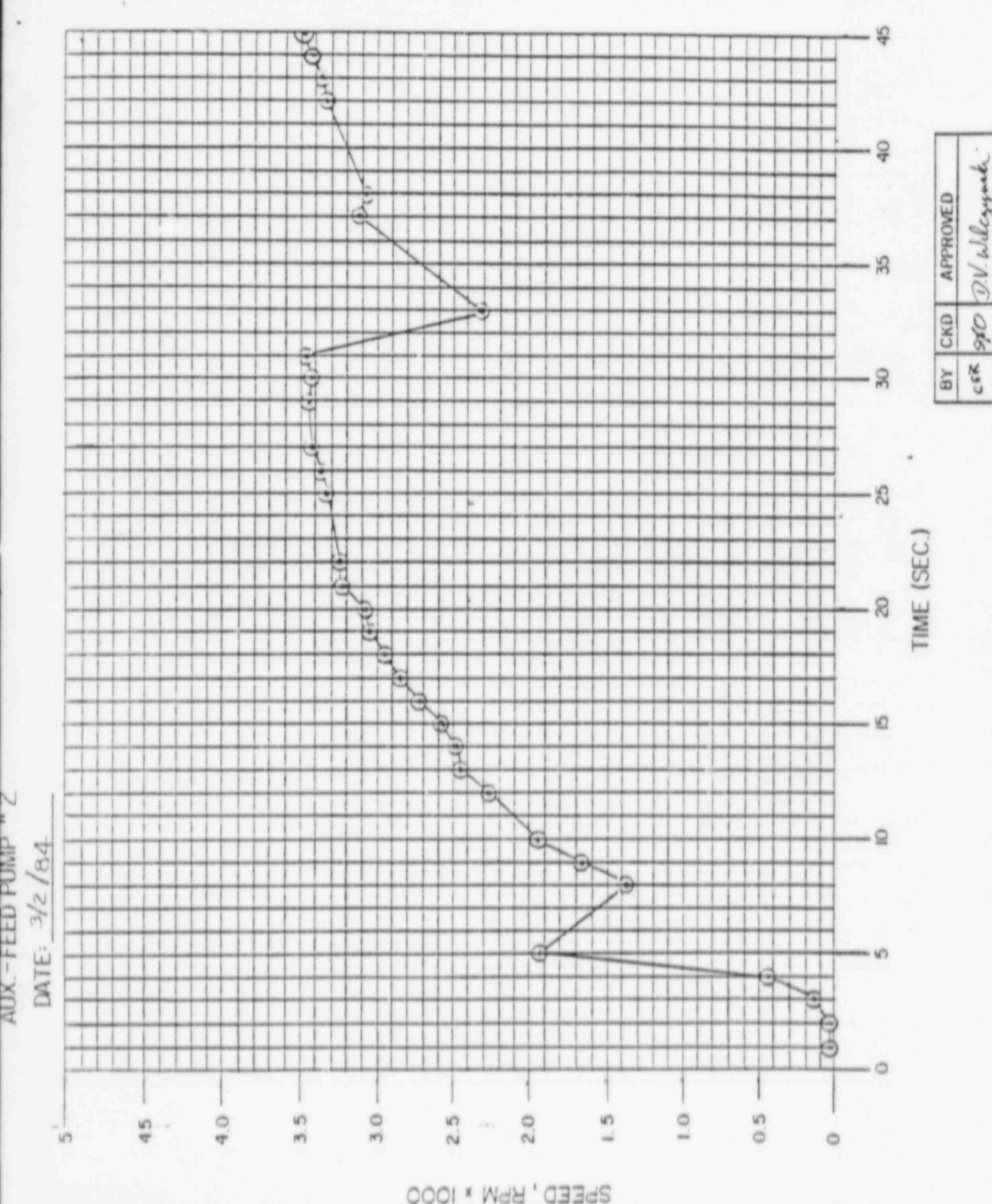

AUX.-FEED PUMP #2
DATE: 3/2/84
SPEED, RPM x 1000
TIME (SEC.)
BY
CKD
APPROVED

Figure 3

AUX FEED PUMP 1-1 SPEED DATA
JANUARY 15, 1985

DATA POINT	TIME	AFP 1-1 SPEED (S008)
1	12:28:35	20.8
2	12:28:36	494.5
3	12:28:37	777.8
4	12:28:38	1210.0
5	12:28:39	NO DATA
6	12:28:40	NO DATA
7	12:28:41	2243.0
8	12:28:42	1681.3
9	12:28:43	1373.6
10	12:28:44	1783.9
11	12:28:45	NO DATA
12	12:28:46	1915.8
13	12:28:47	3205.1
14	12:28:48	NO DATA
15	12:28:49	NO DATA
16	12:28:50	2785.1
17	12:28:51	2770.5
18	12:28:52	3407.9
19	12:28:53	NO DATA
20	12:28:54	3505.5
21	12:28:55	3527.5
22	12:28:56	3437.1
23	12:28:57	3498.2
24	12:28:58	3446.9
25	12:28:59	3615.4
26	12:29:00	NO DATA
27	12:29:01	3649.6
28	12:29:02	3595.8
29	12:29:03	3603.2
30	12:29:04	3615.4
31	12:29:05	3688.6
32	12:29:06	3813.2
33	12:29:07	3842.5

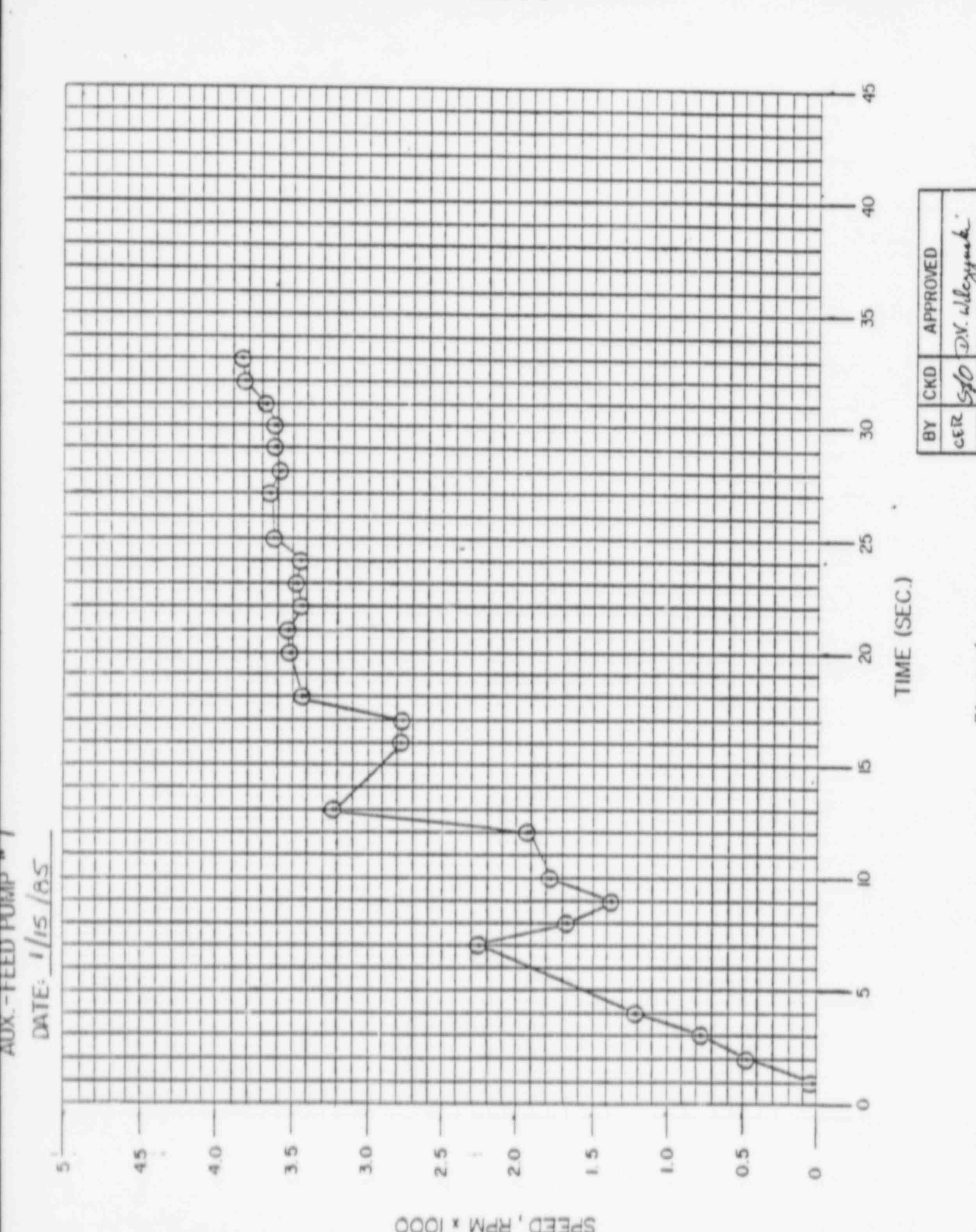

AUX.-FEED PUMP # 1
DATE: 1/15/85
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
45
5
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
BY
CKD
APPROVED
CER

Figure 6

AUX FEED PUMP 1-2 SPEED DATA
JANUARY 15, 1985

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	12:28:54	35.4
2	12:28:55	282.1
3	12:28:56	1197.8
4	12:28:57	2118.4
5	12:28:58	1473.7
6	12:28:59	1390.7
7	12:29:00	NO DATA
8	12:29:01	1593.4
9	12:29:02	1549.4
10	12:29:03	1527.3
11	12:29:04	1515.3
12	12:29:05	1490.8
13	12:29:06	1476.2
14	12:29:07	1466.4
15	12:29:08	1468.9
16	12:29:09	1468.9
17	12:29:10	1471.3
18	12:29:11	1517.7
19	12:29:12	3002.4
20	12:29:13	2992.7
21	12:29:14	3031.7
22	12:29:15	3024.4
23	12:29:16	2982.9
24	12:29:17	2997.6
25	12:29:18	3024.4
26	12:29:19	3026.9
27	12:29:20	3056.2
28	12:29:21	3085.5
29	12:29:22	3097.7
30	12:29:23	3109.9
31	12:29:24	3127.0
32	12:29:25	3139.2
33	12:29:26	3146.5
34	12:29:27	3158.7
35	12:29:28	3161.2
36	12:29:29	3175.8
37	12:29:30	3175.8
38	12:29:31	3180.7

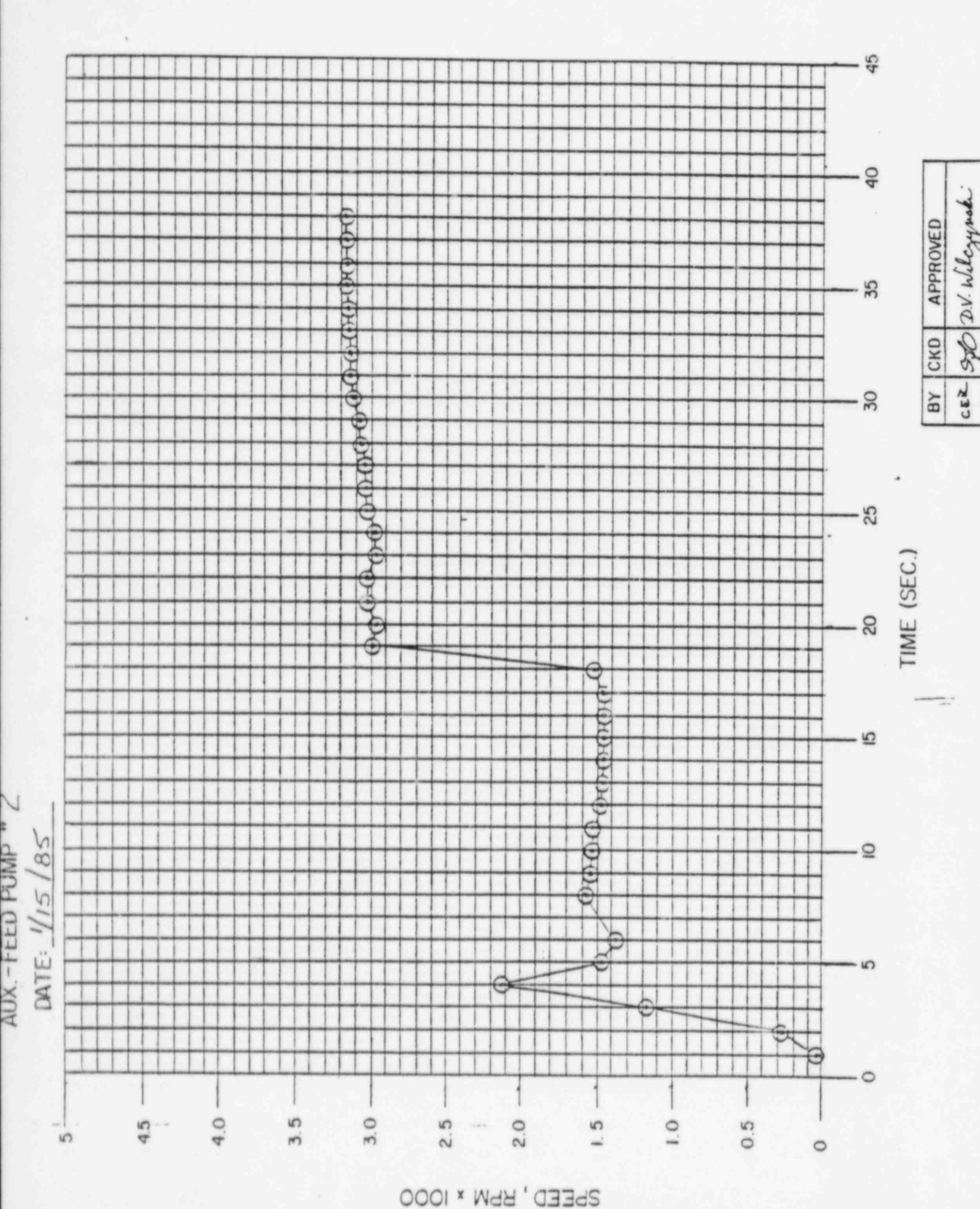

AUX.-FEED PUMP # 2
DATE: 1/15/85
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
BY
CKD
APPROVED
CEZ
D.V. Wilczynski

Figure 7

AUX FEED PUMP 1-1 SPEED DATA
MARCH 21, 1985

DATA POINT	TIME	AFP 1-1 SPEED (S008)
1	19:54:16	25.6
2	19:54:17	106.2
3	19:54:18	230.8
4	19:54:19	550.7
5	19:54:20	826.6
6	19:54:21	1207.6
7	19:54:22	1708.2
8	19:54:23	2733.8
9	19:54:24	2225.9
10	19:54:25	NO DATA
11	19:54:26	2321.1
12	19:54:27	2819.3
13	19:54:28	1979.2
14	19:54:29	3241.8
15	19:54:30	2328.4
16	19:54:31	3312.6
17	19:54:32	2536.0
18	19:54:33	3134.3
19	19:54:34	3222.2
20	19:54:35	3261.3
21	19:54:36	3319.9
22	19:54:37	3363.9
23	19:54:38	3381.0
24	19:54:39	3444.4
25	19:54:40	3490.8
26	19:54:41	3505.5
27	19:54:42	3520.1
28	19:54:43	3561.7
29	19:54:44	3495.7
30	19:54:45	3534.8
31	19:54:46	3527.5
32	19:54:47	3571.4
33	19:54:48	3556.8
34	19:54:49	NO DATA
35	19:54:50	3573.9
36	19:54:51	NO DATA
37	19:54:52	NO DATA
38	19:54:53	3547.0
39	19:54:54	3571.4
40	19:54:55	NO DATA
41	19:54:56	3551.9
42	19:54:57	3547.0
43	19:54:58	3561.7
44	19:54:59	3591.0
45	19:55:00	3571.4

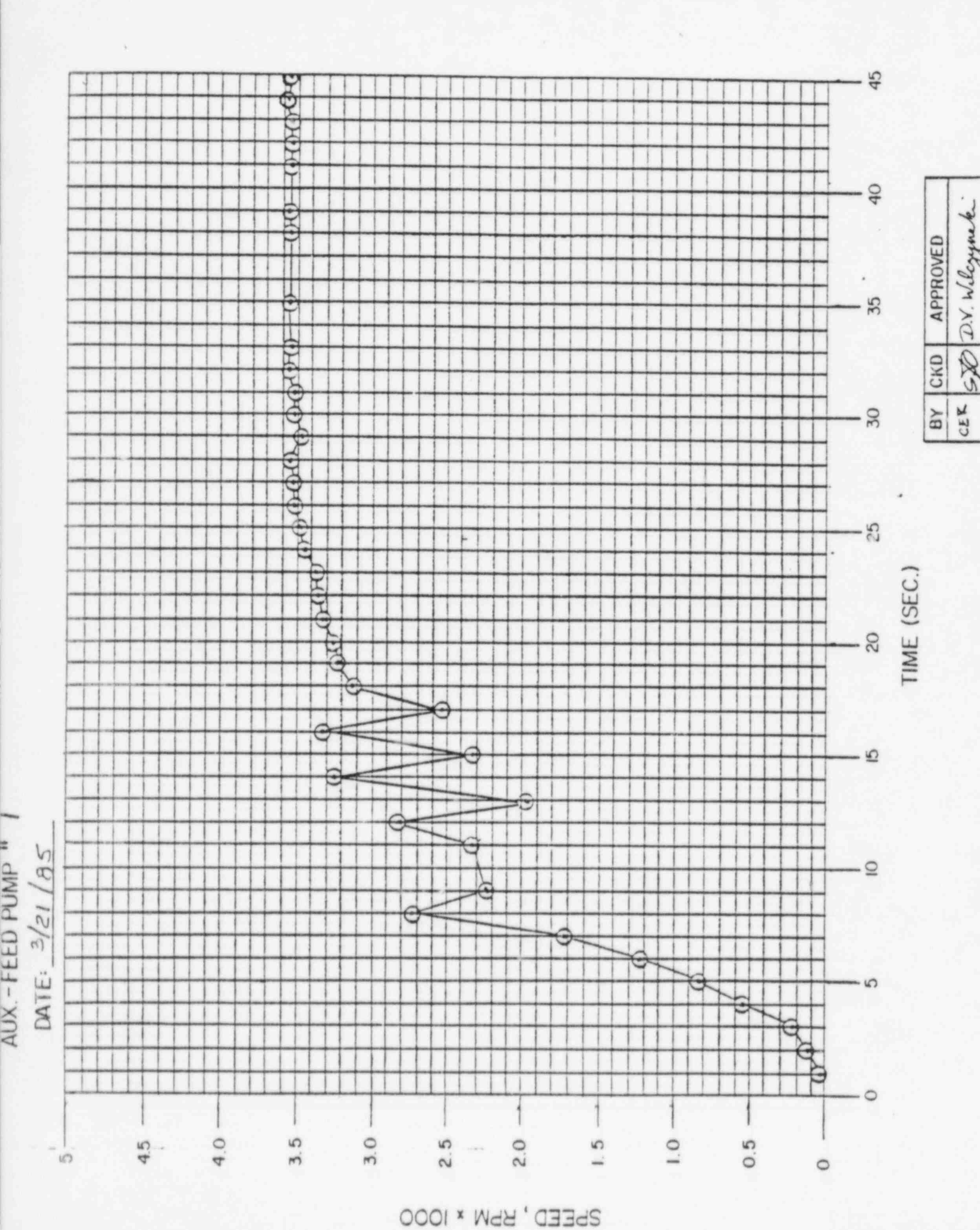

AUX.-FEED PUMP # 1
DATE: 3/21/85
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5
BY
CKD
APPROVED
CER
D.V. Wilczynski

Figure 8

AUX FEED PUMP 1-2 SPEED DATA
MARCH 21, 1985

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	19:54:15	28.1
2	19:54:16	616.6
3	19:54:17	1669.1
4	19:54:18	1520.1
5	19:54:19	1188.0
6	19:54:20	1422.5
7	19:54:21	1537.2
8	19:54:22	1466.4
9	19:54:23	1498.2
10	19:54:24	1520.1
11	19:54:25	NO DATA
12	19:54:26	1561.7
13	19:54:27	1564.1
14	19:54:28	1547.0
15	19:54:29	1566.5
16	19:54:30	1564.1
17	19:54:31	1608.1
18	19:54:32	1686.2
19	19:54:33	1776.6
20	19:54:34	1803.4
21	19:54:35	1874.2
22	19:54:36	1925.2
23	19:54:37	2035.4
24	19:54:38	2147.7
25	19:54:39	2216.1
26	19:54:40	2255.2
27	19:54:41	2272.3
28	19:54:42	2301.6
29	19:54:43	2438.3
30	19:54:44	2614.2
31	19:54:45	2421.2
32	19:54:46	2614.2
33	19:54:47	2604.4
34	19:54:48	2602.0
35	19:54:49	NO DATA
36	19:54:50	2235.7
37	19:54:51	NO DATA
38	19:54:52	NO DATA
39	19:54:53	1825.4
40	19:54:54	1803.4
41	19:54:55	NO DATA
42	19:54:56	3537.2
43	19:54:57	3647.1

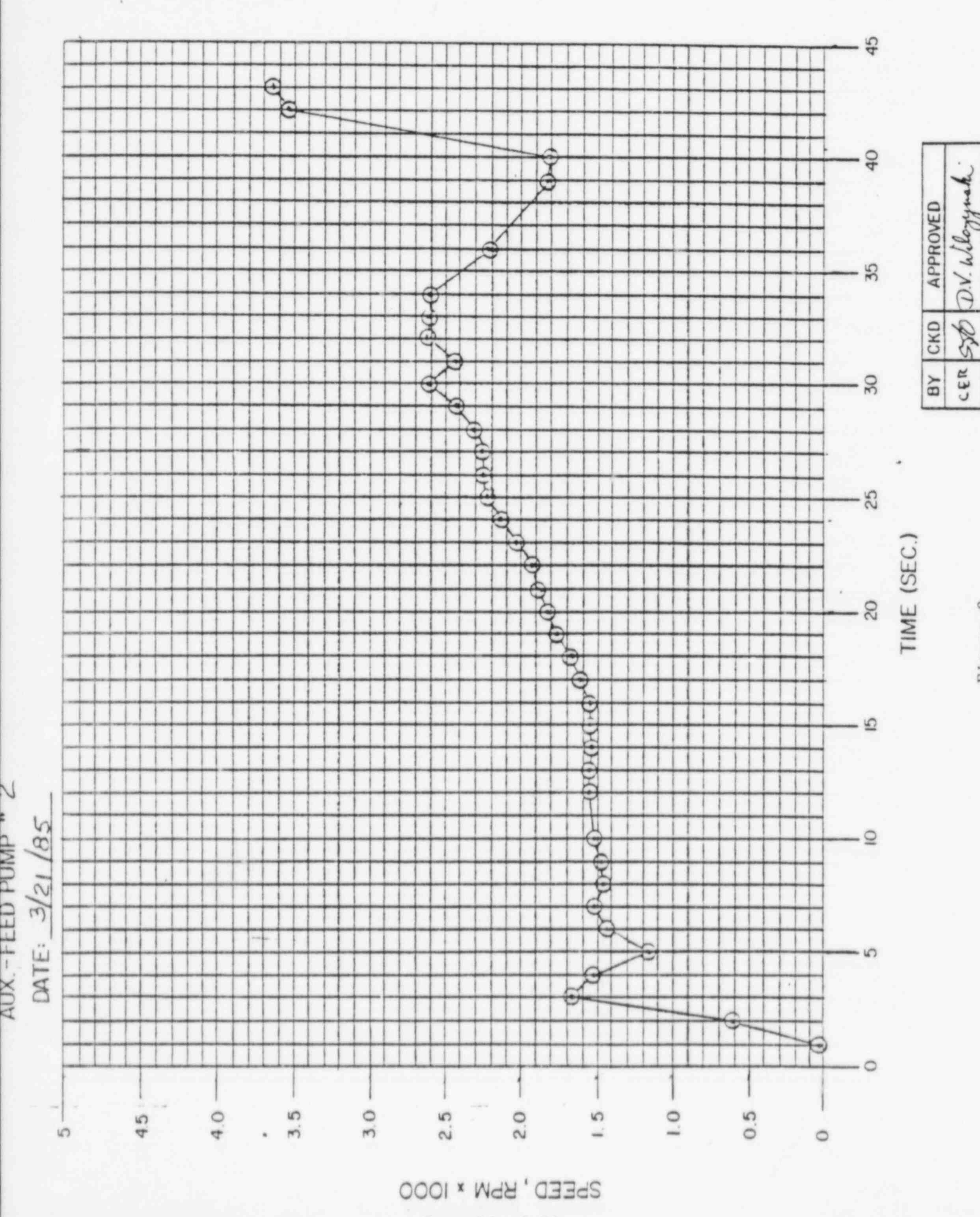

AUX.-FEED PUMP # 2
DATE: 3/21/85
SPEED, RPM x 1000
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
BY
CKD
APPROVED
CER

Figure 9

AUX FEED PUMP 1-2 SPEED DATA
APRIL 12, 1985 - FIRST RUN

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	04:09:13	23.2
2	04:09:14	30.5
3	04:09:15	74.5
4	04:09:16	716.7
5	04:09:17	1962.1
6	04:09:18	1744.8
7	04:09:19	1998.8
8	04:09:20	2123.3
9	04:09:21	2172.2
10	04:09:22	2203.9
11	04:09:23	2457.9
12	04:09:24	2648.4
13	04:09:25	2792.4
14	04:09:26	3503.1
15	04:09:27	3678.9
16	04:09:28	3698.4
17	04:09:29	3722.8
18	04:09:30	3698.4
19	04:09:31	3710.6
20	04:09:32	3759.5
21	04:09:33	3801.0

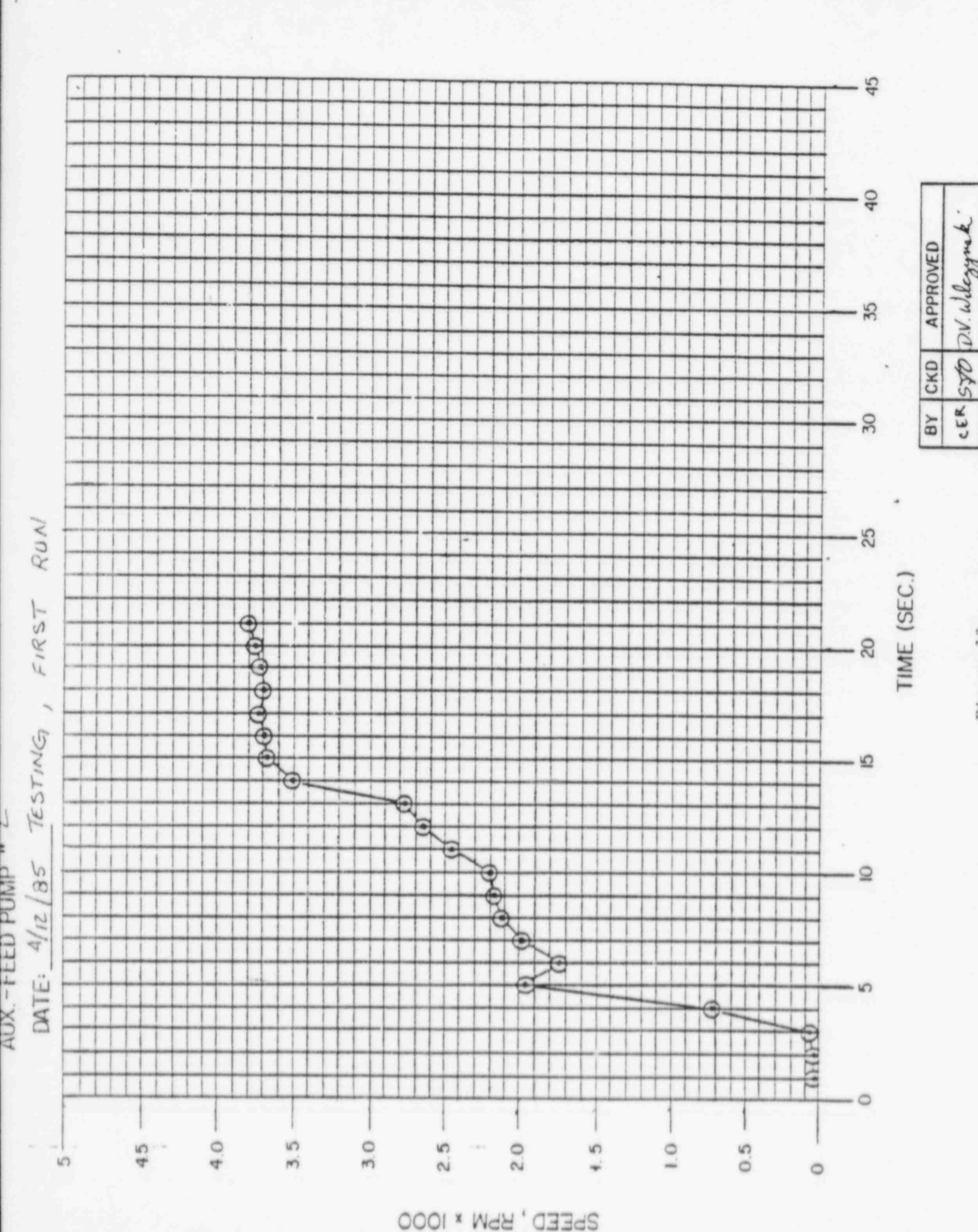

AUX.-FEED PUMP # 2
DATE: 4/12/85 TESTING, FIRST RUN
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5
BY
CKD
APPROVED

Figure 10

AUX FEED PUMP 1-2 SPEED DATA
APRIL 12, 1985 - SECOND RUN

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	04:17:06	23.2
2	04:17:07	25.6
3	04:17:08	387.1
4	04:17:09	2199.0
5	04:17:10	1847.4
6	04:17:11	2145.3
7	04:17:12	2201.5
8	04:17:13	2404.2
9	04:17:14	2633.7
10	04:17:15	2855.9
11	04:17:16	3075.7
12	04:17:17	3302.8
13	04:17:18	3525.0
14	04:17:19	3678.9
15	04:17:20	3676.4
16	04:17:21	3691.1
17	04:17:22	3703.3
18	04:17:23	3710.6
19	04:17:24	3715.5
20	04:17:25	3717.9
21	04:17:26	3722.8

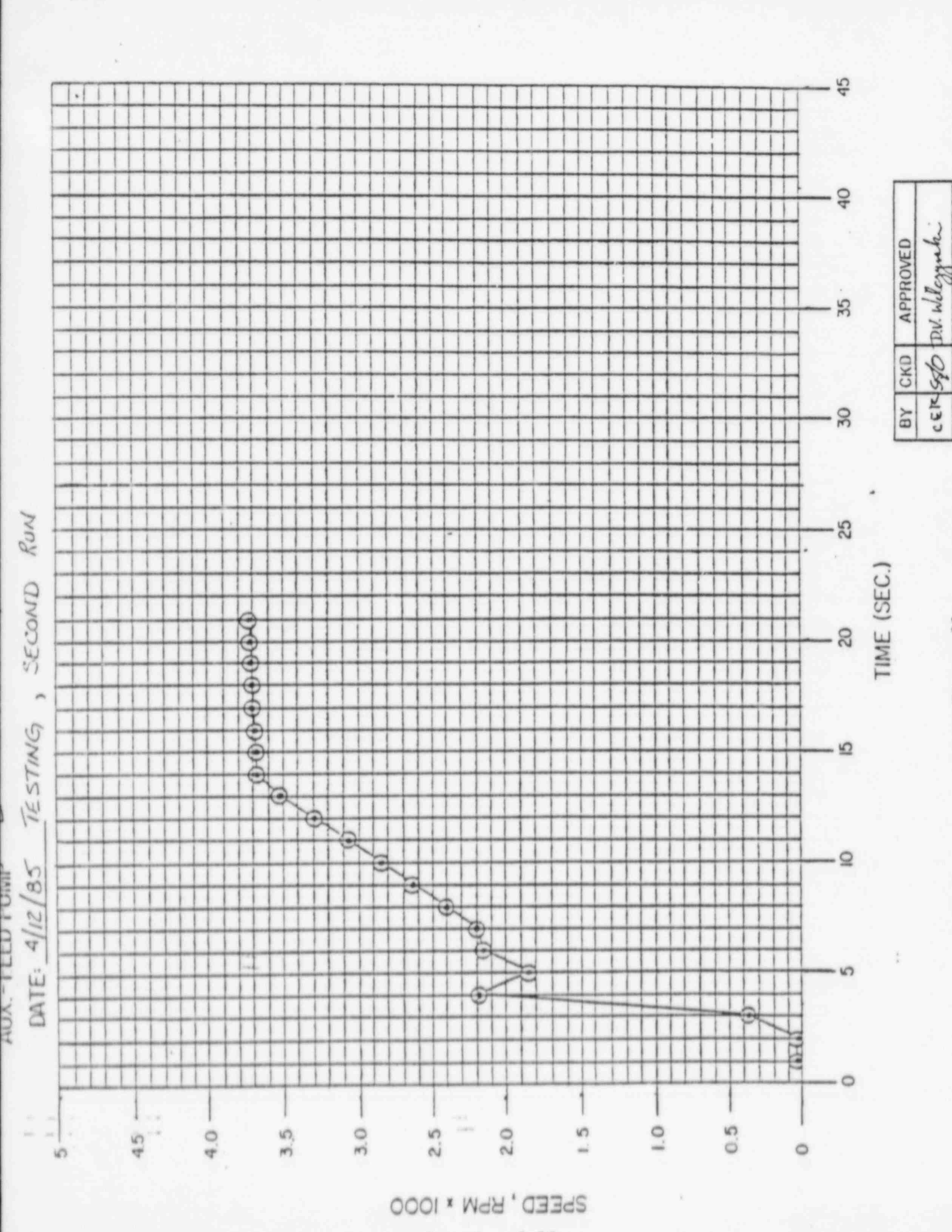

AUX. FEED PUMP
DATE: 4/12/85 TESTING, SECOND RUN
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
BY
CKD
APPROVED
CER

Figure 11

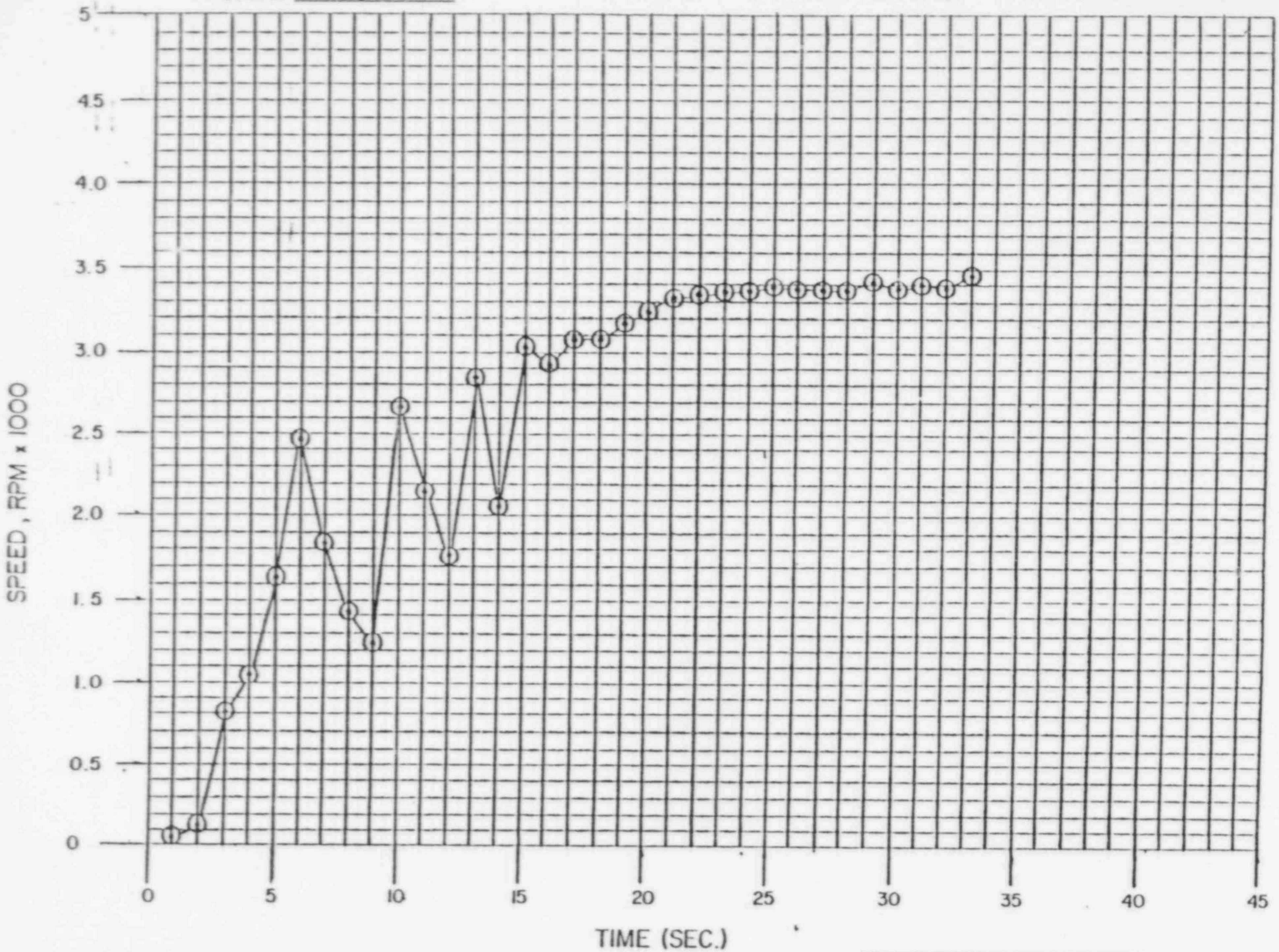
ATTACHMENT 2

AUX FEED PUMP 1-1 SPEED DATA
JUNE 2, 1985

DATA POINT	TIME	AFP 1-1 SPEED (S008)
1	06:05:36	45.2
2	06:05:37	125.8
3	06:05:38	707.0
4	06:05:39	1053.7
5	06:05:40	1637.4
6	06:05:41	2470.1
7	06:05:42	1837.6
8	06:05:43	1427.3
9	06:05:44	1246.6
10	06:05:45	2692.3
11	06:05:46	2135.1
12	06:05:47	1769.2
13	06:05:48	2846.2
14	06:05:49	2074.5
15	06:05:50	3041.5
16	06:05:51	2936.5
17	06:05:52	3080.6
18	06:05:53	3095.2
19	06:05:54	3185.6
20	06:05:55	3241.8
21	06:05:56	3319.9
22	06:05:57	3327.2
23	06:05:58	3361.4
24	06:05:59	3366.3
25	06:06:00	3395.6
26	06:06:01	3361.4
27	06:06:02	3385.8
28	06:06:03	3381.0
29	06:06:04	3407.8
30	06:06:05	3395.6
31	06:06:06	3400.5
32	06:06:07	3390.7
33	06:06:08	3468.9

AUX. FEED PUMP

DATE: 6/2/85



BY	CKD	APPROVED
CER	SVO	D.V. Wilczynski

Figure 12

AUX FEED PUMP 1-2 SPEED DATA
JUNE 2, 1985

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	06:05:21	40.3
2	06:05:22	406.6
3	06:05:23	1627.6
4	06:05:24	2418.8
5	06:05:25	1600.7
6	06:05:26	2113.6
7	06:05:27	2076.9
8	06:05:28	2123.3
9	06:05:29	2460.3
10	06:05:30	2575.1
11	06:05:31	2619.0
12	06:05:32	2629.8
13	06:05:33	2641.0
14	06:05:34	2687.4
15	06:05:35	2741.1
16	06:05:36	2926.7
17	06:05:37	3144.1
18	06:05:38	3144.1
19	06:05:39	3149.0
20	06:05:40	3146.5
21	06:05:41	3149.0
22	06:05:42	3158.7
23	06:05:43	3170.9
24	06:05:44	3200.2
25	06:05:45	3283.3
26	06:05:46	3412.7
27	06:05:47	3488.4
28	06:05:48	3525.0
29	06:05:49	3576.3
30	06:05:50	3610.5
31	06:05:51	3654.5
32	06:05:52	3688.6
33	06:05:53	3727.7
34	06:05:54	3781.4
35	06:05:55	3827.8
36	06:05:56	3866.9
37	06:05:57	3920.6
38	06:05:58	4033.0
39	06:05:59	4023.2
40	06:06:00	3952.4
41	06:06:01	3910.9
42	06:06:02	3879.1
43	06:06:03	3852.3
44	06:06:04	3830.3
45	06:06:05	3808.3

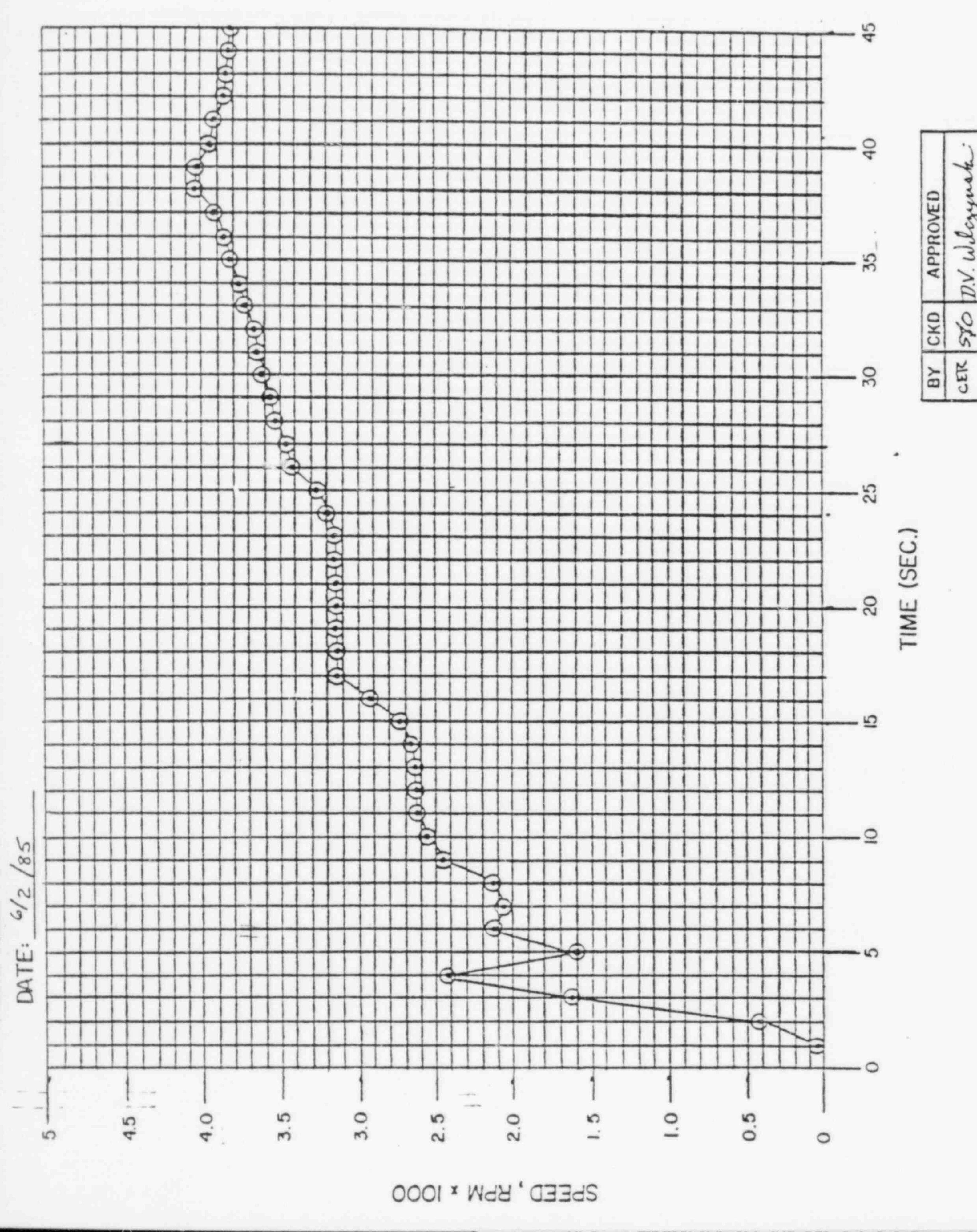

DATE: 6/2/85
SPEED, RPM x 1000
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5
TIME (SEC.)
0
5
10
15
20
25
30
35
40
45
BY
CKD
APPROVED
CER
STO

Figure 13

AUX FEED PUMP 1-1 SPEED DATA
JUNE 9, 1985 - TESTING

DATA POINT	TIME	AFP 1-1 SPEED (S008)
1	13:49:43	42.7
2	13:49:44	NO DATA
3	13:49:45	623.9
4	13:49:46	1007.3
5	13:49:47	1942.6
6	13:49:48	1876.7
7	13:49:49	NO DATA
8	13:49:50	1412.7
9	13:49:51	1854.7
10	13:49:52	2238.1
11	13:49:53	2362.6
12	13:49:54	2467.6
13	13:49:55	2638.6
14	13:49:56	2728.9
15	13:49:57	2821.7
16	13:49:58	2970.7
17	13:49:59	3107.4
18	13:50:00	NO DATA
19	13:50:01	3300.4
20	13:50:02	NO DATA
21	13:50:03	NO DATA
22	13:50:04	NO DATA
23	13:50:05	NO DATA
24	13:50:06	3586.1
25	13:50:07	NO DATA
26	13:50:08	NO DATA
27	13:50:09	3595.8
28	13:50:10	3573.9
29	13:50:11	3583.6
30	13:50:12	3598.3
31	13:50:13	3576.3
32	13:50:14	3605.6
33	13:50:15	3622.7
34	13:50:16	3622.7
35	13:50:17	NO DATA
36	13:50:18	NO DATA
37	13:50:19	NO DATA
38	13:50:20	3622.7
39	13:50:21	NO DATA
40	13:50:22	3639.8
41	13:50:23	3639.8
42	13:50:24	3637.4
43	13:50:25	3632.5

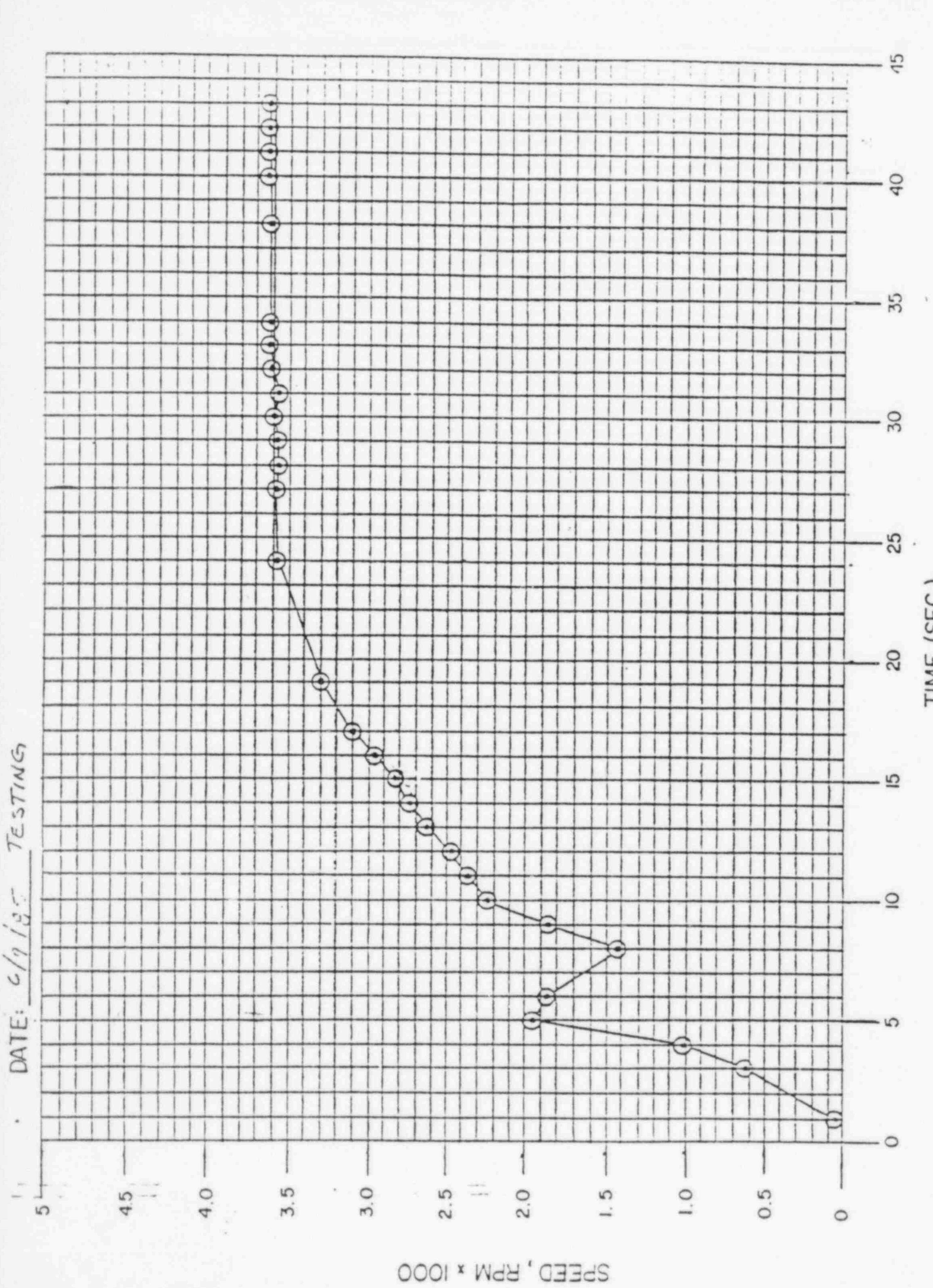


FIGURE 14

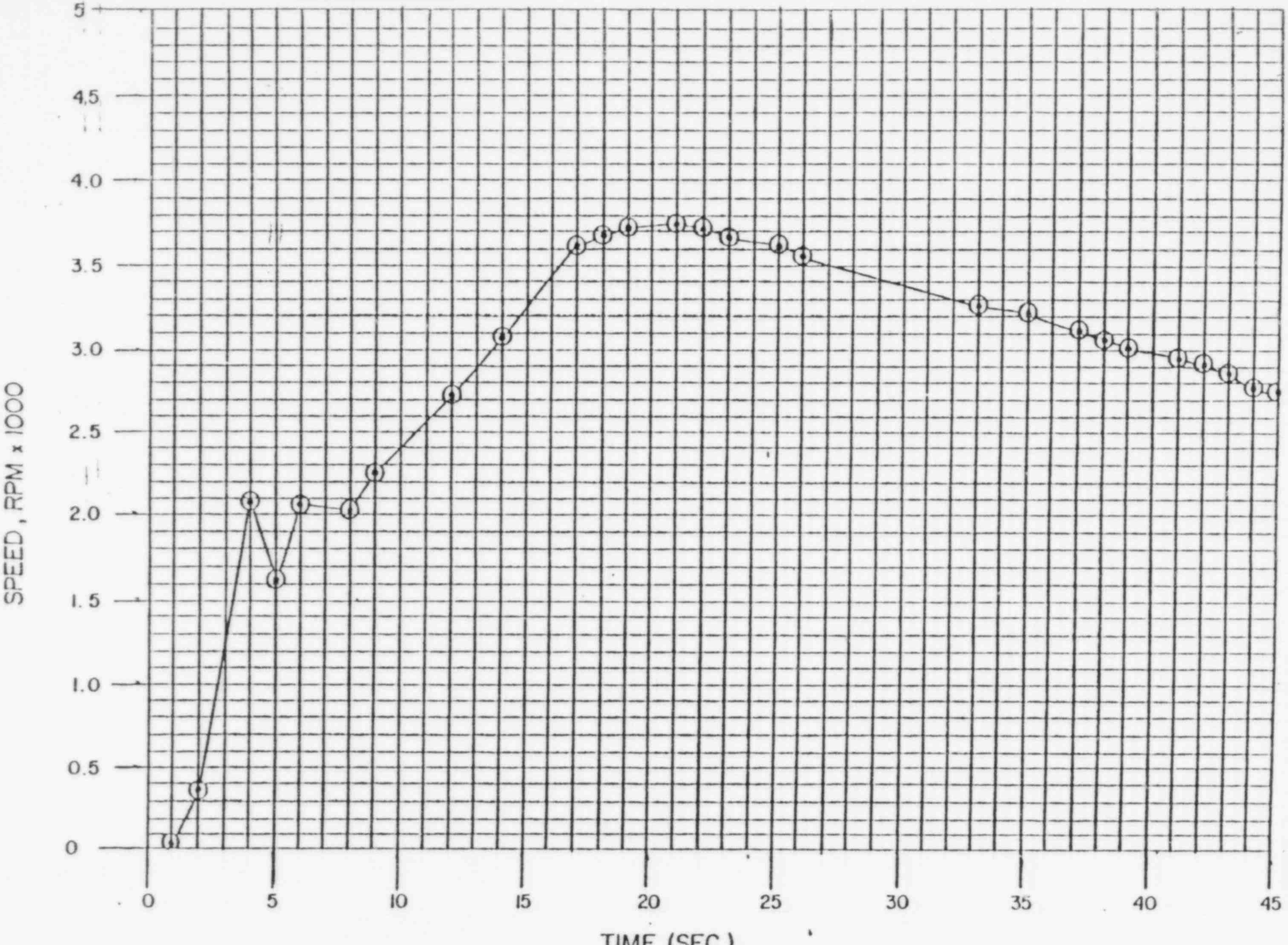
BY	CKD	APPROVED
CEK	GJO	D.V. Wilczynski

AUX FEED PUMP 1-2 SPEED DATA
JUNE 9, 1985 - TESTING

DATA POINT	TIME	AFP 1-2 SPEED (S018)
1	12:34:52	35.4
2	12:34:53	382.2
3	12:34:54	NO DATA
4	12:34:55	2089.1
5	12:34:56	1610.5
6	12:34:57	2054.9
7	12:34:58	NO DATA
8	12:34:59	2028.1
9	12:35:00	2250.3
10	12:35:01	NO DATA
11	12:35:02	NO DATA
12	12:35:03	2731.4
13	12:35:04	NO DATA
14	12:35:05	3092.8
15	12:35:06	NO DATA
16	12:35:07	NO DATA
17	12:35:08	3625.2
18	12:35:09	3691.1
19	12:35:10	3715.5
20	12:35:11	NO DATA
21	12:35:12	3732.6
22	12:35:13	3713.1
23	12:35:14	3683.8
24	12:35:15	NO DATA
25	12:35:16	3627.6
26	12:35:17	3571.4
27	12:35:18	NO DATA
28	12:35:19	NO DATA
29	12:35:20	NO DATA
30	12:35:21	NO DATA
31	12:35:22	NO DATA
32	12:35:23	NO DATA
33	12:35:24	3271.1
34	12:35:25	NO DATA
35	12:35:26	3219.8
36	12:35:27	NO DATA
37	12:35:28	3122.1
38	12:35:29	3092.8
39	12:35:30	3036.6
40	12:35:31	NO DATA
41	12:35:32	2951.2
42	12:35:33	2914.5
43	12:35:34	2868.1
44	12:35:35	2794.9
45	12:35:36	2765.6

AUX. FEED PUMP

DATE: 6/9/85 TESTING



BY	CKD	APPROVED
CER	STO	D.V. Wilczynski

Figure 15

ACTION PLAN

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DATE PREPARED	PREPARED BY
6/24/85	C. E. Rupp Wilczynski D. Missig

TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETE
	ALL STEPS OF THIS ACTION PLAN ARE TO BE PERFORMED IN					
	ACCORDANCE WITH THE LATEST REVISION OF "GUIDELINES TO					
	FOLLOW WHEN TROUBLESHOOTING OR PERFORMING INVESTIGATIVE					
	ACTIONS INTO ROOT CAUSES SURROUNDING THE JUNE 9, 1985					
	REACTOR TRIP".					
1.0	Test of Hypothesis D: <u>Governor Malfunction Caused</u>	Wilczynski	Wilczynski	No Action Required		
	<u>AFPT #1 to Overspeed</u>.					
1.1	Prepare Maintenance Work Order (MWO) for removal of	Wilczynski	Thompson			
	governor cover, inspection, and reassembly of governor.					
	All work to be performed by a representative of					
	Woodward Governor Co.					
1.2	Remove governor cover on AFPT #1.	Wilczynski	Thompson			
1.3	Perform a visual inspection to determine any obvious	Wilczynski	Thompson			
	damage.					
1.4	Check oil level and cleanliness.	Wilczynski	Thompson			
1.5	Document the as-found condition.	Wilczynski	Wilczynski			

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6/24/85	C. E. Rupp Wilczynski D. Missig

TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETE
1.6	Using Woodward Engineering Representative, determine if any repairs are required prior to testing the governors. The basis for this determination will be: "If the repairs are required to preclude further damage to the governor, turbine, or pump, then the repairs shall be made. If further operation of the governor will not cause further damage, then the repairs will be made after the test for overspeed is run to determine if the failed item could have caused the overspeed on 6/9/85". Document all decisions.	Wilczynski	Gradomski			
1.7	Prepare MWO and perform repair work as determined in Step 1.6. All work to be done by Woodward Representative.	Wilczynski	Thompson			
1.8	Install a remote manual trip device in case of failure of the overspeed trip.	Wilczynski	Thompson			
1.9	Perform "quick start" test of AFPT #1 using ST 5071.02 Phase 1 to test Hypothesis D.	Wilczynski	Missig			

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TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETED
1.10	Repeat step 1.9 to prove repeatability.	Wilczynski	Missig			
1.11	Prepare MWO for repair of governor for all items that were	Wilczynski	Thompson			
	not repaired under step 1.7 as determined by step 1.6.					
1.12	Review data to verify applicability to hypothesis.	Wilczynski	Wilczynski			

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AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETE
2.0	Test of Hypothesis A: <u>Condensate in the Main Steam Crossover Line Caused AFPT #1 to Overspeed.</u>	Wilczynski	Wilczynski	No Action Required		
2.1	Develop a Test Procedure (TP) to simulate as close as practical the actual conditions of the June 9, 1985 AFPT #1 overspeed trip. A brief outline of the TP is shown below:	Wilczynski	Missig			
	PURPOSE:					
	- To verify hypothesis that condensate in the cross connect steam supply lines (MS 106A) can cause an overspeed trip of AFPT #1.					
	EQUIPMENT NEEDED:					
	- Existing plant instrumentation					
	- Back-up system for tripping turbines manually					
	- Instrumentation to monitor the thermohydraulic conditions in the steam supply piping to the AFPTs.					

AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

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6/24/85	C. E. Rupp Wilczynski D. Missig

TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETED
	PREREQUISITES:					
	- Governor is at its high speed stop.					
	- Steam supply lines to the AFPTs are at ambient conditions.					
	- Pump discharge valves are closed.					
	- Verify min-recirc valves are open.					
	- Steam Generator (SG) pressures are greater than 870 psig.					
	NOTE: SG pressure will be less than 1050 psig and decreasing during testing. This will not exactly duplicate the conditions of 6/9/85.					
2.2	Perform Test Procedure	Wilczynski	Missig			
2.3	Review test data to verify applicability to hypothesis.	Wilczynski	Wilczynski			
2.4	Repeat Test Procedure	Wilczynski	Missig			
2.5	Review test data from second test to verify applicability to hypothesis.	Wilczynski	Wilczynski			

AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

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6/24/85	C. E. Rupp Wilczynski D. Missig

TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #1 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETED
3.0	Test Hypothesis B: "Double Start" due to cycling of valves MS 106 and MS 106A.	Wilczynski	Wilczynski	No Action Required		
3.1	Develop a Test Procedure (TP) to simulate the cycling of valves MS 106 and MS 106A as occurred on 6/9/85. Prerequisites to be the same as shown in Step 2.1.	Wilczynski	Missig			
3.2	Perform the TP developed above.	Wilczynski	Missig			
3.3	Review test data to verify applicability to hypothesis.	Wilczynski	Wilczynski			
3.4	Perform the TP again.	Wilczynski	Missig			
3.5	Review test data to verify applicability to hypothesis.	Wilczynski	Wilczynski			
4.0	Write final report to document root cause.	Wilczynski	Wilczynski			

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6/24/85	C. E. Rupp Wilczynski D. Missig

TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #2 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETED
	ALL STEPS OF THIS ACTION PLAN ARE TO BE PERFORMED IN ACCORDANCE WITH THE LATEST REVISION OF "GUIDELINES TO FOLLOW WHEN TROUBLESHOOTING OR PERFORMING INVESTIGATIVE ACTIONS INTO ROOT CAUSES SURROUNDING THE JUNE 9, 1985 REACTOR TRIP".					
1.0	Test of Hypothesis D: Govern malfunction caused AFPT #2 to overspeed.	Wilczynski	Wilczynski	No Action Required		
1.1	Prepare Maintenance Work Order (MWO) for removal of governor cover, inspection, and reassembly of governor. All work to be performed by a representative of Woodward Governor Co.	Wilczynski	Thompson			
1.2	Remove governor cover on AFPT #2.	Wilczynski	Thompson			
1.3	Perform a visual inspection to determine any obvious damage.	Wilczynski	Thompson			
1.4	Check oil level and cleanliness.	Wilczynski	Thompson			
1.5	Document the as-found condition.	Wilczynski	Wilczynski			

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6/24/85	C. E. Rupp Wilczynski D. Missig

TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #2 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETED
1.6	Using Woodward Engineering Representative, determine if any repairs are required prior to testing the governors. The basis for this determination will be: "If the repairs are required to preclude further damage to the governor, turbine, or pump, then the repairs shall be made. If further operation of the governor will not cause further damage, then the repairs will be made after the test for overspeed is run to determine if the failed item could have caused the overspeed on 6/9/85." Document all decisions.	Wilczynski	Gradomski			
1.7	Prepare MWO and perform repair work as determined in Step 1.6. All work to be done by Woodward Representative.	Wilczynski	Thompson			
1.8	Install a remote manual trip device in case of failure of the overspeed trip.	Wilczynski	Thompson			
1.9	Perform "quick start" test of AFPT #2 using ST 5071.02 Phase 1 to test Hypothesis D.	Wilczynski	Missig			

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AUXILIARY FEED-PUMP TURBINE (AFPT) #2 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETE
1.10	Repeat step 1.9 to prove repeatability.	Wilczynski	Missig			
1.11	Prepare MWO for repair of governor for all items that	Wilczynski	Thompson			
	were not repaired under Step 1.7 as determined by Step 1.6.					
1.12	Review data to verify applicability to hypothesis.	Wilczynski	Wilczynski			
2.0	Test of Hypothesis A: Condensate in the Main Steam	Wilczynski	Wilczynski	No Action Required		
	crossover line caused AFPT #2 to overspeed.					
2.1	Develop a Test Procedure (TP) to simulate as close as	Wilczynski	Missig			
	practical the actual conditions of the June 9, 1985					
	AFPT #2 overspeed trip. A brief outline of the TP is					
	shown below:					
	PURPOSE:					
	- To verify hypothesis that condensate in the cross					
	connect steam supply lines (MS 107A) can cause an					
	overspeed trip of AFPT #2.					

CTION PLAN

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6/24/85	C. E. Rupp Wilczynski D. Missig

TITLE

AUXILIARY FEED-PUMP TURBINE (AFPT) #2 OVERSPEED TRIP (Rev. 1)

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETED
	EQUIPMENT NEEDED:	Wilczynski	Missig			
	- Existing plant instrumentation.					
	- Back-up system for tripping turbines manually.					
	- Instrumentation to monitor the thermohydraulic					
	conditions in the steam supply piping to the AFPTs.					
	PREREQUISITES:					
	- Governor is at its high speed stop.					
	- Steam supply lines to the AFPTs are at ambient conditions.					
	- Pump discharge valves are closed.					
	- Verify min-recirc valves are open.					
	- Steam Generator (SG) pressures are greater than 870 psig.					
	NOTE: SG pressure will be less than 1050 psig and decreasing					
	during testing. This will not exactly duplicate the conditions					
	of 6/9/85.					
2.2	Perform Test Procedure.	Wilczynski	Missig			
2.3	Review test data to verify applicability to hypothesis.	Wilczynski	Wilczynski			

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AUXILIARY FEED-PUMP TURBINE (AFPT) #2 OVERSPEED TRIP (Rev. 1)

DATE PREPARED: 6/24/85

PREPARED BY: C. E. Rupp, Wilczynski, D. Missig

SPECIFIC OBJECTIVE

Verify hypothesis to support root cause determination.

STEP NUMBER	ACTION STEPS	PRIME RESPONSIBILITY	ASSIGNED TO	START DATE	TARGET DATE	DATE COMPLETE
2.4	Repeat Test Procedure.	Wilczynski	Missig			
2.5	Review test data from second test to verify applicability to hypothesis.	Wilczynski	Wilczynski			
3.0	Evaluate the design of the PGG governor versus the PG-PL governor to determine differences that may cause undesired performance characteristics. (This action to be independent of all other action steps.)	Wilczynski	Gradomski			
4.0	Write final report to document root cause.	Wilczynski	Wilczynski			