KGS OF 68-1

NUCLEAR POWER POTENTIAL IN KANSAS

Remarks by

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This paper will summarize briefly a subject which will be discussed in a more detailed manner in a presentation by Black & Veatch individuals to be made for a proposed March meeting of this Board. Dr. Robinson has given you the broad picture of nuclear power generation situation in the United States today and has noted that a substantial portion of new power generation capability committed has been nuclear. Here, in our own State of Kansas, we find that utilities are on the brink of committing large new units which could be nuclear power units.

What are the differences between the Kansas power generation picture and the national nuclear generation picture? Figure 1 lists a number of factors which need to be considered in Kansas.

The principal factors involved in the feasibility of a nuclear plant are its low fuel cost, the cost of transmission, and the absence of air pollution. The economic feasibility is most important. Kansas possesses economical natural gas and coal fields which are more competitive with nuclear fuel than fossil fuels for instance in the northern parts of the United States.

Generation costs for nuclear plants are lower for large plants (1000 MWe) than for small plants (300 to 500 MWe). If large plants are installed, it might be necessary to transport large quantities of energy within and outside the state, therefore, high voltage transmission facilities become very important. Interstate connections between these high voltage transmission systems at the time of plant startup would limit the amount and quantities of economical energy interchange between utilities in the State of Kansas and those in the bordering states.

The load factor characteristics for generating units in the Kansas area may be different depending on the relative amounts of heavy industry, air conditioning loads, heating loads and other characteristics which involve the weather and degree of industrial development. The wide dispersion of load centers in Kansas is accompanied by the wide dispersion of population within the state, as compared to densely settled areas.

The inadvertent failure or shutdown for maintenance purposes of large generating units requires reserve power supplies the extent of which is determined by the load characteristics and the power available from interconnection of the utilities in Kansas and with bordering states.

All generation units reject heat to bodies of water and/or the atmosphere. A large body of cooling water is available for such heat rejection in some areas of the state. However, "dry sites" require large cooling towers which will require large quantities of makeup water which is not too plentiful in some areas.

Kansas has a fairly high incidence of tornadoes, which affects design criteria. Very intense rainfall and flash flooding occur frequently. Excessive foundation costs can be incurred due to adverse geological considerations. Nuclear power plants require the delivery of large and heavy components including the nuclear pressure vessel to the site. For inland sites, not near navigable water, the reactor vessel must be shipped to the site overland or be field fabricated, as now being done at the plants near Monticello, Minnesota and Vernon, Vermont.

The capital cost of a generating station in Kansas is different than in the cold north or the extremely warm south because of the design and construction factors involved. The labor market is different here and the pay scale for operators and for contractor personnel for construction affects the cost of energy.

These are but a few of the factors which may distinguish our State from other states when evaluating the economic feasibility of nuclear generation.

It is not the purpose of this brief paper to evaluate all the above factors in depth and I have therefore included a procedure only, Figure 2, for use in studying these factors in order to determine the comparative cost for nuclear power stations in Kansas.

Dr. Robinson has mentioned the amount of electricity generated in the State of Kansas. Figure 3 shows a linear projection of both this energy generation[3] and also of the power capacity required to meet this energy generation through the year 1980. (The growth may, however, actually occur on a compound basis.) As the population in the State of Kansas increases, the energy generation requirements increase in somewhat the same proportion.

Figure 4 is a schematic illustration of the major transmission systems within the State of Kansas. These transmission systems have been designed to carry the required amount of power from a large number of dispersed power stations. Installation of a single large nuclear power station would require extensive study and probably the modification of the transmission systems in order to best serve Kansans for normal and emergency conditions.

As you probably know, utilities in Kansas have planning and coordinating groups to plan the economic interchange of power, one of which is the Mo-Kan Pool. Rural Electric Cooperatives and municipal systems are interested in power planning as users of considerable amounts of electric power.

What are the elements involved in the cost of a nuclear power plant in Kansas? Figure 5 illustrates the cost of plants,[1,2] some of which are in the mid-western area, such as Consumers Public Power District, near Lincoln, Nebraska. Figure 5 also shows the approximate cost of the nuclear steam supply and turbine-generators offered by General Electric Company and Westinghouse, based on their price book data, (and using appropriate multiplying factor). The total plant cost for various sizes of plants are also illustrated with a line drawn as the mean cost. One can conclude that, depending on size and location, the investment cost may range from $115 to $200 per kilowatt for a nuclear power plant.

Costs of plants vary depending on the source of cooling water for the condensers. The investment cost differential for 500 and 1000 MWe plants with cooling towers (and well makeup) and, as an alternate, with circulating water from the Missouri River is listed in Figure 6. Another approach would be to place the plant on a lake and use the lake for cooling water. Development costs for the lakes vary extensively and were not estimated.

Fossil-fired plants, such as coal-fired or oil-fired plants, vary in capital and fuel costs. Oil and gas-fired plants are less expensive than coal-fired plants from a capital cost viewpoint and both are less expensive than a nuclear power plant. Usually a large coal-fired plant is about $30/kw less expensive than a nuclear plant and a gas-fired plant is about $25/kw less expensive than a coal-fired plant.

Nuclear fuel costs are quite low depending somewhat on the financial structure of the utility. Investor-owned utilities pay higher fixed charges than public-owned utilities largely due to the federal income taxes which they and their stockholders must pay. Nuclear fuel cycle costs are about 15 cents per million Btu whereas the national average costs of coal fuel is 25 cents per million Btu. In Kansas, however, coal is a lower cost fuel than the national average fuel cost for coal field areas. There are some existing reserves of economical fossil fuels in Kansas which can and should be utilized. It appears however that the local fossil fuel supplies will be used up in the forseeable future and that nuclear power will be required to supply the needs of Kansas.

A number of factors must be considered when evaluating the site for a nuclear power plant in Kansas. Since it would be a large source of generation, the load distribution and electric transmission requirements must be evaluated. Heat rejection from the current generation of nuclear plants is approximately 60 per cent greater than for a modern coal-fired plant compared on the basis of a kilowatt hour of energy output; therefore, cooling water requirements must be included in the evaluation. Factors which may affect the licensing of a particular unit and site by the Atomic Energy Commission must be considered. Some of these are: extreme weather conditions (tornado), seismology, meteorology, hydrology, geology, etc.

Transportation is an important factor since many heavy items must be transported to the site. If transportation links are poor, costs will escalate.

There will be a need for nuclear power in the future in Kansas, the degree and timing of which will be determined by the comparative economics, the complete utilization of existing energy resources, and the requirements for distribution of large blocks of power. The industrial development of Kansas depends to an important degree on the provision of ample quantities of economic electric power. Fossil fuel has supplied this energy up to now and nuclear energy can supply this power in the future wherever it is economical to do so.

REFERENCES

1. Nucleonics Week, A McGraw Hill Publication.

2. Atomic Energy Clearing House, a weekly publication by Congressional Information Bureau, Inc., 14th & 6th Street NW, Washington, D.C. 20005.

3. Statistical Abstract of the U. S. Department of Commerce 1957 to 1966.

SUMMARY OF FACTORS IN KANSAS

1. FUEL COST AND AVAILABILITY
2. TRANSMISSION
3. INTERSTATE CONNECTIONS
4. LOAD CHARACTERISTICS
5. LOAD CENTER LOCATION
6. RESERVE REQUIREMENTS
7. COOLING WATER REQUIREMENTS AND AVAILABILITY
8. PHYSICAL CHARACTERISTICS (TORNADOES, FLASH FLOODS, GEOLOGY, ETC.)
9. TRANSPORTATION FACILITIES
10. LABOR MARKET

FIGURE I
NUCLEAR POWER POTENTIAL
IN KANSAS

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KANSAS CITY, MO.
1968

PROCEDURE FOR
NUCLEAR GENERATION STUDY

1. PRELIMINARY REVIEW
2. POTENTIAL SITE STUDY AND EVALUATION
3. TRANSMISSION NETWORK ANALYSIS
4. GENERATION PLANNING
5. GENERATION COST ANALYSIS
6. TOTAL SYSTEM COST ANALYSIS
7. COMPARISON WITH FOSSIL-FIRED PLANTS
8. DECISION - SELECT MOST ATTRACTIVE ALTERNATE

FIGURE 2
NUCLEAR POWER POTENTIAL
IN KANSAS

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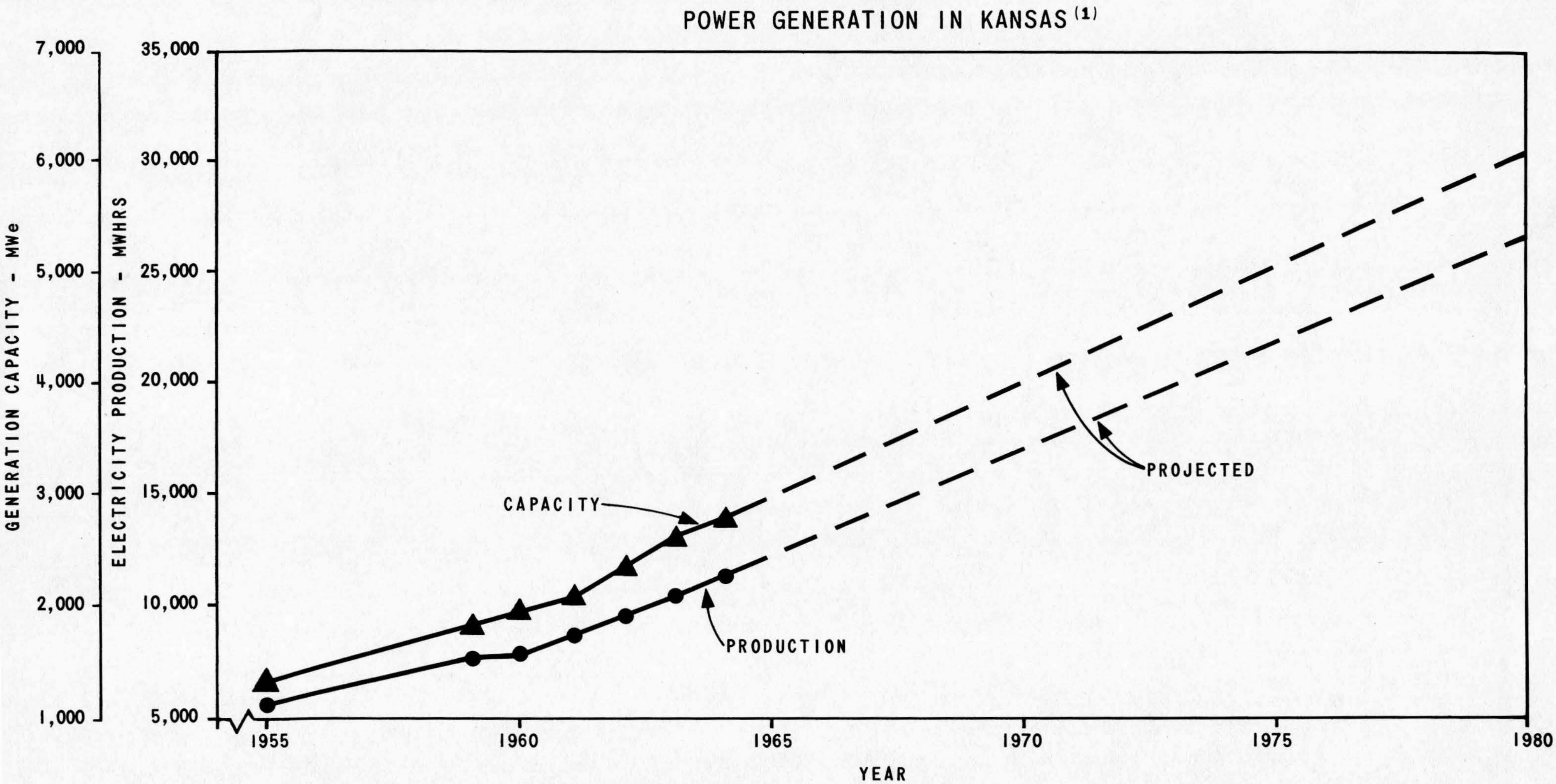
CONSULTING ENGINEERS
KANSAS CITY, MO.
1968



(1) REFERENCE 3

FIGURE 3
NUCLEAR POWER POTENTIAL
IN KANSAS

BLACK & VEATCH
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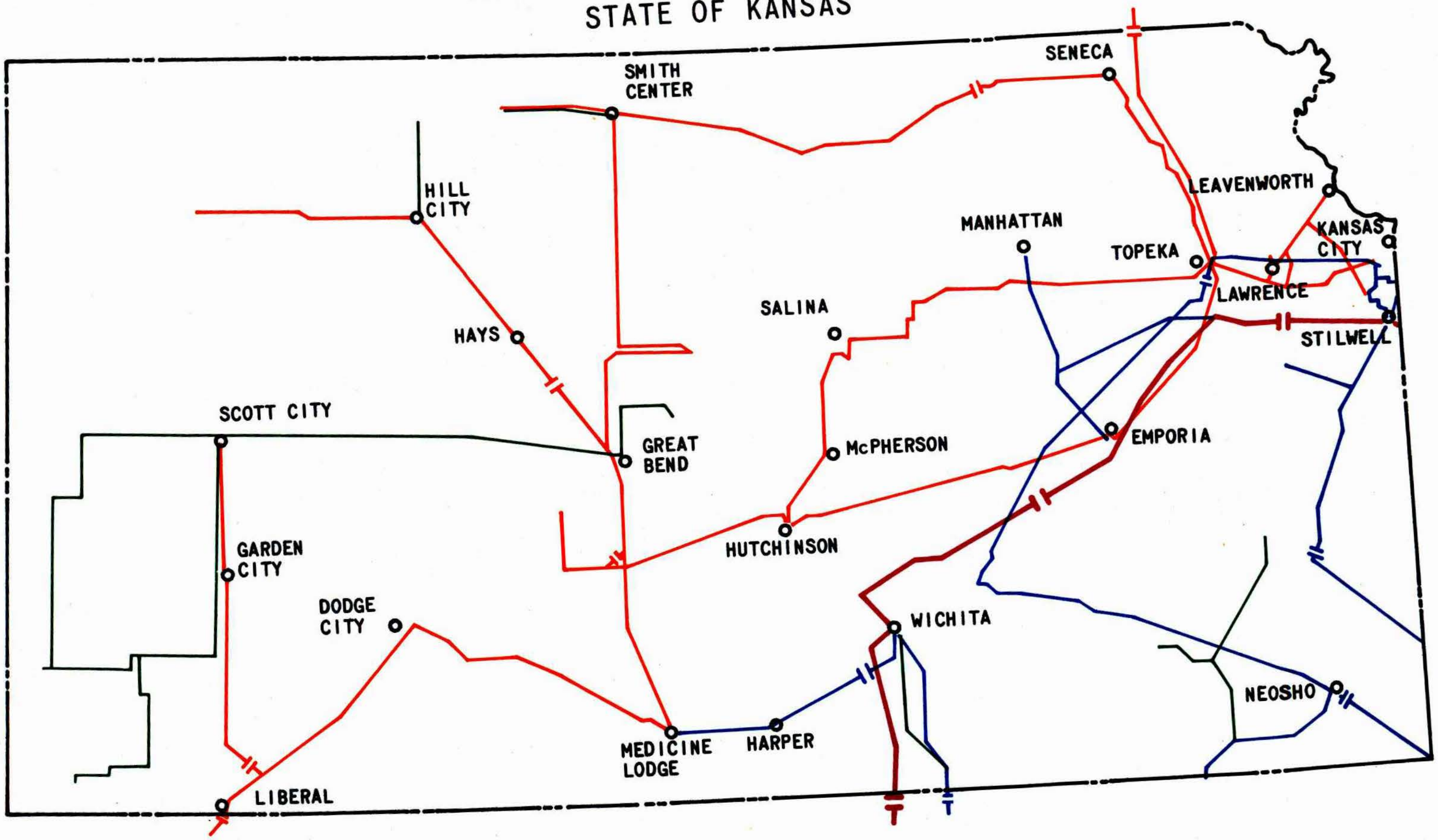
1968

MAJOR ELECTRIC TRANSMISSION
STATE OF KANSAS



LEGEND

345 KV	
138, 161, 230 KV	
115 KV	
69 KV	
34 KV (NOT SHOWN)	

FIGURE 4
NUCLEAR POWER POTENTIAL
IN KANSAS

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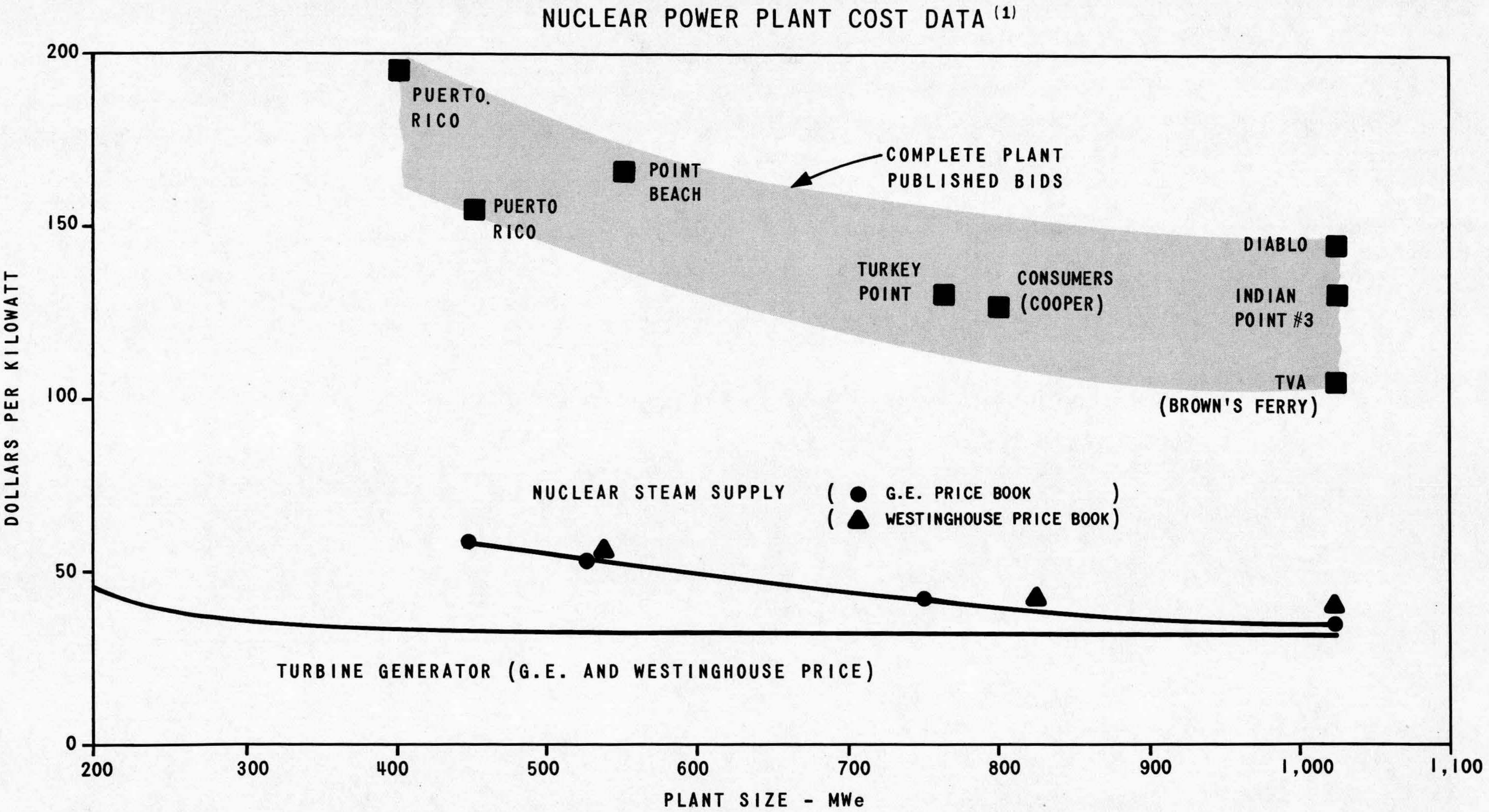

(1) REFERENCE 1 AND 2, EXCLUDING INITIAL CORE.

FIGURE 5
NUCLEAR POWER POTENTIAL
IN KANSAS

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APPROXIMATE DIFFERENTIAL CAPITAL COST FOR COOLING SYSTEMS

ITEM	RIVER SYSTEM $/KW		COOLING TOWER SYSTEM $/KW	
	500 MWe	1000 MWe	500 MWe	1000 MWe
CIRCULATING RIVER WATER SYSTEM	4.06	3.58		
COOLING TOWER COOLING SYSTEM			6.76	6.10

FIGURE 6
NUCLEAR POWER POTENTIAL
IN KANSAS

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