Minnesota Energy Agency

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VIRGINIA, MINNESOTA PEAT TEST

BURN PROPOSAL

PREPARED BY

THE MINNESOTA INTERAGENCY PEAT

TASK FORCE

The Minnesota Department of Energy, Planning & Development

epd

July 20, 1982

Lt. Governor Lou Wangberg
Chairman
Governor's Council on Rural Development
122 State Capitol
St. Paul, Minnesota 55155

Dear Lt. Governor Wangberg:

The Minnesota Interagency Peat Task Force, through its member agency, the Department of Energy, Planning and Development, the Virginia Public Utilities and the Iron Range Development Council are pleased to have the opportunity to submit this request for funding of the Virginia, Minnesota Peat Test Burn Proposal. This project represents a major effort to demonstrate the use of peat for energy in Minnesota.

In addition to the energy we in Minnesota can derive from peat, the development of this resource represents considerable new opportunities for jobs, new business development and economic improvement with benefits in northeast Minnesota and throughout the rest of the state.

This project has been designed as a demonstration as well as a test intended to gather data for technical and economic analyses. Such data will allow us to more accurately determine the actual market for which peat can be used as a fuel. Equipment similar to that in place at the Virginia power plant exists in numerous installations throughout the state; therefore, the results of this project will have considerable use.

At the present time, Minnesota has no commercial producers of fuel peat because there is no market for fuel peat. It is apparent that a market will not develop until there are stable producers. The Peat Task Force feels that it is appropriate for the state to help establish a link between the potential producers and consumers of fuel peat. This project will demonstrate that a market can be created, thus encouraging producers to invest in the facilities necessary to start a Minnesota fuel peat industry.

This document contains a copy of the proposal as well as general information relating to peat development. Dennis Asmussen, Chair of the Peat Task Force, has provided us with a memo discussing the implications of this project as they relate to peatland development. Mr. Asmussen has also included a paper discussing current and planned efforts for peat and biomass development in Minnesota. A brief discussion of the economic

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consequences of such development, in terms of its value-added potential, is presented along with an excerpt from the DNR Peat Program Final Report, relating to direct combustion. We have also included copies of an article which appeared in the Minnesota Volunteer magazine. The article is based on an interview with Dennis Asmussen.

The funds necessary to complete this project have been solicited from several sources. At the present time, funds have been received from the following organizations: Iron Range Resources and Rehabilitation Board ($25,000), Legislative Commission on Minnesota Resources ($10,000), Minnesota Power Company ($5,000), and the Department of Energy, Planning and Development/Energy Division ($10,000). This provides us with a present total of $50,000. It is felt that a minimum budget of $80,000 is required and a complete budget of $114,000 is necessary. Therefore we are requesting that the Governor's Council on Rural Development contribute $30,000 to $64,000 to this project. Funds would be channeled through the Energy Division of the DEPD as we are the group which the Peat Task Force has designated as project manager. Both budget figures will allow the project to proceed on schedule; however, the larger figure will allow us to partially compensate the Virginia Public Utility for their considerable expenses involved as well as allowing a more complete analysis and distribution of test results. This larger budget will therefore make maximum use of the information which is developed.

The need for a project of this nature is clear and the formulation of this project has been taking place since the summer of 1981. We sincerely hope that the Governor's Council shares with us this sense of need and will provide us with the additional funds needed to complete this project.

This project represents a first step toward what everyone in Minnesota is concerned with today--that is the improvement and diversification of the State's economy. We would welcome the opportunity to answer any questions you may have regarding this proposal. We look forward to your response and your support for this effort.

Sincerely,

Michael J. Murphy
Assistant Commissioner

MJM/kvs

SF-00006-02

STATE OF MINNESOTA

DEPARTMENT NATURAL RESOURCES

Office Memorandum

TO : Members of the Governor's Rural Development Council DATE: July 14, 1982

FROM : Dennis Asmussen, Chair PHONE: 296-4807
Interagency Peat Task Force

SUBJECT: The Larger Context for the Virginia, MN Peat Test Burn Proposal

The Virginia Peat test burn proposal is an issue with origins in research commissioned 5 years ago by the DNR Peat Program and is a project that has had wide discussion within the Governor's Interagency Peat Task Force, a group formed to provide a clearing-house function for all peat related issues and research proposals. The test burn project is an important effort for both concrete and symbolic reasons including: 1) the need to physically demonstrate the ability to burn peat in conventional boilers in Minnesota, 2) the importance of linking in one project harvesting, drying, densification, transportation and final combustion of peat, 3) the significance of peat to employment and industrial needs in a predominantly non-urban area, and 4) the symbolic importance of this first demonstration to a fledgling but potentially vital new industry. The larger context for this test is the over six years of work the DNR has invested in peat research. Also part of this context are the peat management policies the DNR and the Task Force developed to guide the management of Minnesota's Peatlands. These policies, now being implemented (see accompanying handout), were widely reviewed and discussed by the legislature and others during the 1981 Legislative Session. The policies are cautious about large-scale peat mining but supportive of small and moderate-scale enterprises along the lines developed by the Irish and Finns. The Virginia test burn is complimentary with this emphasis.

Development Opportunities (also see accompanying handout)

Minnesota's peat resources provide the opportunity to derive energy in several forms but the most important initial application is direct combustion as a substitute for coal. This is widely practiced in Ireland and Finland where significant percentages of electric generation and home heating depend on peat. Minnesota has a similar potential to satisfy a share of the state's energy requirements from peat or biomass, however, promotion and support is probably necessary to initiate movement toward this goal. In northern European countries the use of peat, especially in initial stages of development, enjoyed several forms of subsidy and incentive (low interest financing, grants, price restraints). In some form, and the Virginia Test Burn is an example, incentives must be provided in Minnesota too. In the future other forms of peat derived energy may be important. These include gas and liquid conversions that are discussed elsewhere.

Development Impacts

There can be both beneficial and negative impacts from peat mining and development. The latter, we are confident, can be mitigated or controlled for small and modest scale mining activities employing, for instance, water retention at drainage outlets and measures to control wind erosion of stockpiled peat. In addition, the DNR includes stringent reclamation requirements in all its peat mining leases.

The potential positive impacts of development have been lately much discussed: the stimulation of jobs and new industry in the depressed areas of northern Minnesota. There is a dramatic locational coincidence in northern Minnesota of peat and unemployment. Within fifty miles of the major Iron Range Communities, for example, there are several hundred thousand acres of peat with development potential. Job potential should not be overestimated, however. Peat mining employment will probably never replace the jobs lost in the declining iron mining industry. Instead, there is a potential 50 to 60 jobs created for every thousand acres of peat mined. This could total 5,000 to 6,000 jobs should we ever have 100,000 acres of peatland developed for mining and/or biomass production.

Cooperative Nature of Peat Planning Efforts

Neither the proposed Virginia Test Burn nor any other current peat or biomass endeavor is the sole province of one agency or group. What has distinguished peat development and management efforts, especially the past three years, is its intensely interactive and cooperative nature. In addition to the important roles of the two peat advisory groups (Peat Advisory Committee and the Interagency Peat Task Force) cooperation with local units of government has been a very important factor for the proposed test burn and other elements of peat planning. The Peat Program in the DNR in partnership with the Energy Division of DEPD has met on numerous occassions with local, county, and regional groups to discuss the opportunities for local peat development initiatives. Special emphasis has been given the identification of suitable peat resources in areas accessible to various northern Minnesota communities. Findings of this work have been widely shared (in Itasca, Koochiching, St. Louis, Aitkin, and Carlton counties and in various communities).

In summary, the Virginia Test Burn Proposal has significant statewide, regional, and local significance and its planning and implementation have been characterized by the intense cooperation of state, local and private concerns. If financial support permits the test to occur, we may expect several important benefits including, the promotion of a new industry with impacts on direct and indirect employment and, the beginnings of a trend to make Minnesota more energy independent. And this can occur in an area of the state with

high unemployment, rural character, and crying need for diversification and value-added enterprises. Parenthetically, support for the test burn proposal will not be at odds with or duplicate effects of the recently passed Iron Range emergency employment initiative. That legislation permits only 25% of total funds to be spent for long range development projects; the rest must be spent for immediate employment opportunities. The test burn proposal, in contrast, is part of a long-range plan to carefully develop peatland energy resources.

MINNESOTA'S PEAT/BIOMASS PROGRAM

CURRENT POLICIES AND ACTIVITIES

Policies

The DNR has developed policies with respect to peatland resources based upon 5 years of field-based research and the review and comment of numerous agency staff, citizens groups, and legislative bodies. The Governor's (appointed) State Interagency Peat Task Force (led by DNR and including Agriculture, DEPD, SPA, PCA, LCMR, and others) has played a critical role in coordinating the development of these policies and continues to promote the rational management of the resource. Policies governing the leasing and management of the peatlands include the following points:

Peatlands should support a diversity of uses including energy, horticulture, agriculture, forestry, recreation and protection.

Development must be accompanied by proper environmental controls, among them, monitoring of air and water, mitigation of adverse impacts, and reclamation of mined areas.

For the present, and until technological progress and economic feasibility are otherwise, lease tracts of a maximum of 3,000 acres will be offered in public sale. Lease area additions in subsequent years will be granted developers if need is demonstrated.

The Department is and has been encouraging concrete development proposals from the private sector; to date only one (Fleet Mgmt). has surfaced. It is the Department's estimate that economics, not state government policies, are the chief impediment to development.

CURRENT MANAGEMENT ACTIVITIES

The DNR and the Interagency Peat Task Force are proceeding on a number of fronts to promote reasonable peat/biomass development, a few of which will be mentioned here.

Mapping Resource Availability

Recently, the DNR completed the first phase of a continuing computer mapping program designed to identify areas of the state's peatlands that have the highest suitability fro energy, horticulture, agriculture and other uses. So far, the Peat Program has mapped, in an eight county region, the areas of peatland that are available for leasing for energy purposes (see attached press release). Following on this initial work the program plans to further refine the peat suitability criteria to include water proximity and other variables.

Virginia Test Burn

The Interagency Task Force on Peat is sponsoring the testing of peat in the boilers of the power plant in Virginia, Minnesota this summer. The test will establish the feasibility of burning densified peat as a substitute for coal. If successful, the city of Virginia has expressed interest in using peat if the costs are competitive with coal.

Current Leasing Activities

The DNR leased the peat in the West Central Lakes Bog in December 1981. In 1982 the Department plans to lease one or two additional deposits if demand warrants doing so. The Peat Program also has identified other horticultural bogs in 4 counties that appear to be suitable candidates for leasing and has had contact with the county boards of several of these counties to coordinate state and county leasing efforts.

THE PROSPECTS FOR PEAT AND BIOMASS DEVELOPMENT

Companies and Concerns Expressing Interest in Peat/Biomass

The DNR and DEPD have been in contact with a number of parties interested in peat and/or biomass development. These include the American Peat Company of Hill City, Minnesota, Stott Briquett, Superior Wisconsin (Bob Beaudin), Power-o-Peat (Gardner McKay in St. Louis County), Gene Harter of California (who owns 4,000 acres of peat near Zim), Control Data (interested in the future business a peat industry might represent) and one European producer (from Sweden). In addition numerous inquiries from consulting firms and interested companies from around the country signal that interest is high in the potential of peat for energy production and in horticultural markets.

Potential Markets for Peat/Biomass

Peat can be converted into solid, liquid or gaseous fuels. The solid fuel market consists of existing large boilers and new boilers designed to burn peat.

The existing boiler will, in most cases, require a peat fuel which is quite dry and dense. A peat cube or briquette containing 10 to 20% moisture would probably be satisfactory. The fuel should cost about $30-$35 per ton in order to directly compete with western coal. This price is lower than what can be reasonably expected from a new, relatively low volume industry. However, economic benefits gained from peat production may well justify a subsidy which could get the industry started.

New boilers would most likely be designed to burn milled peat. The use of peat in this form would reduce its cost. In the long run, conversion to milled peat could eliminate the need for purchase subsidies. A natural progression would be to start with densified peat in existing boilers, and over time convert to newer equipment as production economics dictate. In any case some form of help will be needed to get the new industry started.

Liquid and gaseous fuel can be produced from peat through gasification and chemical synthesis. The first step in the process is gasification to produce a mixture of carbon monoxide and hydrogen. This mixture may then be reacted to produce methane (pipeline quality gas), methanol (a potential liquid fuel), or other chemicals. The cost of these fuels produced from peat could be competitive with deregulated natural gas, Alaskan, or newer more expensive petroleum. They will not compete at current prices, which are influenced by costs of older traditional energy supplies.

Potential markets are quite large. Pipeline quality gas could be injected into the existing distribution system to displace Canadian supplies. Methanol could be used by local refineries to improve the octane rating of unleaded gasoline.

Even a small substitution of locally produced fuel would create a large economic benefit in northern Minnesota. A 6 million gallon per year methanol plant could generate as many as 60-70 jobs and about $800,000 per year of income plus sales taxes. Ten plants of this size would constitute only 3 percent of Minnesota's gasoline demand. Peat, and in the longer run, biomass would provide a useable feed stock for these fuel production processes.

Long-term Research Needed

Looking beyond the immediate potential for mining peat for direct combustion we must plan for energy production from peatlands and other wetlands in the long run. Minnesota's best hope in this regard lies in renewable biomass crops -- willows, cattails, and other fast growing species that can thrive on marginal lands. The Interagency Task Force recently submitted a proposal to the LCMR to do hands-on-work in the field with growth and productivity of biomass crops and harvesting methods.

Current Status: Peatland Management Activities

Since the release, in summer 1981, of the Peat Program Final Report and Policy Recommendations to the Legislature, the Department of Natural Resources and the other agency members of the Interagency Peat Task Force have worked to enunciate a rational development process for the state's peatlands. An aspect of this is the recent work of the DNR Peat Program to map peatlands of highest suitability for the variety of uses recommended in the Department's policies. Before discussing the findings of this mapping process, however, a short review of the state's peatland management policies is provided below.

Peatland Policies Overview

- To encourage a diversity of uses (not only energy but horticulture, forestry, wildlife, and others);
- To offer leases for up to 3,000 acres in public (sealed bid) lease sales;
- To maintain northern Minnesota's high quality of environment by requiring:
  - -Monitoring of air and water connected with peat mining operations or peatland drainage,
  - -Impact control measures, such as settling ponds for bog outlets,
  - -Reclamation of all mined or disturbed leased state peatlands, and
  - -Protection of peatlands with unusual characteristics or value for wildlife, forestry, or continuing scientific study.

Current Policy Status

The DNR is currently encouraging proposals for peatland leasing. To date, one bog (West Central Lakes) has been leased to a prospective horticultural and energy peat producer. Other bogs will be offered as interest is expressed. There are no barriers at the state level to immediate initiation of the leasing process, should interest be expressed.

The only barriers to the initiation of a peat-based industry in Minnesota are economic and, to some extent, technical. Peat may initially not be able to compete with cheaper coal. In the short run, some economic boost may be required to establish the economic feasibility of peat fuels. Once a market is created and demand established economic subsidy might be diminished or dispersed with. It is likely that the economic and employment benefits of initiating a peat-based energy industry will outweigh the costs.

Current Peatland Management Efforts

The identification of peatland areas suitable for horticultural or energy mining (as well as other development types) is a principal management activity of the DNR Peat Program. Using information being gathered by the Peat Inventory Project we are identifying the depth, quality, extent, and location of Minnesota's significant deposits. To date, the important peat resource counties of St. Louis (the SW part), Koochiching, Aitkin, Beltrami (northern part) and Lake of the Woods have been surveyed and sampled. Reports describing peat characteristics in these counties are available for St. Louis and Koochiching, nearly available for Aitkin, with the balance of reports to be made available over the next 18 months.

The maps produced by the peat inventory project are excellent resource maps by themselves. However, we have added further to their utility by encoding their information in the LMIC computer files. This step permits the combination of peat resource information with the plethora of cultural and physical information existing in the LMIC files.

Computer maps can be produced through this means to show peat resource characteristics in combination with, for example, peatland ownership,

accessibility, distance from cities, water proximity of peatlands, presence of forest cover types, and many other variables.

Recently, the program produced computer maps that identify peatlands satisfying three current state management needs, specifically:

-the need to protect some categories of peatland from development (examples-wildlife lands, forest resources, high amenity areas and areas of scientific interest)

-the need to identify areas of peatland available for immediate development

-the need to allocate the balance of the state's resource to a peatland reserve from which, should future requirements dictate, acres could be withdrawn for a variety of uses.

The map following this narrative shows the peatlands in an eight-county region in northern Minnesota that appear to be suitable and available for immediate development. Of course, more detailed site analysis and inventory will be required to identify sites for concrete development proposals. Specifically, the map shows areas of peatland in the 8-county region that:

1. are at least 1000 acres of contiguous bog in size;
2. are no farther than 51 miles from one of the communities of International Falls, Grand Rapids, Duluth, Hibbing, Virginia, and Bemidji;
3. are within one mile of a road access point, but no part of the bog is farther than 6 miles from the road;
4. are not in recommended protected status (wildlife management areas, or unique areas);
5. are state-owned and, therefore, leaseable.

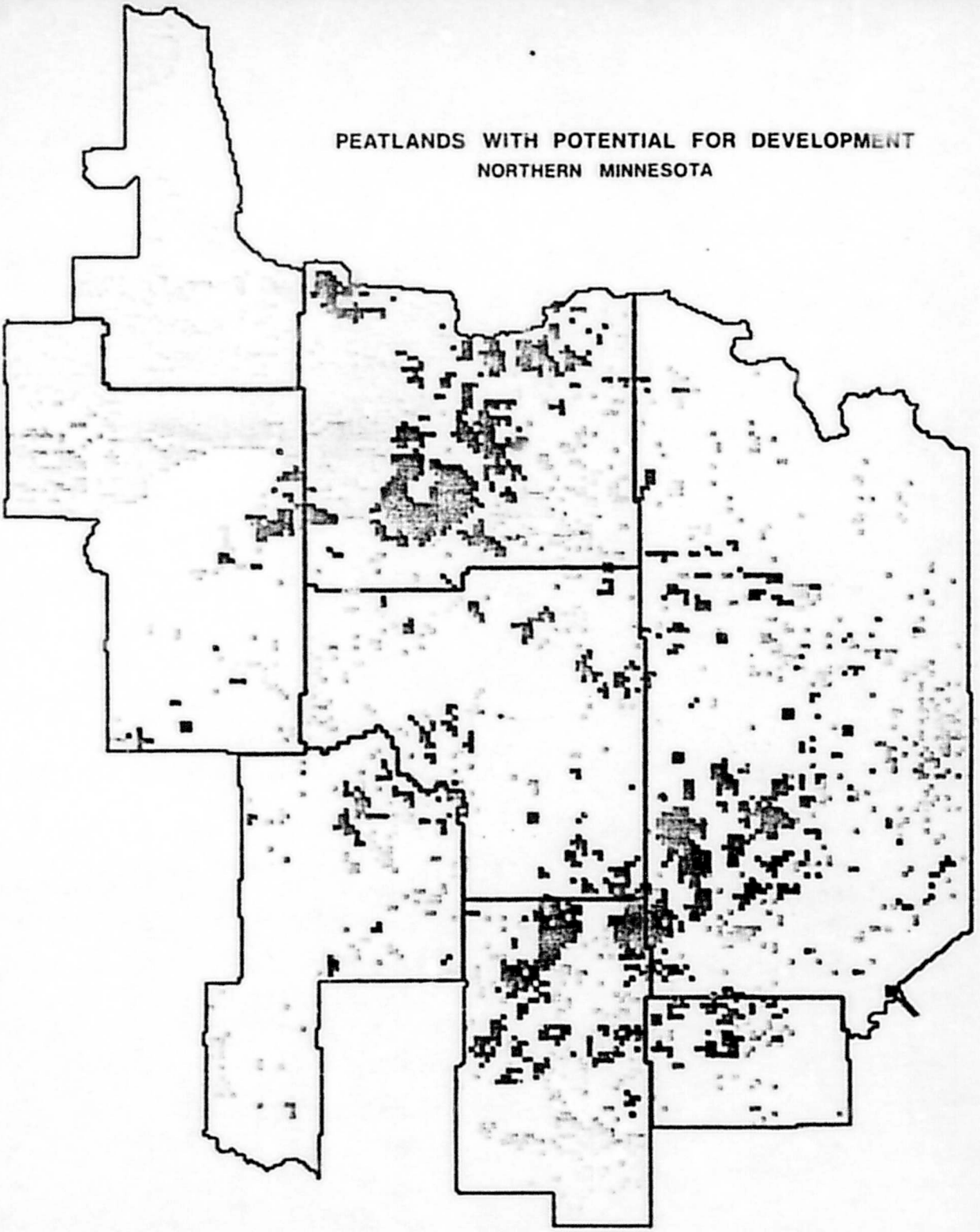
Peatlands with immediate development potential total nearly a million acres. However, due to technical difficulties in computer programming, we have not yet identified the depth factor for these peatlands (mining requires at least 5 feet). A guess would be that 20 to 30% of the total are peatlands greater than 5 feet in depth. Of course, the shallower acreages could have value for bioenergy crops, forestry or agriculture. In addition,

there are 123,000 acres of private peatland holdings and over 2.5 million acres of peatland reserve, which includes areas that are currently inaccessible, smaller than 1,000 acres, protected, or in protected ownership categories such as tribal lands, state and national parks, the BWCA and so on.

Summary

Finland, a country rich in peatlands and advanced in peatland development and management, has about 100,000 acres under production currently. From this plus some additional acreage to be added about 10 percent of the nation's energy needs will eventually be provided. The Minnesota Peat Program has identified, through its computer mapping activities, between 200,000 and 300,000 acres of deep, available, and accessible peat that could be leased in 5,000 acre units by the state to private sector producers, assuming environmental and other rules be satisfied. This resource and our state policies, the Inter-Agency Task Force believes, set the state for the kind of peat-based energy industry thriving today in northern Europe.

PEATLANDS WITH POTENTIAL FOR DEVELOPMENT
NORTHERN MINNESOTA



SYMBOL	COUNT	PERCENT	ACRES	LEGEND
1	95	0.1	15200.0	CITIES: BEMIDJI, DULUTH, GRAND RAPIDS, HIBBING, INTERNATIONAL FALLS, VIRGINIA
2	6334	6.8	1013440.0	STATE AVAILABLE
3	704	0.8	112640.0	PRIVATE
4	13445	14.5	2151200.0	OTHER PEATLANDS
5	72260	77.8	11561600.0	MINERAL OR WATER

Economic Benefits of Peat Development

Introduction

The Minnesota Interagency Peat Task Force, the Virginia Public Utility Commission, the Iron Range Development Council and Minnesota Power Company have proposed a peat test burn in Virginia, Minnesota. The proposal and its engineering aspects are contained in a separate document

This paper discusses the economic benefits of processing northern Minnesota's peat resources. The value added in the production process, job creation, economic development and environmental benefits will be included in the discussion. Direct cost savings in energy production could be realized if peat is cheaper than coal. The purpose of this paper is to discuss other economic benefits beyond the direct cost savings.

Valve Added

This test will demonstrate the feasibility of burning Minnesota peat instead of coal imported from other states. If the test is successful, it will open the door to development of peat for energy production. If this development occurs, it will create a new industry with characteristics of the mining or agriculture industries.

At present, Minnesota's electricity and district heating are fueled primarily by coal. Western states such as Montana and North Dakota have enjoyed substantial economic benefits from coal and lignite production. One of those benefits has been the demand for labor in the mining sector. If peat is mined to replace coal, it will create jobs in Minnesota that would have gone to other states.

Peat development will also enhance the overall level of economic development in Minnesota. The value of the coal that would have been

imported will be retained in the state instead. This will increase the vertical integration of the state economy. As a result, more of wages, tax revenues and profits will remain in Minnesota. The benefits of this development will not be confined to northern Minnesota. Through the multiplier effect, the benefits will spread throughout the entire state.

If a dollar is spent on Minnesota goods instead of goods from another state, that dollar is received as income by someone in Minnesota, and is spent again on other goods. This process continues until the dollar is invested or spent on goods from another state. This multiplier effect spreads throughout Minnesota like ripples on a pond, increasing wages, economic output and tax revenues throughout the state.

The Department of Energy, Planning and Development has developed a quantitative measure of the multiplier effect. Every dollar spent on energy from an electric utility generates $1.61 of economic output within Minnesota. By contrast, a dollar spent on electricity from peat or biomass would generate between $2.00 and $3.00 of gross state output.

The benefits to the state as a whole are clear. However, this is an instance where the whole is greater than the sum of the parts. Although the benefits would be enjoyed by many Minnesotans, particularly those in rural northern Minnesota, the costs are not easily apportioned to everyone receiving benefits. Therefore, it would be appropriate for a group such as the Governor's Council on Rural Development to defray part of the cost of the test.

Environment

Peat contains 73% less sulfur than coal. This can lead to lower costs if less desulfurization equipment is required to burn peat. Less sulfur in the fuel can result in less sulfur in the atmosphere.

Atmospheric sulfur can be captured by raindrops and fall to the earth as acid rain. As this rain runs into lakes, it increases their acidity, eventually killing fish, plant life and other wildlife in the lakes. A recent study by the U.S. Congress showed that 48% of northeast Minnesota's lakes are at risk of acidification. The effects of acidification on the tourist industry of northern Minnesota could be devastating. The use of peat instead of coal could reduce this risk substantially, in addition to reducing the cost of pollution control equipment.

Minnesota has 5.9 million acres of peat, 12% of which are in use for agriculture and other purposes. The remaining 5.2 million acres are available for development, except for perhaps 360,000 acres of state-administered land that could be set aside for wetlands preservation and protection.

One possible conflicting use is the extraction of sphagnum peat moss for horticultural use. Sphagnum peat comprises 2% of the total peat resource in Minnesota. Thus, extraction for horticultural purposes of all sphagnum peat would still leave almost 5 million acres of peat available for energy purposes.

Energy crops could be grown on peatlands, which might conflict with peat extraction. However, recent studies have shown that energy crop production could be enhanced by the removal of some peat. More research is in progress on energy crop production, but it does not now appear to be in conflict with peat extraction.

Conclusion

The proposed test burn at Virginia, Minnesota will demonstrate the feasibility of burning peat as fuel. If the test is successful, it could lead to the development of a peat mining industry in Minnesota.

This industry could capture jobs, income and tax revenues that are presently benefiting other states. These economic benefits would concentrate in rural northern Minnesota, and would spill over to the rest of the state through the multiplier effect.

The following discussion pertaining to the direct combustion of peat has been excerpted from the "Minnesota Peat Program Final Report".

DIRECT COMBUSTION

INTRODUCTION

Direct combustion of peat is a method of producing energy, which has been developed in Ireland, Finland, and the Soviet Union. Like coal and oil, peat is used as fuel to fire steam boilers. The steam turns turbines to generate electricity. The thermal efficiency of this process can be increased by also using the steam to heat water for district heating networks.

Peat used for direct combustion is usually mined by the milled-peat or sod-peat methods. Further processing of the peat depends on the type of boiler. Most boilers in Finland and Ireland use milled peat that has been dried with hot gas and pulverized. Sod peat and briquettes, which are milled peat that has been screened, dried, and pressed, are used in some boilers. Briquettes are also sold for use as a domestic fuel.

RESOURCE REQUIREMENTS AND AVAILABILITY

Peat-fired power plants in Europe are of various sizes: 20-MW, 30-MW, and 40-MW plants are common in Ireland; one of Finland's largest plants produces 60 MW of electricity and 117 MW for district heating; the Soviet Union has plants as large as 600 MW.

A 20-MW plant operating at 40% efficiency is estimated to consume 2,000 acres of peat 5 feet deep during a 20-year plant life. Given the same conditions, a 100-MW plant would require about 10,000 acres of peat.

Hemic and sapric peats are the peat types suitable for direct combustion. The greater the degree of decomposition, the greater the fuel value of the peat. However, the more decomposed sapric peats often contain large amounts of ash, which reduces the fuel value of the peat because it is not combustible. Thus, hemic peat generally has the highest fuel value. The U.S. Department of Energy (DOE) has set 25% ash content as the upper limit in their definition of fuel-grade peat.

DOE has set three other criteria for fuel-grade peat: (1) the peat must have a heating value of 8,000 Btu/lb (dry weight), (2) peat areas must have greater than 80 acres of peat/square mile, and (3) the peat must be more than 5 feet deep. Figures 9, 10, and 11 show the location of the peat resources, including fuel-grade peat, in the areas inventoried by the Minnesota Peat Inventory Project.

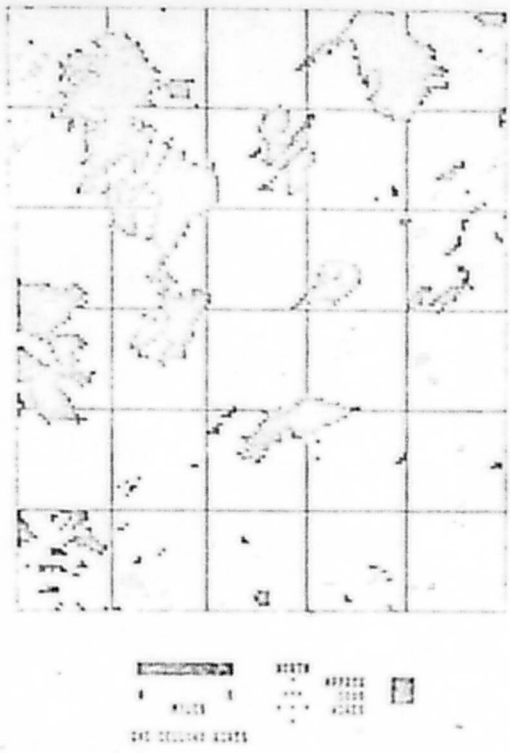
TECHNICAL FEASIBILITY

The technology of peat-fired power plants is well developed in Europe and the Soviet Union and is not

SYMBOL	PERCENT	AREA (ACRES)	DESCRIPTION
	19.5	599200	DEEP PEAT 150+ CM. (APPROX. 5+ FEET)
	36.6	748360	SHALLOW PEAT 0-150 CM. (APPROX. 0-5 FEET)
	42.8	876200	MINERAL SOIL
	1.1	22240	WATER

THIS STUDY IS BEING CONDUCTED BY THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF WATERS, IN COOPERATION WITH
THE MINNESOTA STATE CLEARINGHOUSE AGENCY, LAND
MANAGEMENT INFORMATION CENTER

Fig. 9. Peat Resources in Koochiching County



SYMBOL	PERCENT	AREA (ACRES)	DESCRIPTION
	16.1	109760	DEEP PEAT 150+ CM. (APPROX. 5+ FEET)
	23.8	162960	SHALLOW PEAT 0-150 CM. (APPROX. 0-5 FEET)
	59.2	404520	MINERAL SOIL
	0.9	6280	WATER

Fig. 10. Peat Resources in Southwest St. Louis County

significantly different from the technology of coal and oil-fired power plants. Ekono, Inc. investigated the feasibility for the Minnesota Peat Program of using peat in two existing power plants in Minnesota, in pelletizing kilns at the Eveleth Taconite Company, and in a new power plant that would be designed to use peat (Ekono, Inc. 1977).

Ekono, Inc. determined that the two power plants and the pelletizing kilns could be modified to burn peat. They also determined, however, that the advantages of using peat are most evident when a new plant can be designed and built specifically for using peat.

Peat mining technology for direct combustion is available if milled-peat or sod-peat methods are feasible. Wet mining methods, however, are still being developed. Furthermore, if a wet mining method is used, the peat must be dewatered, and those technologies are also still being researched.

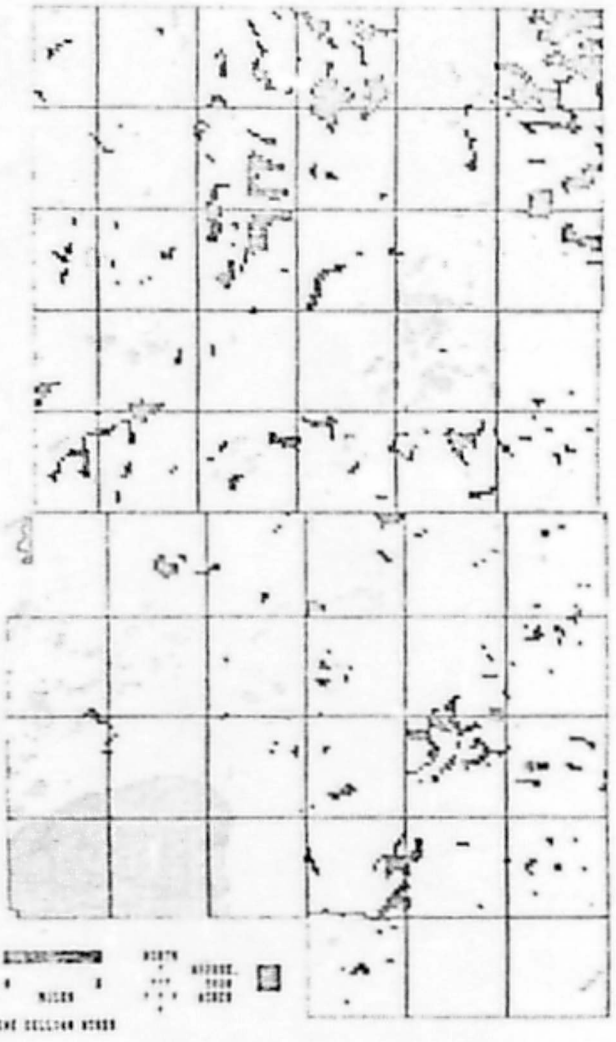
ECONOMIC FEASIBILITY

A major barrier to using peat as a power-plant fuel in Minnesota is economic feasibility. Neither the modification of existing plants for peat nor the construction of new peat-fueled plants is likely to occur unless the cost of using peat is competitive with the cost of using other fuels.

Because peat has never been used as a fuel in the United States, it is difficult to determine its cost. The following factors will affect the cost:

- the cost of mining peat,
- the cost of transporting the peat to the plant, and
- the cost of reclamation and mitigation of environmental impacts.

While the cost of peat is probably the most important factor in determining the economic feasibility of using peat as a fuel, the cost of modification or construction of plants must also be figured in. For the four cases studied, peat would have to be $0.20 to $0.40 cheaper per million Btu than coal (Ekono, Inc. 1977).



SYMBOL	PERCENT	AREA (ACRES)	DESCRIPTION
	5.8	74600	DEEP PEAT 150+ CM (APPROX. 5+ FEET)
	27.0	345080	SHALLOW PEAT 0-150 CM. (APPROX. 0-5 FEET)
	59.3	757880	MINERAL SOIL
	7.9	100520	WATER

Fig. 11. Peat Resources in Aitkin County

1.0 INTRODUCTION

The Minnesota Interagency Peat Task Force, in cooperation with the Iron Range Development Council, proposes to test the use of peat as a fuel in conventional boilers for the production of both electric and thermal energy which can be used in district heating systems. This test, to take place in August, 1982, at the municipal power plant in Virginia, Minnesota, is the first hands-on effort to demonstrate the technical and economic viability of using this State resource for energy purposes.

Peat, a sizeable Minnesota resource, has potential for development to meet energy needs, to create new jobs, to develop new businesses and industries and, importantly, to help reduce the State's dependence on traditional fuels-oil, coal, natural gas--which must be imported. In order to determine where and when peat could be utilized in Minnesota, it is necessary to apply available resource and technology to test and pilot demonstration efforts. This test burn will accomplish this goal.

While the primary objective of this project is to further define the potential of peat as an energy resource, there are other objectives which also will be sought. They include determination of:

1) the maximum sustainable capacity of the boiler relative to its design capacity, using peat, and peat/coal mixtures, rather than the fuel (coal) for which it orig lly was designed;

2) boiler efficiency;

3) emissions from the boiler (gases and particulates);

4) prevailing conditions relating to fuel handling, ash production and other operating characteristics.

While it is premature to speculate on the actual economic potential of peat as a boiler fuel, this effort will advance understanding considerably and is a logical next-step toward determination of peat as an energy and an economic opportunity in Minnesota.

2.0 The Minnesota Interagency Peat Task Force

The Minnesota Interagency Peat Task Force, under the lead of the Department of Natural Resources, coordinates peat policy for the State of Minnesota. The task force includes representatives from many groups concerned with the use of peat: the Department of Energy, Planning and Development, the Pollution Control Agency, the Department of Agriculture, the Iron Range Resources and Rehabilitation Board, the University of Minnesota Departments of Soil Science and Botany, the Minnesota Geologic Survey and the Center for Urban and Rural Affairs.

The Energy Division of the Department of Energy, Planning and Development will be the lead agency for the pilot peat test burn. Its engineering analysis activity, which has managed the state's district heating and biomass projects, will manage the test burn project. The Department of Natural Resources will advise onpeat harvesting and preparation, and other task force members will provide advice as needed. Consultants will be hired for test burn management, emissions testing and laboratory analysis, as needed.

3.0 Economic Impact of Peat Development

In 1979 the States of Minnesota, Wisconsin and Michigan imported a total of 21 million tons of western coal that cost $406.4 million. This represents a significant flow of money from these states, slowing growth in the economy, lowering employment and limiting investment. The Minnesota Energy Agency, in its 1980 Biennial Report, estimated that a dollar spent on peat for fuel rather than coal would create an additional 41¢ of economic activity in the state. The following table illustrates the potential for fuel peat usage.

	Minnesota	Wisconsin	Michigan
Western coal imported in '79 (millions of tons)	12.1	5.2	3.7
Cost (millions of dollars)	$203.9	$98.4	$104.1
Equivalent of coal in dry peat fuel (millions of tons)	16.3	7.1	5.5
Peatlands (millions of acres)	5.9	2.8	4.5
Peat supply, '79 consumption levels	300 years	300 years	600 years

About one-third of the coal used in Minnesota is used near northern peatlands. The market for peat in existing Minnesota boilers could reach 1 million tons of peat per year, considering only the obvious market of municipal utility boilers near peat regions. The use of peat at this level could create nearly 200 new jobs. Wisconsin and Michigan could have similar economic impacts from the development of a peat industry.

4.0 Project Design

The proposed project will consist of a series of tests, each using a different fuel mixture (see Table 1). The objectives are those already stated in section 1.0. Theoretical calculations presented in the Appendix provide us with an initial estimate of the test results.

4.1 Method of Approach

The approach to this project is intended to conform to accepted industry standards, thus allowing for maximum use of the data collected. The required work can be grouped into four major areas as follows:

1) Test preparation - Consists of preliminary equipment inspection, and repair where needed, such that a base line condition can be defined. As testing progresses the equipment (of most interest is the condition of the boiler) will be inspected and changes noted. The other item in this task is fuel mixture preparation. Fuel mixtures will be prepared according to the schedule presented in Table 1.

2) Testing - Testing will be done in accordance with the ASME[1] heat loss method. The method requires the determination of a number of heat losses and credits (see heat balance of a steam generator, figure 1).

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[1] American Society of Mechanical Engineers

These values will be determined from the measurements to be taken (Table 2). A number of other parameters, besides those required, will be measured to establish the behavior of the system. A total of six tests will be conducted, the first two will be control burns using eastern and then western coal. Each test will require two to three days (approximately 24 hours actual burning time). Following each test the boiler will be shut down, cleaned and inspected.

3) Laboratory work - The major laboratory work required will be for fuel and ash analyses. These tests are required for determining the boiler efficiency. In addition to these analyses it is desirable to run tests for:

   a) particle size distribution of fuel
   b) friability of fuel
   c) grindability of fuel
   d) free swelling index of fuel
   e) pH of ash

   These additional tests will assist in assessing the handling characteristics and use of the fuel in other boiler types (particularly in pulverized coal fired units).

4) Data analysis - Data will be analyzed according to standard engineering practices.

4.2 Personnel Needs and Facilities

The personnel required for this project will be drawn from the following sources:

1) Virginia Public Utilities
2) Minnesota Department of Energy, Planning and Development - Energy Division
3) As yet unspecified consultants in the areas of:
   a) test management
   b) stack testing
   c) laboratory analyses
   d) fuel preparation and delivery

Note: Some of these tasks may be done by other state agencies.

The test will be conducted at the Virginia Public Utilities power plant in Virginia, Minnesota. Boiler number 5 (possibly number 6) will be used for testing. It is a 60,000 pound per hour steam boiler operating at 400 psig and 725°F. The unit was manufactured at Edge Moor Iron Works and installed in 1949. Originally the fuel used was eastern coal which was fed using a Detroit Rotograte stoker. There is overfire air provided as well as fly ash recirculation. The boiler has not been in regular service for several years due to emissions problems. A sectional view of the boiler is shown in figure 2. The relationship of this boiler to other plant components can be seen in figure 3.

4.3 Time Schedule

Figure 4 indicates the time schedule to be followed. At

the present time, the planned starting date is September 1, 1982.

4.4 Budget

Estimates of major budgeting outlays are included in Table 3. Cost figures for subcontracted activities are the best estimates available to us at the present time. A large sum is allocated for instrument preparation because of the high cost of repair and calibration.

5.0 Summary

This proposal has been developed around standard testing methods in order to make the results as useful and reliable as possible. The results will allow the preparation of a series of performance curves indicating the relative behavior of fuel peat to coal. This information can then be used in planning for the potential use of peat as a supplement to currently used coal supplies.

Besides the three major objectives; maximum capacity, efficiency and emissions; there are a number of things which can be observed. Among these are the handling behavior of peat and mixtures of peat and coal. Ash and ash handling characteristics will also be observed.

Completion of this test will help provide answers to some of the questions relating to fuel peat usage. It will also help to demonstrate the use of peat and allow the determination of the actual size of the fuel peat market.

TABLE 1: FUEL MIXTURES

Test	Peat:Coal	Tons of Peat	Tons of Coal	Tons of Fuel[1]
1	0:1	0	80	80
2	0:1	0	125	125
3	1:3	32.5	97.5	130
4	1:1	67.5	67.5	135
5	3:1	105	35	140
6	1:0	150	0	150
	TOTALS	355	325[2]	680[2]

[1] estimate of fuel required for 24 hour test

[2] does not include test 1 (test 1 = eastern coal)

totals do not include fuel contingencies

TABLE 2: REQUIRED MEASUREMENTS TO BE TAKEN

Weights of:

1) fuel fired
2) water fed
3) water blown down
4) ash pit refuse
5) fly ash

Temperatures of:

6) feedwater
7) superheated steam
8) gas to and from air heater
9) air to and from air heater (wet and dry bulb)

Pressure of:

10) steam
11) gas in furnace
12) gas at boiler outlet
13) gas at air heater inlet
14) air undergrate

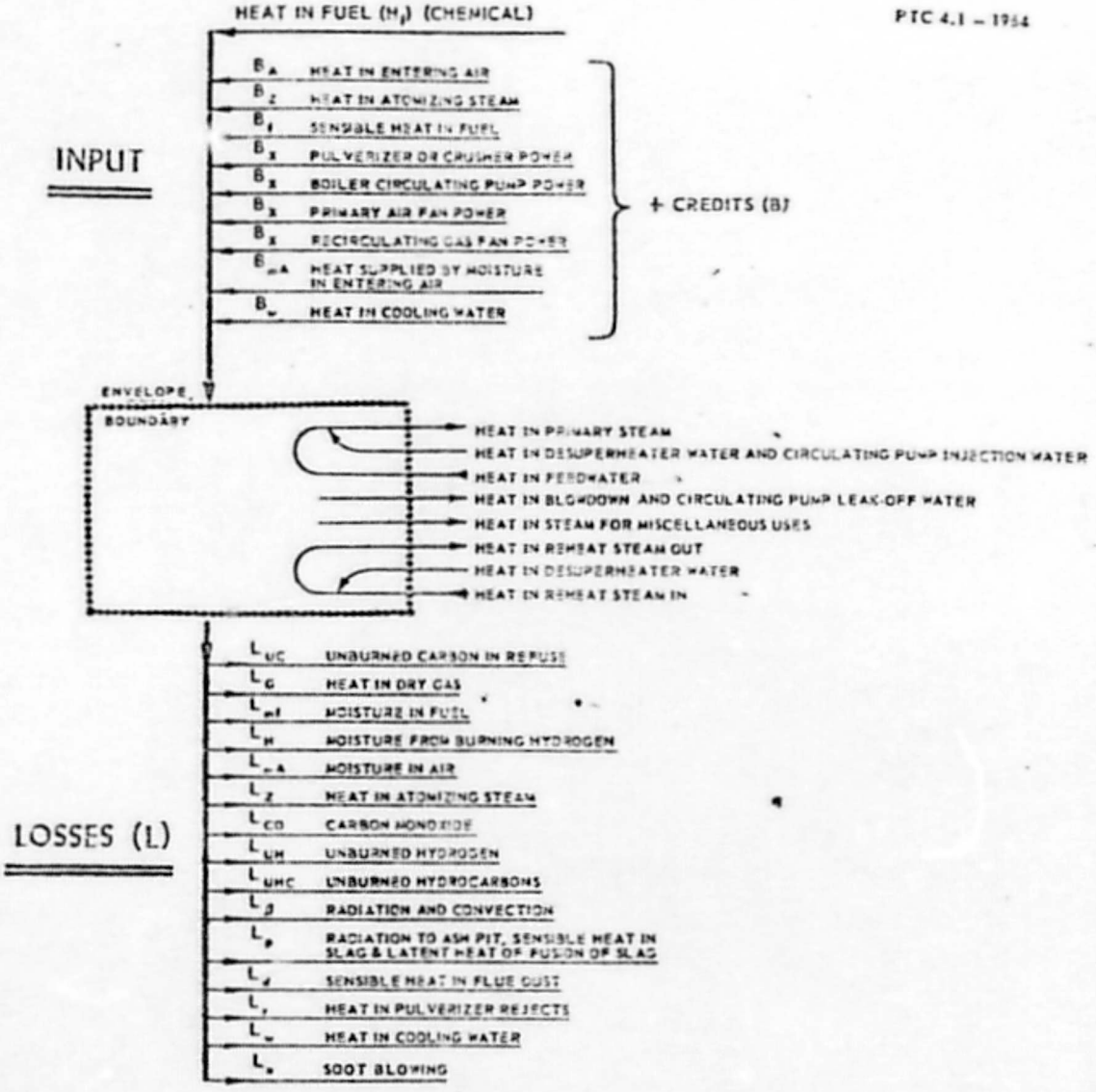
Laboratory analyses of:

15) as fired fuel
16) ash pit refuse
17) stack refuse
18) flue gas

TABLE 3: BUDGET

Personnel:		
State Virginia Public Utilities		
	Subtotal	$ 21,850
Fuel:		
120 tons* eastern coal @$67/T	$ 8,040	
490 tons* western coal @ 33/T	16,170	
530 tons* peat cubes @ 30/T	15,900	
	Subtotal	$ 40,110
Subcontracted Activities:		
test manager	$12,000	
stack testing	23,000	
laboratory sample analyses	7,450	
	Subtotal	$ 42,450
Miscellaneous:		
instrumentation preparation	$ 3,000	
computer time, printing, travel expenses, etc.	6,590	
	Subtotal	$ 9,590
	TOTAL	$114,000

*Equals Estimated Requirements plus Contingency



OUTPUT = INPUT − LOSSES

DEFINITION: EFFICIENCY (PERCENT) $= \eta_g\,(\%) = \dfrac{\text{OUTPUT}}{\text{INPUT}} \times 100 = \dfrac{\text{INPUT} - L}{H_f + B} \times 100$

HEAT BALANCE: $H_f + B = \text{OUTPUT} + L$ OR $\eta_g\,(\%) = \left[1 - \dfrac{L}{H_f + B}\right] \times 100$

Figure 1: HEAT BALANCE OF STEAM GENERATOR

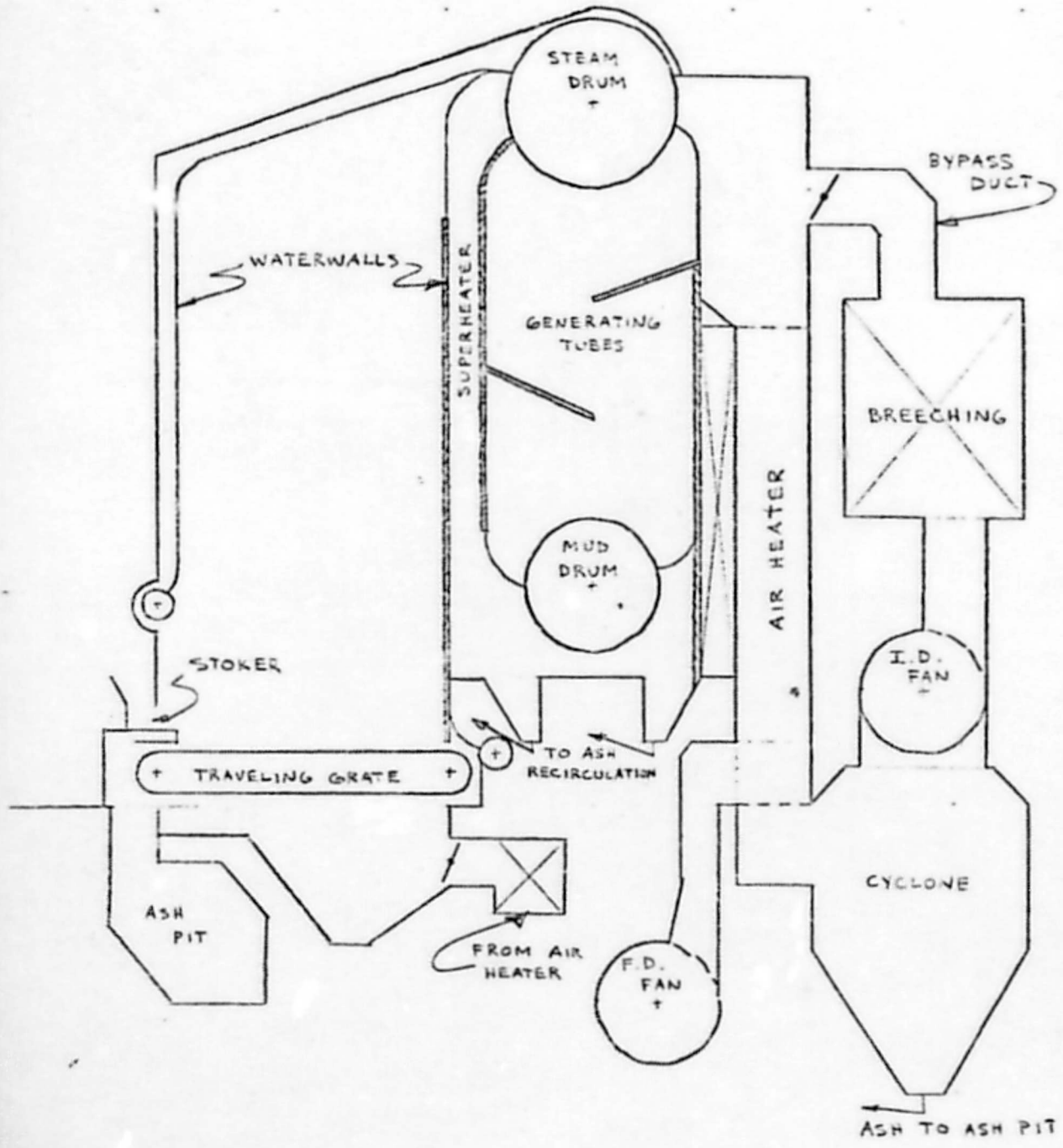
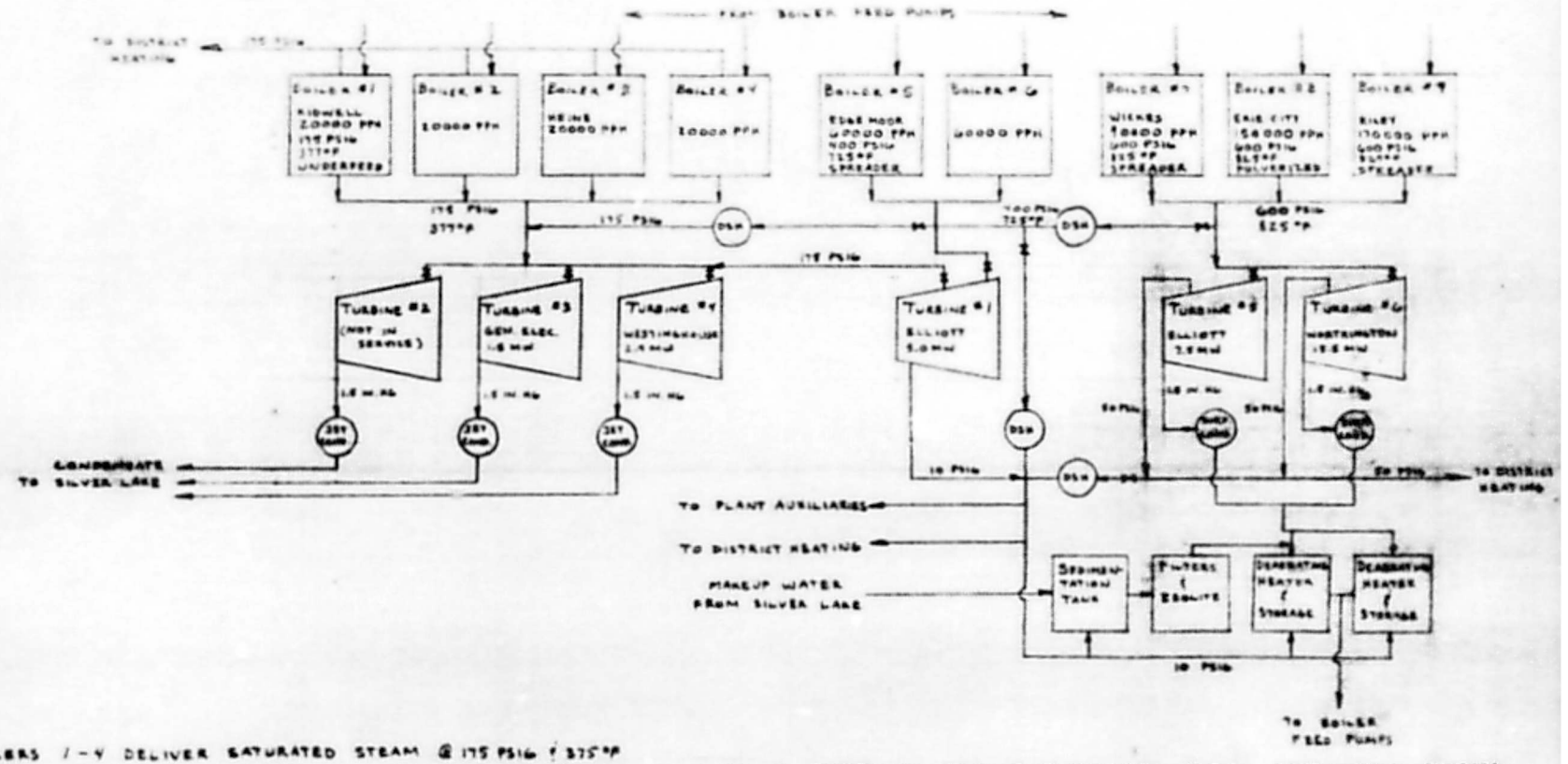


FIG 2: GENERAL LAYOUT OF TEST BOILER (V.P.U. BOILER #5)



BOILERS 1-4 DELIVER SATURATED STEAM @ 175 PSIG & 375°F
" 5&6 " SUPERHEATED " @ 400 PSIG & 725°F
" 7-9 " " " @ 600 PSIG & 825°F

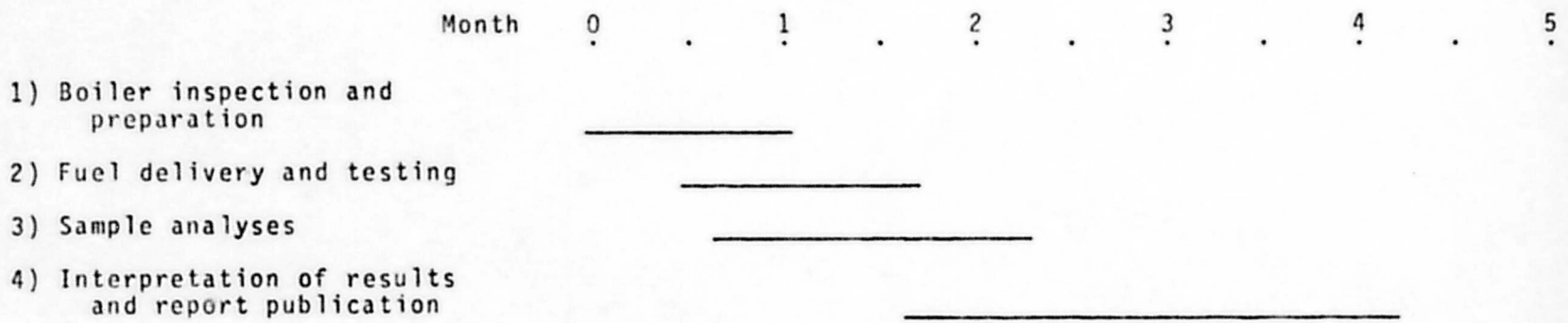
TURBINES 1 & 6 CARRY BASE LOAD (#1 IS OFF LINE DURING SUMMER)
" 2 IS OUT OF SERVICE
" 5 IS BACK UP FOR #6
" 3 & 4 PROVIDE EXTRA CAPACITY AS NEEDED
GENERATORS 1, 5 & 6 OPERATE @ 3800 V)
" 2, 3 & 4 " @ 2400 V)

PLANT AUXILIARIES USE 10 PSIG STEAM

FIG. 3: PARTIAL FLOW DIAGRAM FOR VIRGINIA, MINN. POWER PLANT

NOTES: 1) NOT ALL VALVES, PIPING, AUXILIARIES, ETC. ARE INCLUDED; DIAGRAM INDICATES MOST MAJOR COMPONENTS
2) DISTRICT HEATING USES 10,000 # 175 PSIG STEAM
3) DSH INDICATES PRESSURE REDUCERS AND DESUPERHEATERS

FIGURE 4: TIME SCHEDULE



Appendix: Theoretical Performance Calculations

Tables A1-A8 provide some estimates of boiler performance when different fuels are used (eastern coal for which the boiler was designed, western coal and peat). Representative analyses of the fuels (see Table A9) were selected and calculations based on the following assumptions:

1) combustion air @ 70°F, 45% relative humidity
2) flue gas temperature @ 300°F
3) steam @ 400 psig, 725°F (h_s = 1376 Btu/lb steam)
4) feedwater @ 240°F (h_w = 208 Btu/lb water)
5) unburned combustible @ 0.25 lb/100 lb fuel
6) maximum feed rate is limited to a volumetric flow of 240 ft^3/hr

Table A1 indicates efficiency estimates based on 300°F flue gas temperatures. If flue gas temperatures rose to 500°F the efficiencies would all drop about 5 percent (0.05).

The data in Table A2 can provide us with a comparison of fuel bed depths at equal boiler outputs. For example; a typical depth with eastern coal would be 2-4 inches, if sod peat at 20% moisture is used the depth would be 15-31 inches.

Table A3 contrasts the maximum steaming capacities with different fuels assuming that output is limited by the volumetric flow through the stoker. Note that densified peat at 20% moisture will provide only about 62% of the boilers rated output.

Table A4 shows a division of ash flows based on the ASME standard of 0.85 pounds of fly ash per 1000 pounds of flue gas.

Tables A5-A8 provide comparisons of some of the other important operating parameters. The cooler flame temperatures

in Table A5 could indicate a reduction in heat transfer in the boiler. Higher flue gas volumes indicated in Table A6 can cause problems in gas handling equipment and passages. Dewpoints and $C\emptyset_2$ differences may not be significantly different.

TABLE A1 THEORETICAL BOILER EFFICIENCY (decimal)

Fuel	% Moisture Content	@ 120% Theo. Air		@ 140% Theo. Air	
		η	f_e	η	f_e
Peat	20	0.808	0.934	0.800	0.933
	50	0.686	0.793	0.677	0.790
Western Coal	20	0.814	0.941	0.805	0.939
Eastern Coal	5	0.865	--	0.857	--

Note:

η = output/input

$f_e = \eta_x / \eta_e$

TABLE A2 THEORETICAL FUEL VOLUME (ft^3/100# steam)

Fuel	% Moisture Content	@ 120% Theo. Air $\dot{V}$	@ 120% Theo. Air f_e	@ 140% Theo. Air $\dot{V}$	@ 140% Theo. Air f_e
Sod Peat	20	1.62	7.71	1.64	7.81
	50	2.08	9.90	2.11	10.05
Densified Peat	20	0.65	3.10	0.65	3.10
	50	0.83	3.95	0.84	4.00
Western Coal	20	0.28	1.33	0.28	1.33
Eastern Coal	5	0.21	--	0.21	--

Note:

$\dot{V}$ = $ft.^3$ fuel/100# steam

$f_e = ft.^3{}_x/ft.^3{}_e$

fuel bulk densities calculated from:

density = dry density/(1-moisture content)
where the following dry bulk densities are used:
sod peat @ 10 pcf
densified peat @ 25 pcf
coal @ 50 pcf

TABLE A4 THEORETICAL ASH FLOWS (#ash/100# steam; #ash/10^6 Btu)

Fuel	% Moisture Content	@ 120% Theo. Air $\dot{M}_{fl}$	$\dot{M}_b$	$\dot{M}_t$	f_e	f'_e	% 140% Theo. Air $\dot{M}_{fl}$	$\dot{M}_b$	$\dot{M}_t$	f_e	f'_e
#ash/100# steam											
Peat	20	0.12	1.32	1.44	1.38	1.42	0.14	1.32	1.46	1.39	1.42
	50	0.15	1.70	1.85	1.78	1.83	0.17	1.71	1.88	1.79	1.84
Western Coal	20	0.12	1.44	1.56	1.50	1.54	0.14	1.44	1.58	1.50	1.55
Eastern Coal	5	0.11	0.93	1.04	--	--	0.13	0.92	1.05	--	--
#ash/10^6 Btu											
Peat	20	1.03	11.30	12.33			1.20	11.30	12.50		
	50	1.28	14.55	15.83			1.46	14.64	16.10		
Western Coal	20	1.03	12.33	13.36			1.20	12.33	13.53		
Eastern Coal	5	0.94	7.96	8.90			1.11	7.88	8.99		

Notes:

fl = fly
b = bottom
t = total

$f_e = \dot{M}_{t,x}/\dot{M}_{t,e}$

$f'_e = \dot{M}_{b,x}/\dot{M}_{b,e}$

TABLE A3 MAXIMUM THEORETICAL STEAMING CAPACITY (1000# steam/hr)

Fuel	% Moisture Content	@ 120% Theo. Air			@ 140% Theo. Air		
		$\dot{M}_s$	f_e	f'_e	$\dot{M}_s$	f_e	f'_e
Sod Peat	20	14.8	0.13	0.25	14.6	0.13	0.24
	50	11.5	0.10	0.19	11.4	0.10	0.19
Densified Peat	20	36.9	0.32	0.62	36.9	0.32	0.62
	50	28.9	0.25	0.48	28.6	0.25	0.48
Western Coal	20	85.7	0.75	1.43	85.7	0.75	1.43
Eastern Coal	5	114.3	--	1.91	114.3	--	1.91

Note:

$f_e = lb_{s,x}/lb_{s,e}$

$f'_e = lb_{s,x}/60$

Maximum steaming capacity is based on a maximum volumetric flow rate (for fuel) of 240 ft^3/hr (3 spreader stokers with a maximum capacity of 4000#/hr each; assuming a 50 pcf material density this yields 240 ft^3/hr for all 3 stokers together)

TABLE A5 ADIABATIC FLAME TEMPERATURES (^{o}F)

Fuel	% Moisture Content	@ 120% Theo. Air T_a	@ 120% Theo. Air Δ_e	@ 140% Theo. Air T_a	@ 140% Theo. Air Δ_e
Peat	20	3315	-246	2990	-185
	50	2747	-814	2513	-662
Western Coal	20	3308	-253	2972	-203
Eastern Coal	5	3561	-	3175	-

Note:

$$\Delta_e = T_{a,x} - T_{a,e}$$

TABLE A6 THEORETICAL FLUE GAS VOLUME (scf/1000 Btu & scf/100# fuel)

Fuel	% Moisture Content	@ 120% Theo. Air $\dot{V}$	@ 120% Theo. Air $\dot{V}'$	@ 140% Theo. Air $\dot{V}$	@ 140% Theo. Air $\dot{V}'$
Peat	20	13.4	9560	15.4	10969
	50	16.5	6762	18.7	7643
Western Coal	20	13.5	11128	15.6	12810
Eastern Coal	5	12.6	15735	14.6	18247

Note:

$\dot{V}$ = scf/1000 Btu

$\dot{V}'$ = scf/100# fuel

TABLE A7 THEORETICAL FLUE GAS DEW POINTS (^{o}F)

Fuel	% Moisture Content	T_{dp} @ 120 Theo. Air	T_{dp} @ 140 Theo. Air
Peat	20	126.2	121.6
	50	147.3	142.7
Western Coal	20	122.3	117.7
Eastern Coal	5	105.6	101.5

TABLE A8 THEORETICAL $C\emptyset_2$ (%)

Fuel	% Moisture Content	% $C\emptyset_2$ @ 120 Theo. Air	% $C\emptyset_2$ @ 140 Theo. Air
Peat	20	21.09	18.41
	50	19.51	17.19
Western Coal	20	20.37	17.72
Eastern Coal	5	20.72	17.94

TABLE A9 FUEL ANALYSES USED

	Peat	Eastern Coal	Western Coal
County	St. Louis	Allegheny	Carbon
State	Minnesota	Pennsylvania	Montana
C	53.0%	73.8%	59.8%
H_2	5.3	5.3	5.6
O_2	30.0	8.2	21.0
N_2	2.5	1.5	1.3
S	0.3	1.1	1.1
Ash	8.9	10.2	11.2
Gross Heating Value ($\frac{Btu}{lb}$ @ 0% MC)	9149	13217	10525