Exhibit No.:
Issue : Weather Normalization
Witness: Dennis Patterson
Type of Exhibit: Direct
Sponsoring Party: MoPSC Staff
Case No.: ER-97-81

MISSOURI PUBLIC SERVICE COMMISSION

POLICY & PLANNING DIVISION

DIRECT TESTIMONY

OF

DENNIS PATTERSON

THE EMPIRE DISTRICT ELECTRIC COMPANY

CASE NO. ER-97-81

Jefferson City, Missouri

February, 1997

DIRECT TESTIMONY

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EMPIRE DISTRICT ELECTRIC COMPANY

CASE NO. ER-97-81

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 Economic Analysis Department of the Policy and Planning 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 Commission Staff in April, 1986. I established the Staff's centralized weather database, and have continued to maintain and improve it by employing data and 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.

Q. What is the purpose of your testimony?

A. I will explain my calculation of actual and normal temperature variables which I furnished to Staff Witness Lena M. Mantle. The temperature data are acquired from the National Oceanic and Atmospheric Administration (NOAA).

Q. Which weather station did you use?

A. I used the weather station at Springfield, Missouri.

Q. What type of weather station is maintained at Springfield?

A. Springfield has a first-order weather station.

Q. What is a first-order weather station?

A. A first-order station is usually located at an airport which serves a large population center. It is manned around the clock by professional observers who monitor instruments and record weather observations. At cooperative weather stations, weather observations are recorded once daily by volunteers.

Q. When is weather data published for these stations?

A. For first-order and cooperative stations, the official weather data are published shortly after the month in which the weather occurs. Updated thirty-year histories of adjusted monthly averages, and the normals calculated from these averages, are usually published during the second year after the end of a decade.

Q. How are weather normals calculated?

A. A weather normal is calculated as the average of a given weather element for a day, month or year, over the NOAA time period of thirty years. Special precautions are taken to insure that all the years of data in the calculations are consistent.

If necessary, adjustments are made for "exposure changes," which may have occurred because of changes in observation practice, instrument type, or instrument location.

Q. How are temperature observations adjusted for exposure changes?

A. At the end of each decade, sections of the current thirty-year series of monthly data are examined for exposure changes by comparing them with data from surrounding stations where no exposure changes occurred. Using results from these comparisons, NOAA calculates adjustments and provides them to the public; e.g. "1961-90 Sequential Temperatures and Precipitation" (NOAA sequentials).

Q. Did you incorporate the NOAA sequentials when you tabulated the daily temperature data for Springfield?

A. Yes, I did. I incorporated temperature adjustments for Springfield which NOAA has calculated for months from the years 1961-1963 and 1988-1990. This step resulted in 1961-90 simple averages of daily HI and LO that were equal to the published 1961-90 NOAA normals.

Q. Does this complete the adjustment for exposure changes?

A. No. It is possible that exposure changes exist which occurred during 1961-90 period but have not been addressed by NOAA. It is also possible that exposure changes have occurred in the several years since 1990. NOAA states in "Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1961-90 MISSOURI:" "Since it is nearly impossible to maintain a multiple purpose network of meteorological stations without having some exposure changes, it is first necessary to identify and evaluate these changes and then make adjustments for them if

necessary." The user of historical weather data is responsible for adjusting the data when these additional exposure changes have occurred.

Q. Did you examine the Springfield temperature data for additional exposure changes?

A. Yes, I did. After applying NOAA adjustments to the data for all the stations, I compared the Springfield temperature data with temperatures from surrounding stations (Anderson, Bolivar, Dora, Lamar, Lebanon, Lockwood, and Neosho). Based on this comparison, I found exposure changes which appear to have occurred in about 1963, 1980 and 1985. The graph on Schedule 1-1 shows that the relationship changes between the Springfield monthly average temperature and the average of the average monthly temperature at the surrounding stations at the points labeled 1963, 1980 and 1985. These relationships are estimated in a regression of the trends over time of the cumulative difference in monthly average temperatures.

Q. What do you mean by "trends over time"?

A. A trend is the tendency for a quantity to increase or decrease over time. A constant trend would indicate no change over time in the rate of increase or decrease. If the exposure conditions at weather station were constant, then the difference between temperatures from that station and a set of temperature where exposures conditions were also constant would not vary over time. Therefore, a constant trend in the cumulative difference between the two sets of temperatures would be desirable.

Q. Was the trend in temperature differences constant for Springfield and surrounding stations?

A. No. The graph on Schedule 1-1 shows that the trend changes at the points labeled 1963, 1980 and 1985. In essence, when the trend over time changes, a significant change has occurred in the relationship of temperatures measured at Springfield to those measured at surrounding stations. The surrounding stations were chosen because the temperature measures from 1961 through the present indicated no significant changes in time trends when compared with each other. Therefore, when Springfield is compared to the average of these surrounding stations, significant changes in time trends would indicate that observation changes have occurred at Springfield.

Q. How did you correct for these significant changes in time trends at Springfield?

A. The correction involves making adjustments to the average monthly observations prior to the most recent change in time trends; i.e., prior to 1986. Adjustments are made to monthly average temperatures that would result in the time trend over the entire period being the same as for the most recent time trend period. The result is shown on Schedule 1-2, where the time trend is constant over the entire period. The data I furnished to Ms. Mantle contains adjustments based on the estimated relationships.

Q. Did you calculate the thirty-year normal weather variables used for weather normalization in this case?

A. No, I did not. Ms. Mantle calculated these values from the adjusted daily temperature data which I furnished to her. However, for the purpose of comparing the data I provided to Ms. Mantle with the NOAA sequentials, I have calculated modified 1961-90 normals of monthly average high, low and mean daily temperatures (HI, LO, MDT), as well as heating degree days (HDD) and cooling degree days (CDD) with respect to 65 degrees Fahrenheit.

Q. What was the effect of incorporating the NOAA sequentials in the published daily temperature series for Springfield?

A. Simple averages of MDT, HDD and CDD were very nearly equal to published normals, with small differences due to rounding procedures used by NOAA.

Q. What was the effect of incorporating the additional adjustments you made to Springfield monthly temperatures?

A. The monthly and annual normal HI, LO and MDT were raised by about 3/10 of a degree from published normals, as is shown on Schedule 2. As a consequence of the adjustments to the temperatures used to calculate the modified normals, normal annual HDD were reduced by 30 HDD, while normal annual CDD were increased by 80 CDD. The reduction was about 0.65% for HDD, while the increase was about 6.06% for CDD.

Q. Does this conclude your direct testimony?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the matter of the Empire District Electric Company of Joplin, Missouri, for Authority to File Tariffs Increasing Rates for Electric Service Provided to Customers in the Missouri Service Area of the Company.	) CASE NO. ER-97-81

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 6 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 10th day of February, 1997.

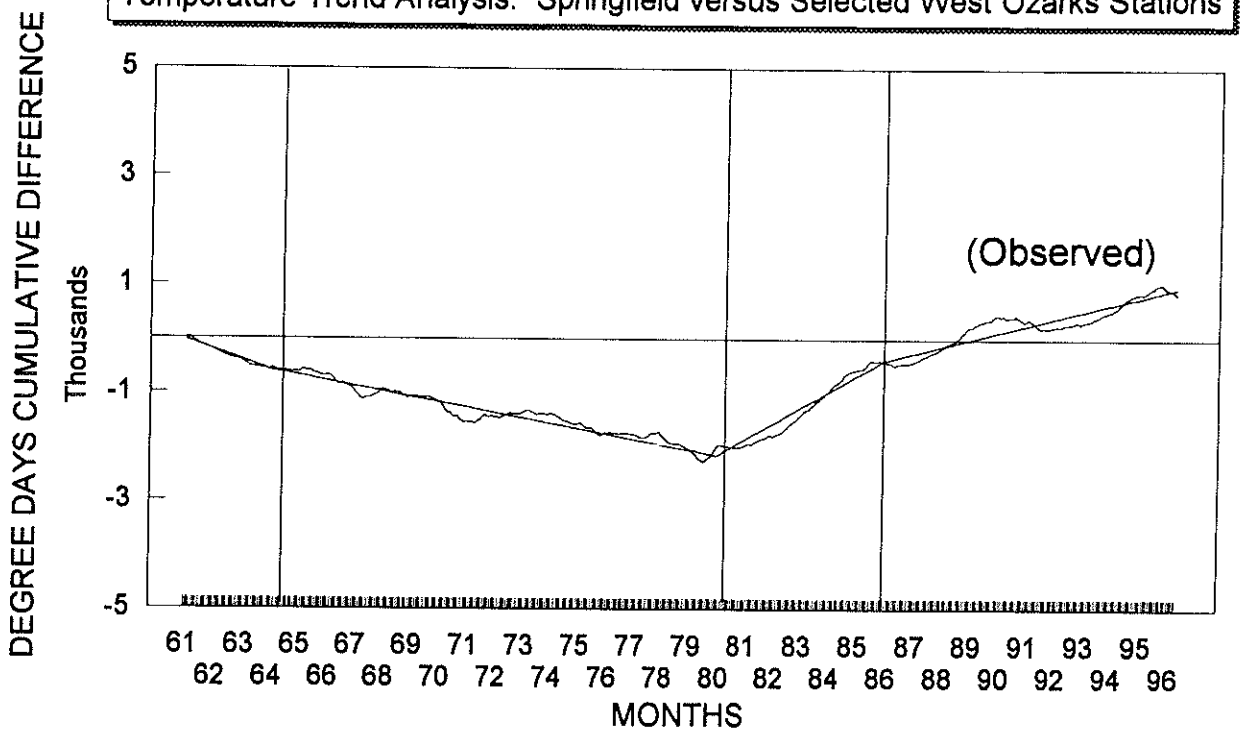
Judy Fritsch
Notary Public

JUDY FRITSCH
NOTARY PUBLIC STATE OF MISSOURI
COLE COUNTY
MY COMMISSION EXPIRES SEPT 22,1997

My commission expires

EMPIRE DISTRICT ELECTRIC COMPANY

Temperature Trend Analysis: Springfield versus Selected West Ozarks Stations

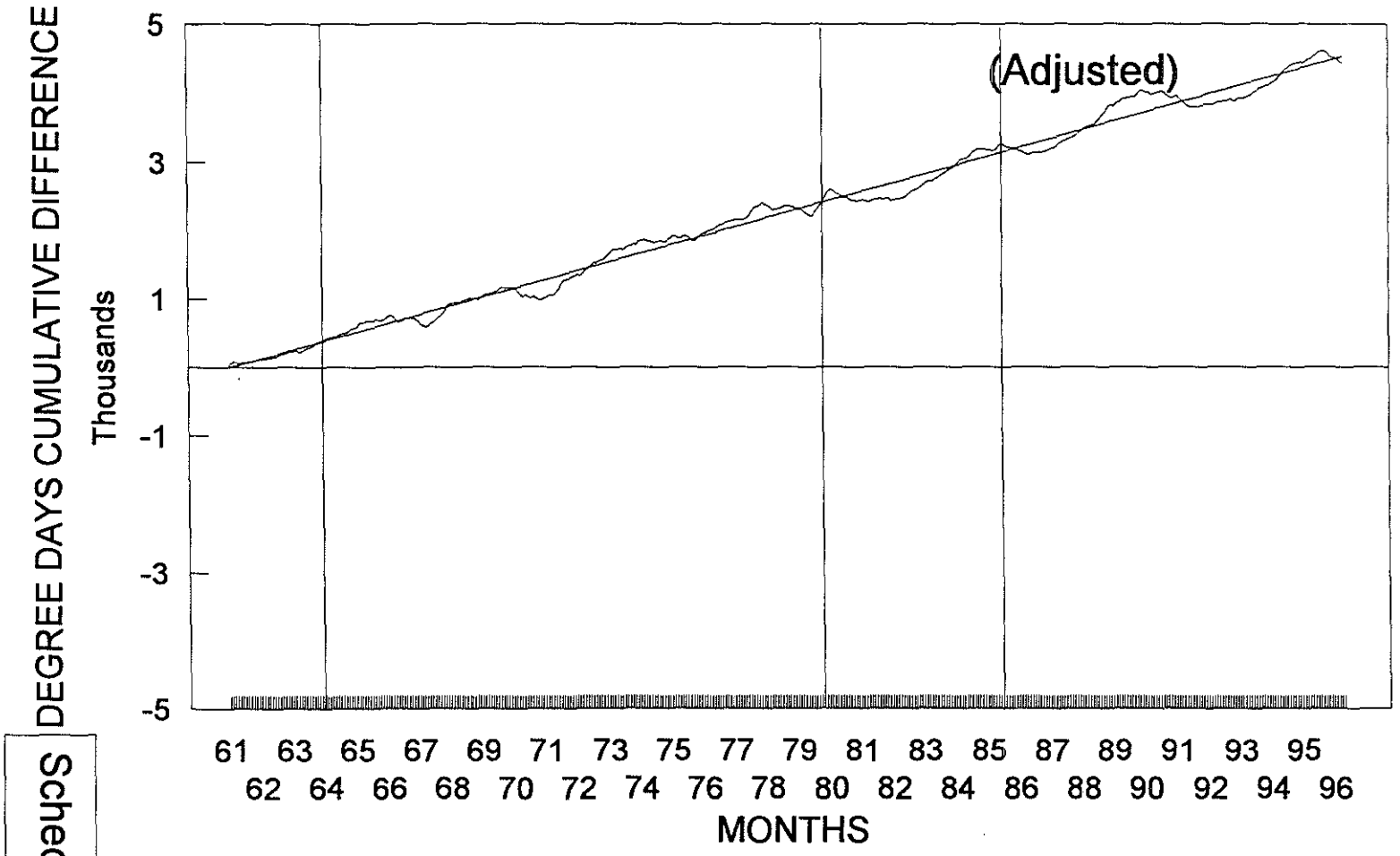


Springfield versus Surrounding Stations				
Regression Output:				
Constant	-3643.31			
Std Err of Y Est	126.3647			
R Squared	0.978864			
No. of Observations	425			
Degrees of Freedom	420			
	61-63	61-79	61-85	61-96
X Coefficient(s)	-0.23284	-1.07269	0.449012	0.355315
Std Err of Coef.	0.04153	0.014504	0.018145	0.008595
Student's " t "	-5.60651	-73.9579	24.7462	41.33885
Total Slope:	-0.501199	-0.268363	0.804327	0.355315
Years:	**61-63**	**64-79**	**80-85**	**86-96**
Correction:	**0.856514**	**0.623678**	**-0.449012**	**0.000000**

1. Data description in text.
2. Vertical lines mark dates of exposure changes.

EMPIRE DISTRICT ELECTRIC COMPANY

Temperature Trend Analysis: Springfield versus Selected West Ozarks Stations



Schedule 1-2

1. Data description in text.
2. Vertical lines mark dates of exposure changes.

SPRINGFIELD MO NORMS 1961-1990						
MONTH	LEVELS			ACCUMULATIONS		
MM	HH.H	LL.L	MD.T	HDD	CDD	P.CP
1	41.8	20.4	31.1	1051	0	1.79
2	46.3	25	35.7	820	0	2.17
3	57.4	34.4	46	589	0	3.89
4	67.9	44.1	56	280	10	4.18
5	76	53.2	64.6	110	98	4.38
6	84.4	61.9	73.2	5	251	5.09
7	89.6	66.6	78.1	0	406	2.92
8	88.6	65	76.8	0	366	3.51
9	80.3	57.7	69	43	163	4.62
10	69.8	45.9	57.8	249	26	3.58
11	56.6	35.5	46	570	0	3.75
12	45.3	25.3	35.3	921	0	3.16
YEAR	67	44.6	55.8	4638	1320	43.04

SPRINGFIELD X WEST OZARKS MO NORMS 1961-1990						
MONTH	LEVELS			ACCUMULATIONS		
MM	HH.H	LL.L	MD.T	HDD	CDD	P.CP
1	42.1	20.8	31.4	1041	0	1.79
2	46.6	25.3	36	819	0	2.17
3	57.8	34.8	46.3	585	4	3.89
4	68.2	44.5	56.3	284	24	4.18
5	76.3	53.6	64.9	95	93	4.38
6	84.7	62.3	73.5	7	262	5.09
7	90	66.9	78.4	1	417	2.92
8	89	65.3	77.1	2	378	3.51
9	80.7	58	69.3	54	184	4.62
10	70.1	46.2	58.1	249	36	3.58
11	56.9	35.8	46.3	562	2	3.75
12	45.6	25.6	35.6	911	0	3.16
99	67.3	44.9	56.1	4608	1400	43.06

SPRINGFIELD X WEST OZARKS MO NORMS 1961-1990						
MONTH	CHANGE IN LEVELS			CHANGE IN ACCUMULATIONS		
MM	HH.H	LL.L	MD.T	HDD	CDD	P.CP
1	0.3	0.4	0.3	-10	0	
2	0.3	0.3	0.3	-1	0	
3	0.4	0.4	0.3	-4	4	
4	0.3	0.4	0.3	4	14	
5	0.3	0.4	0.3	-15	-5	
6	0.3	0.4	0.3	2	11	
7	0.4	0.3	0.3	1	11	
8	0.4	0.3	0.3	2	12	
9	0.4	0.3	0.3	11	21	
10	0.3	0.3	0.3	0	10	
11	0.3	0.3	0.3	-8	2	
12	0.3	0.3	0.3	-10	0	
YEAR	0.3	0.3	0.3	-30	80	

SPRINGFIELD X WEST OZARKS MO NORMS 1961-1990						
MONTH	% CHANGE IN LEVELS			% CHANGE IN ACCUMULATIONS		
MM	HH.H	LL.L	MD.T	HDD	CDD	P.CP
1	0.72%	1.96%	0.96%	-0.95%	NA	
2	0.65%	1.20%	0.84%	-0.12%	NA	
3	0.70%	1.16%	0.65%	-0.68%	NA	
4	0.44%	0.91%	0.54%	1.43%	NA	
5	0.39%	0.75%	0.46%	-13.64%	-5.10%	
6	0.36%	0.65%	0.41%	40.00%	4.38%	
7	0.45%	0.45%	0.38%	NA	2.71%	
8	0.45%	0.46%	0.39%	NA	3.28%	
9	0.50%	0.52%	0.43%	25.58%	12.88%	
10	0.43%	0.65%	0.52%	0.00%	NA	
11	0.53%	0.85%	0.65%	-1.40%	NA	
12	0.66%	1.19%	0.85%	-1.09%	NA	
YEAR	0.45%	0.67%	0.54%	-0.65%	6.06%	