

Exhibit No.:
Issues: Weather
Witness: Dennis Patterson
Sponsoring Party: MoPSC
Type of Exhibit: Direct Testimony
Case No.: ER-2001-299
Date Testimony Prepared: April 3, 2001

MISSOURI PUBLIC SERVICE COMMISSION

UTILITY OPERATIONS DIVISION

Exhibit No. 68
Date 5/29/01 Case No. ER-2001-299
Reporter KLR

DIRECT TESTIMONY

OF

DENNIS PATTERSON

THE EMPIRE DISTRICT ELECTRIC COMPANY

CASE NO. ER-2001-299

Jefferson City, Missouri
April, 2001

TABLE OF CONTENTS

SUMMARY	2
THE DEFINITION OF NORMAL WEATHER	3
TEMPERATURE MEASUREMENT INCONSISTENCIES	4
CALCULATION OF DAILY NORMAL TEMPERATURES	8

DIRECT TESTIMONY
OF
DENNIS PATTERSON
THE EMPIRE DISTRICT ELECTRIC COMPANY
CASE NO. ER-2001-299

Q. Please state your name and business address.

A. My name is Dennis Patterson and my business address is Missouri Public Service Commission, P. O. Box 360, Jefferson City, Missouri, 65102.

Q. What is your present position with the Missouri Public Service Commission (Commission)?

A. I am a Regulatory Economist in the Electric Department of the Utility Operations Division.

Q. Please review your educational background and work experience.

A. I was trained as an officer and aviator in the U.S. Army. I studied economics, math, sciences and languages, receiving a B.A. in Latin American Studies (University of Missouri, 1983) and an M.S. in Agricultural Economics (University of Missouri, 1989). I joined the Staff of the Commission in April, 1986. I established the Staff's centralized weather data base, and have continued to maintain and improve it by obtaining data and applying methods from reliable sources. I have been employed by the Commission, the Missouri Army National Guard, the University of Missouri, U.S. Army Reserves, and the U.S. Army.

1 **SUMMARY**

2 Q. Please summarize the issues, position, method, process and products that
3 you describe in your written direct testimony.

4 A. The relevant issue is weather normalization of test year electricity sales.
5 The specific position I espouse in my testimony is that temperatures from the Springfield
6 Regional Airport (SGF) should be used to perform the weather normalization in this case.
7 I will explain my method of tabulating a history of daily maximum temperatures and
8 daily minimum temperatures for SGF that are consistent with daily maximum and
9 minimum temperatures that were measured during the test year. Where it is not
10 otherwise explained, the term "temperatures" will refer to daily maximum temperature
11 and daily minimum temperature.

12 I provided the consistent history of SGF temperatures to staff witness
13 Lena M. Mantle in the present Empire District Electric Company (EDE) rate case, Case
14 No. ER-2001-299. The history included an observation of each day's temperatures for all
15 days from January 1, 1961 through the last billing month of the test year, which ends in
16 December of 2000. Daily temperatures dating from January 1, 1961 through December
17 31, 1990 contain adjustments that cause them to correspond with published normals from
18 the National Oceanic and Atmospheric Administration (NOAA). The large data set
19 containing these daily temperatures for SGF is provided in my working papers. In her
20 direct testimony, Ms. Mantle will explain how she used this information to calculate
21 actual and normal weather.

22 Q. Are the methods you applied in this case consistent with those used in
23 previous cases?

Direct Testimony of
Dennis Patterson

1 A. Yes. The Commission accepted this methodology in the Report and Order
2 for the Missouri Gas Energy rate case, Case No. GR-96-285. I developed the
3 methodology in 1992, well in advance of the 1996 report and order, and have continued
4 to apply it consistently since 1994 for weather normalization in electric, natural gas and
5 water cases.

6 Q. What are the contents of your written direct testimony?

7 A. I have organized my written direct testimony in the following sections:

8 I. THE DEFINITION OF NORMAL WEATHER.

9 II. TEMPERATURE MEASUREMENT INCONSISTENCIES.

10 III. THE CALCULATION OF DAILY NORMAL TEMPERATURES.

11
12
13 **THE DEFINITION OF NORMAL WEATHER**

14 Q. What are weather normals?

15 A. "Normals have been defined as the arithmetic mean of a climatological
16 element computed over a long time period." See Climatology of the United States No.
17 81 Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling
18 Degree Days, 1961-90, MISSOURI, NOAA, National Climatic Data Center, Asheville,
19 North Carolina. NOAA applies this concept to temperature by calculating thirty-year
20 temperature normals as monthly average maximum temperature and monthly average
21 minimum temperature.

22 Q. What period is used by NOAA in its calculations of its thirty-year
23 temperature normals?

24 A. NOAA uses the three most recent consecutive decades, which are
25 currently the thirty years ending December 31, 1990. International agreements among

1 members of the World Meteorological Organization, and its predecessor, the
2 International Meteorological Committee, have established that three-decade periods are
3 appropriately long and uniform periods for the calculation of normals. NOAA
4 recalculates thirty-year normals at the end of each decade as a way of dealing with
5 changes in measurement conditions and changes in the climate itself. The 1961-1990
6 normals were published in early 1992, and it is expected that the 1971-2000 normals will
7 be published in early 2002.

8 Q. Has the Missouri Public Service Commission (Commission) made any
9 findings with respect to the use of NOAA's thirty-year normal?

10 A. Yes. The use of the NOAA thirty-year normal and 30-year normals period
11 complies with a provision of the Commission's Report and Order in the Missouri Gas
12 Energy rate case, Case No. GR-96-285. At page 18, the Commission's Report and Order
13 states:

14 The Commission finds that NOAA's 30-year normals is the more
15 appropriate benchmark . . . In addition, the data upon which Staff's
16 recommendation is based has gone through the processes established by
17 NOAA to ensure the best data possible.
18

19 **TEMPERATURE MEASUREMENT INCONSISTENCIES**

20 Q. What type of weather station is maintained at SGF?

21 A. SGF has a first-order weather station. A first-order weather station is
22 usually located at a regional or municipal airport, where the weather instruments are
23 continuously monitored by professional observers. The instruments record hourly
24 observations of precipitation, temperature, dew point, wind and other weather elements.
25 In contrast, cooperative weather stations are usually manned by trained volunteers who

Direct Testimony of
Dennis Patterson

1 record daily observations. When temperature normals are calculated for first-order
2 stations and selected cooperative stations, special measures are taken to insure that all the
3 years of temperatures in the calculations are consistent. To achieve this consistency,
4 NOAA makes adjustments to the historical temperatures for the effects of changes in
5 observation practice, changes in instrument type, and changes in instrument location.

6 Q. When are temperatures published for these stations?

7 A. For first-order and cooperative stations, the original daily temperatures are
8 first subjected to quality checks. When the quality checks are complete, the daily
9 temperatures are deemed official and printed in monthly publications. When the daily
10 temperatures are published, monthly average temperatures are published with them.
11 After making adjustments for changes in measurement conditions, NOAA eventually
12 calculates normal monthly temperatures from the monthly averages of daily temperature
13 observations.

14 Q. Did the temperature data series for SGF include any inconsistencies?

15 A. Yes. The weather instruments have been moved and instrument types
16 have been changed in several instances since 1961. These events are documented in the
17 1999 Local Climatological Data Annual Summary With Comparative Data, Springfield,
18 Missouri (SGF), Annual Summary, Asheville, North Carolina: National Climatic Data
19 Center, 151 Patton Avenue, Rm 120, Asheville NC 28801-5001.

20 Q. Has NOAA calculated adjustments for all of these inconsistencies?

21 A. No. NOAA calculated adjustments only for instrument moves in 1963 and
22 1988. The adjustments were calculated with reference to monthly average temperatures
23 at surrounding stations where no exposure changes took place for a sufficient length of

Direct Testimony of
Dennis Patterson

1 time before and after the dates of the exposure changes at SGF. Adjusted monthly
2 average maximum temperatures and adjusted monthly average minimum temperatures
3 for SGF are published by NOAA in the computer tape deck, TD-9641: 1961-90
4 Sequential Temperature And Precipitation, Asheville, North Carolina: National Climatic
5 Data Center, NOAA/NESDIS/NCDC, Federal Building, 37 Battery Park Avenue,
6 Asheville, NC, 28801-2733. I will refer to these 360 observations containing adjusted
7 monthly average maximum temperature and adjusted monthly average minimum
8 temperature as the "NOAA sequentials" for SGF. The adjustment process is described in
9 an undated narrative that was supplied with the tape deck.

10 Q. Do published NOAA temperature normals for SGF contain adjustments
11 from the NOAA sequentials?

12 A. Yes. NOAA's normal temperatures for the 12 calendar months for SGF
13 are each calculated as the average of all the adjusted temperatures observations for that
14 month, over thirty years, from the NOAA sequentials.

15 Q. Have instrument moves and type changes occurred at SGF since the 1961-
16 1990 normals were published?

17 A. Yes. According to the Annual Summary cited above, two more exposure
18 changes have occurred. First, the Springfield weather site was moved and commissioned
19 at the new Regional Airport in 1994. Second, the automated ASOS instrumentation was
20 installed and was commissioned at the Regional Airport site in 1995.

21 Q. Has NOAA calculated adjustments for the exposure changes that occurred
22 after 1990?

Direct Testimony of
Dennis Patterson

1 A. No. While the earlier exposure changes were adjusted when the 1961-
2 1990 normals were calculated, exposure changes that occurred after 1990 will not be
3 addressed until the 1971-2000 normals are published.

4 Q. Will the movement of the weather site in 1994 have significant effects on
5 the calculations of normal?

6 A. It is not yet possible to make this judgment with confidence. However,
7 because important factors did not appear to change significantly, I do not anticipate that
8 commissioning the instruments at the new weather site will have material effects on the
9 calculation of normals.

10 First, according to the Annual Summary, the surface altitude of the
11 Regional Airport site is only 10 feet higher than the surface altitude at the former
12 Municipal Airport site, which is a negligible change. Second, both locations are at
13 airports with sparse vegetation on relatively level terrain. Finally, nearby buildings were
14 not documented at either site when the move took place. Taken together, these facts
15 would imply that the temperature measurement characteristics did not change
16 significantly when the instruments were moved from one site to the other.

17 Q. Will the instrument type change of 1995 have a significant effect on the
18 calculation of normals?

19 A. It is not yet possible to make this judgment with confidence. However,
20 indications are that the effect will be small.

21 First, the Annual Summary mentions no site relocation when it documents
22 the commissioning of the automated ASOS thermometer, that replaced the former HO-83

1 instrument. This implies that the effects of a possible location change at that time would
2 not be significant, and that the instrument change may be considered by itself.

3 Secondly, under most conditions, a properly calibrated HO-83 instrument
4 is known to exhibit only a small warming bias. This warming bias is less than 6/10 of a
5 Fahrenheit degree on the average when compared with a properly calibrated ASOS
6 thermometer that is at the same location. See Climatology Report No. 00-3: Climate
7 Data Continuity with ASOS, Report for Period April 1996 through June 2000, Fort
8 Collins, Colorado: Colorado State University, Department of Atmospheric Science, Fort
9 Collins, CO 80523-1371, at p. 1.

10 Q. Were you able to verify the size of any effects from the 1994 station move
11 and the 1995 instrument type change at Springfield?

12 A. Not at this time. It would be very time-consuming to calculate
13 adjustments for temperatures recorded before such exposure changes that could be used
14 to make the records consistent with temperatures measured afterward. There was not
15 sufficient time to perform such an analysis for this case.

16 Q. Based on these facts, what is your recommendation regarding temperature
17 adjustments?

18 A. In the present case, I would recommend that Springfield temperature data
19 be used, but with NOAA's adjustments over the normals period, 1961 through 1990.

20
21 **CALCULATION OF DAILY NORMAL TEMPERATURES**

22 Q. Do the NOAA monthly temperature normals contain sufficient detail for
23 weather normalizing electricity use?

Direct Testimony of
Dennis Patterson

1 A. No, they do not. Daily temperature normals are also needed, because
2 electricity usage varies differently at extreme daily temperatures than it does at mild ones.

3 Q. Does NOAA calculate daily normals for SGF that are consistent with the
4 adjusted monthly normals?

5 A. Yes. Unfortunately, NOAA's daily normal temperatures are calculated
6 from a smooth curve that has been fitted to the monthly normals, by a mathematical
7 splining process that does not regain the lost information about the distribution of daily
8 extremes. Although NOAA's daily temperature normals are appropriate for their stated
9 purpose of averaging normal climatic values over intervals of time, they are not
10 appropriate for the purpose of normalizing electricity usage.

11 Q. Is it possible to calculate daily temperature normals that include
12 information about the distribution of extreme daily temperatures?

13 A. Yes. However, if daily temperature normals are to include the desired
14 information about the distribution of days with extreme temperatures, then the daily
15 normals must be calculated from properly adjusted daily temperature data that correspond
16 with the NOAA normals.

17 Q. How is this correspondence insured?

18 A. Before daily temperature normals that are consistent with NOAA's
19 monthly normals can be calculated, it is first necessary to calculate properly adjusted
20 daily temperature data for the NOAA normals period. Fortunately, it is possible to
21 calculate the necessary adjustments by referring to the NOAA monthly sequentials for the
22 1961-1990 normals period. Thus, even though the thirty years of adjusted monthly
23 temperature averages from the NOAA sequentials don't provide the required information

Direct Testimony of
Dennis Patterson

1 about days with extreme temperatures, they do serve a necessary and crucial function as a
2 benchmark for making the daily temperature data consistent over the NOAA normals
3 period.

4 Q. What information did you use to calculate adjusted daily temperatures for
5 the thirty-year NOAA normals period?

6 A. I used two NOAA temperature data sets to make these calculations. First,
7 I consulted the NOAA sequentials (above). This data set has 30 entries for each of the 12
8 calendar months, or 360 entries. As stated above, the average of these 30 adjusted values
9 for each of the 12 months constitute NOAA's 30-year normals. These 360 entries
10 provide the benchmarks for adjusting actual daily temperatures in these months.

11 Secondly, I obtained official daily temperatures for the same thirty-year
12 time period from NOAA Internet sources such as the Midwest Climate Information
13 Service and the National Climatic Data Center. The temperatures may also be compiled
14 from other official NOAA data products and publications. The resulting data set includes
15 the daily maximum and minimum temperatures for each day since January 1, 1961. In
16 this data set, there are a total of 10,957 entries drawn from the 360 months in the 1961-
17 1990 normals period. These are the actual daily temperatures that must be adjusted.

18 Q. How did you use the monthly sequentials make the adjustments to daily
19 temperatures?

20 A. First, over the years 1961 through 1990, I calculated monthly averages of
21 the actual daily temperatures that had to be adjusted. This provided 360 observations
22 containing monthly averages of both actual daily maximum temperature and actual daily
23 minimum temperature.

Direct Testimony of
Dennis Patterson

1 Secondly, I calculated temperature adjustments for each month of each of
2 the thirty years. This was done by subtracting each of the 360 monthly averages of actual
3 daily maximum and actual daily minimum temperature that were just calculated, from the
4 corresponding adjusted maximum and minimum temperature in the monthly sequential
5 described above.

6 Finally, I applied the temperature adjustments just calculated for each of
7 the 360 months in the thirty years by adding them to the corresponding observations of
8 daily actual temperatures. These calculations yielded 10,957 observations containing the
9 adjusted daily maximum and adjusted daily minimum temperature, over the 360 months
10 in the years 1961 through 1990.

11 Q. How did you crosscheck your results to make sure that the adjusted daily
12 temperatures corresponded to NOAA's normals?

13 A. For this crosscheck, I first took the monthly averages of the daily
14 maximum and minimum temperatures that were just adjusted. I then verified that these
15 monthly averages were equal to the benchmarks, which are the monthly sequential
16 temperatures that were used by NOAA to calculate its thirty-year temperature normals. I
17 also verified that the twelve, thirty-year monthly averages of the adjusted daily
18 temperatures were equal to NOAA's 12 monthly normal temperatures for SGF. The
19 crosschecks were successful in this case, thus insuring that the adjusted daily temperature
20 products that I supplied to Ms. Mantle did correspond with the NOAA normals.

21 Q. Does this conclude your direct testimony?

22 A. Yes, it does.

**BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI**

IN THE MATTER OF THE)
APPLICATION OF THE EMPIRE)
DISTRICT ELECTRIC COMPANY FOR)
A GENERAL RATE INCREASE)

Case No. ER-2001-299

AFFIDAVIT OF DENNIS PATTERSON

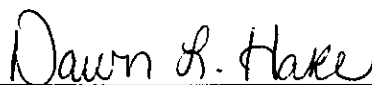
STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Dennis Patterson, of lawful age, on his oath states: that he has participated in the preparation of the foregoing written testimony in question and answer form, consisting of 11 pages of testimony to be presented in the above case, that the answers in the attached written testimony were given by him; that he has knowledge of the matters set forth in such answers; and that such matters are true to the best of his knowledge and belief.


Dennis Patterson

Subscribed and sworn to before me this 2nd day of April, 2001.

My commission expires _____
DAWN L. HAKE
Notary Public - State of Missouri
County of Cole
My Commission Expires Jan 9, 2005


Notary Public