UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 18 1980

MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

FROM: Thomas E. Murley, Acting Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER # 97 - "AN ECONOMETRIC STUDY OF ELECTRICITY DEMAND BY MANUFACTURING INDUSTRIES"

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Introduction and Summary

This memorandum transmits the results of completed research on electricity demand in the United States originating in the manufacturing sector of the economy. It is part of a research program in support of NRC's effort to maintain an adequate capability to evaluate need for power, as required by the licensing process for nuclear power plants under the National Environmental Policy Act. Demand from the manufacturing sector accounts for approximately 38 percent of total electricity demand and is a relatively volatile component of total demand. An accurate forecasting model must include a detailed manufacturing sector. The research effort described here will be used in the development of the SLED (State Level Electricity Demand) model used to assess forecasts of total electricity demand by state. The research was performed by Oak Ridge National Laboratories under the direction of the Environmental Effects Research Branch in response to a request from your office (NRR-77-01).

Methodology

A model of electricity demand was specified which contained two simultaneous equations. One equation reflects the behavior of the firm with an assumed objective of cost minimization. This results in an equation for each manufacturing firm of the type:

$$Yj = F\ (Q, P1, P2\text{---}, Pj)\ j=1, 2\text{---}J$$

where Yj is the quantity demanded of the jth input in production, Q is the output level of the firm, and Pj is the price of the jth input.

Since the production input of interest is electricity, the derived demand for electricity can be expressed as a function of final output of the firm, price of electricity, and prices of other production inputs, including substitute fuels. Summing the equations over all firms in an industry yields an equation for that industry. The second equation incorporates electricity prices into the model, specifically the declining block-rate pricing structure in practice for most U.S. manufacturing industries.

The equations were estimated for 15 U.S. manufacturing industries at the SIC (Standard Industrial Classification) three-digit level plus one category representing all remaining manufacturing industries. Time series data on an annual basis for the years 1959-1976 were used in estimation.

Table 1. Identification of the Manufacturing Industries Analyzed

SIC Code	Description	Electrical Consumption[a] in 1976 10^{12} kWH	Percent of Total
	All industries	634.9	100.0
203	Canned, cured, and frozen foods	5.2	0.8
204	Grain-mill products	6.1	1.0
221	Weaving mills, cotton	4.2	0.7
225	Knitting mills	3.9	0.6
262	Paper mills, except building paper	20.9	3.3
263	Paperboard mills	10.2	1.6
281A	Industrial chemicals, exclusive of the Department of Energy's three uranium enrichment plants	74.9	11.8
282	Plastic materials and synthetics	16.8	2.6
291	Petroleum refining	26.3	4.1
322	Glass and glassware; pressed or blown	6.5	1.0
324	Cement, hydraulic	9.1	1.4
331	Blast furnace and basic steel products	54.6	8.6
332	Iron and steel foundries	11.4	1.8
333	Primary nonferrous metals	66.8	10.5
371	Motor vehicles and equipment	17.7	2.8
	All remaining industries	300.2	47.3

[a]Does not include the amount of self-generated electricity consumed. Source: U.S. Bureau of the Census, Annual Survey of Manufacturers, 1976, Washington, D. C., June 1978.

Results

The results of estimating the system of equations for each manufacturing industry were quite favorable. Coefficients for the price of electricity and output were of the expected sign for all industries and were statistically significant at the 5 percent level for most. The results indicated that natural gas was a significant substitute for electricity for the majority of industries. The following table shows the price elasticity of demand (percent change in demand caused by a 1 percent change in electricity price) and value-added elasticity (percent change in electricity demand caused by a 1 percent change in final output less raw materials) for each industry SIC code.

Table 2. Estimated short-run and long-run elasticities of demand for electricity

Industry SIC code	Own-price elasticities		Value-added elasticities	
	Short run	Long run	Short run	Long run
203	-1.46	-2.59	0.28	0.49
204	-0.23	-1.52	0.10	0.66
221	-0.13	-0.17	0.46	0.62
225	-1.00	-1.86	0.48	0.90
262	-0.86	-1.20	0.23	0.32
263	-0.21	-0.24	0.71	0.81
282	-0.58	-1.46	0.32	0.82
281A	-0.22	-0.40	0.43	0.79
291	-0.03	-0.19	0.18	1.03
322	-1.07	-1.29	0.21	0.25
324	-0.09	-0.11	0.82	1.02
331	-0.43	-0.95	0.39	0.85
332	-0.46	-2.01	0.38	1.61
333	-0.65	-1.02	0.60	0.94
371	-1.51	-1.66	0.46	0.51
Other	-0.89	-1.57	0.31	0.55

The model was used to forecast annual rates of change of electricity demand through 1995. Where inputs of future levels of variables such as prices were needed, standard forecasts of the Department of Energy or other sources were used. For the manufacturing sector as a whole, electricity demand is forecast to increase at an average rate of 3.7 percent per year from 1977 to 1995, somewhat less than the 5.1 percent growth experienced during the 1959-1974 period.

Table 3 gives growth rates for each manufacturing industry.

Table 3. Forecasted average annual growth rate of consumption by industry

Industry	Average annual growth rate of demand (1977 to 1995) %
SIC 203	3.7
SIC 204	3.8
SIC 221	3.3
SIC 225	5.5
SIC 262	3.5
SIC 263	3.3
SIC 281A	5.6
SIC 282	4.7
SIC 291	0.8
SIC 322	2.3
SIC 324	4.1
SIC 331	5.8
SIC 332	6.9
SIC 333	2.7
SIC 371	2.2
Other Industries	2.8
All Industries	3.7

Conclusions and Recommendations

The results of the research will be incorporated into the SLED (State Level Electricity Demand) Model, and should lead to a significant enhancement in the capability of that modeling system to supply need for power forecasts. This should be useful to your staff in their evaluations of need for power, as called for in the licensing process.

For further information on this study, please contact Dr. Clark Prichard (427-4358).

Thomas E. Murley, Acting Director
Office of Nuclear Regulatory Research

Enclosure: NUREG/CR-1135

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Original Signed by
T. E. Murley

Thomas E. Murley, Acting Director
Office of Nuclear Regulatory Research

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RECORD NOTE: A meeting was held with S. Feld, cognizant individual from the user office (NRR) at which it was agreed that a RIL should be issued.

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SURNAME ►	CPrichard:fkm	FSwanberg, Jr.	JDavis	Bassett/Arsenault	JLarkins	TMurley
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