

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILES 86/2
952 SCOMM44: HOUSE POWER ALTERNATIVES STUDY COMM. 1979-80 952

- b. prepare recommendations for an emergency allocation plan specifying actions to be taken in the event of an impending serious shortage of energy;
- c. undertake a continuing assessment of trends in the consumption of all forms of energy and analyze the social, economic, and environmental consequences of those trends;
- d. collect and analyze data relating to present and future demands and resources for all sources of energy and project energy requirements for the state and various service areas within the state;
- e. evaluate policies governing the fixing of rates and prices for energy in terms of their relationship to energy conservation and make recommendations with respect to those policies;
- f. analyze energy related activities of agencies of state government and make recommendations with respect to those activities;
- g. prepare, on a continuing basis, recommendations for a comprehensive energy policy for the state of Montana and study the impact and relationship of the state energy policies to international, national, and regional energy policies;
- h. formulate a state program for energy conservation, including without limitation general commercial, industrial, and residential areas and the evaluation of energy systems as they relate to lighting, heating, refrigeration, air conditioning, building design and operation, and appliance manufacturing and operation;
- i. inform and educate the public about ways of conserving energy; and
- j. develop and prepare on a continuing basis, the policy and plans required by 70-827(1)(a).

D. ENVIRONMENTAL RESIDUALS STATEMENT

The state of Montana has made a commitment to environmental protection. Every citizen's right to a clean and healthful environment is protected constitutionally in Montana.

Environmental residuals specifically were considered in developing this plan from both a state and a national perspective. Environmental residuals were calculated using FEA methodology for each program measure, and no program is included which, in our judgement, has a significant negative environmental impact.

Special consideration was given to programs which would increase the amount of insulation in Montana residences. It is known that certain types of insulating materials present environmental and occupational health and safety hazards both in their manufacture and use. To counteract this potential problem, a bill will be introduced into the 1977 Montana Legislature to prohibit certain uses of specific insulating materials (primarily asbestos) and to develop criteria for safe substitute materials. This legislation was a direct result of our analysis of potential environmental problems related to energy conservation.

In general, we found that a decrease in energy consumption results in positive environmental benefits due to reduced environmental degradation from energy conversion. Also, the aspect of individual participation in energy conservation promotes an increased sense of community and a feeling of participation in an action that is socially important. Thus, participating in a large scale, coordinated energy conservation program may have, in fact, a synergistic environmental benefit. People conserving energy

realize that their actions will have positive environmental consequences and hence, may open their eyes to other areas where they can act individually in an environmentally beneficial manner.

The FEA environmental residuals summary follows on the next pages.

TABLE VII-3

TITLE: DIRECT EMISSION FROM DIESEL BUS OPERATION
 (Environmental Impact per 10^{12} Btu of Diesel Oil)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	-		
Bases	-		
Dissolved Solids, Mis.	-		
Suspended Solids	-		
Non-Degradable Org.	-		
Biological Oxygen Dem.	-		
Chemical Oxygen Demand	-		
AIR (TONS)			
Particulates	45.7	.01	.457
Oxides of Nitrogen	1296	.01	12.96
Sulfur Dioxide	94.8	.01	.948
Hydrocarbons	127	.01	1.27
Carbon Monoxide	787	.01	7.87
Carbon Dioxide	85000	.01	850.00
Aldehydes	20.7	.01	.207
OTHER			
Thermal Rejection (Btu)	-		
Occupational Death (Men)	-		
Occupational Injuries (Men)	-		
Occupational Man Day Lost (Man-day)	-		
Solid Waste Tons	-		

Note: Data courtesy of FEA.

TABLE VII-4

TITLE: EMISSIONS FROM PRODUCTION AND DISTRIBUTION OF VEHICLE FUELS
(Environmental Impact per 10^{12} Btu of Vehicle Fuels)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids			
Bases			
Dissolved Solids, Mls.	0.4	5.55	2.22
Suspended Solids	0.76	5.55	4.22
Non-Degradable Org.	2.41	5.55	13.33
Biological Oxygen Dem.	0.76	5.55	4.22
Chemical Oxygen Demand	4.66	5.55	25.86
AIR (TONS)			
Particulates	3.2	5.55	17.76
Oxides of Nitrogen	26	5.55	144.3
Sulfur Dioxide	23.5	5.55	130.43
Hydrocarbons	26	5.55	33.3
Carbon Monoxide	3	5.55	16.65
Carbon Dioxide	-	5.55	
Aldehydes	4.15	5.55	23.03
OTHER			
Thermal Rejection (Btu)	-		
Occupational Death (Men)	0.0007	5.55	.0039
Occupational Injuries (Men)	.05	5.55	.2775
Occupational Man Day Lost (Man-day)	2.5	5.55	13.83
Solid Waste Tons	48	5.55	266.4

Note: Data courtesy of FEA.

TABLE VII-4

TITLE: EMISSIONS FROM PRODUCTION AND DISTRIBUTION OF VEHICLE FUELS
(Environmental Impact per 10^{12} Btu of Vehicle Fuels)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids			
Bases			
Dissolved Solids, Mls.	0.4	5.55	2.22
Suspended Solids	0.76	5.55	4.22
Non-Degradable Org.	2.41	5.55	13.38
Biological Oxygen Dem.	0.76	5.55	4.22
Chemical Oxygen Demand	4.66	5.55	25.86
AIR (TONS)			
Particulates	3.2	5.55	17.76
Oxides of Nitrogen	26	5.55	144.3
Sulfur Dioxide	23.5	5.55	130.43
Hydrocarbons	26	5.55	33.3
Carbon Monoxide	3	5.55	16.65
Carbon Dioxide	-	5.55	
Aldehydes	4.15	5.55	23.03
OTHER			
Thermal Rejection (Btu)	-		
Occupational Death (Men)	0.0007	5.55	.0039
Occupational Injuries (Men)	.05	5.55	.2775
Occupational Man Day Lost (Man-day)	2.5	5.55	13.83
Solid Waste Tons	48	5.55	266.4

Note: Data courtesy of FEA.

TABLE VII-5

TITLE: SPACE HEAT, COMMERCIAL, NATURAL GAS
(Environmental Impact per 10^{12} Btu)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	-		
Bases	-		
Dissolved Solids, Mis.	-		
Suspended Solids	-		
Non-Degradable Org.	.02	2.289	.046
Biological Oxygen Dem.	-	2.289	
Chemical Oxygen Demand	-	2.289	
AIR (TONS)			
Particulates	9.25	2.289	21.2
Oxides of Nitrogen	152.06	2.289	348.1
Sulfur Dioxide	.314	2.289	.719
Hydrocarbons	3.95	2.289	9.04
Carbon Monoxide	9.72	2.289	22.25
Carbon Dioxide	61,000	2.289	139629.
Aldehydes	4.9	2.289	11.22
OTHER			
Thermal Rejection (Btu) $\times 10^9$	.89	2.289	2.04
Occupational Death (Men)	.0002	2.289	.0005
Occupational Injuries (Men)	.03	2.289	.069
Occupational Man Day Lost (Man-day)	92.8	2.289	212.42
Solid Waste Tons	-		

Note: Data courtesy of FEA.

TABLE VII-6
 TITLE: SPACE HEAT, COMMERCIAL, DISTILLATE OIL
 (Environmental Impact per 10^{12} Btu)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	-		
Bases	-		
Dissolved Solids, Mis.	.4	.596	.238
Suspended Solids	.76	.596	.453
Non-De gradable Org.	2.4	.596	1.430
Biological Oxygen Dem.	.76	.596	.453
Chemical Oxygen Demand	4.66	.596	2.78
AIR (TONS)			
Particulates	57.26	.596	34.13
Oxides of Nitrogen	242.98	.596	144.82
Sulfur Dioxide	137.45	.596	81.92
Hydrocarbons	37.17	.596	22.15
Carbon Monoxide	75.00	.596	44.7
Carbon Dioxide	85,000	.596	50660
Aldehydes	11.4	.596	6.79
OTHER			
Thermal Rejection (Btu)	-	.596	
Occupational Death (Men)	.0007	.596	.0004
Occupational Injuries (Men)	.05	.596	.0298
Occupational Man Day Lost (Man-day)	2.5	.596	1.49
Solid Waste Tons	48	.596	28.61

Note: Data courtesy of FEA.

TABLE VII-7

TITLE: SPACE HEAT, COMMERCIAL, RESIDUAL OIL
(Environmental Impact per 10^{12} Btu)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	-		
Bases	-		
Dissolved Solids, Mils.	0.39	.299	.117
Suspended Solids	0.76	.299	.227
Non-Degradable Org.	2.41	.299	.721
Biological Oxygen Dem.	0.76	.299	.227
Chemical Oxygen Demand	4.66	.299	1.39
AIR (TONS)			
Particulates	80.06	.299	23.94
Oxides of Nitrogen	226.9	.299	67.84
Sulfur Dioxide	540.5	.299	161.62
Hydrocarbons	36.4	.299	10.88
Carbon Monoxide	3.47	.299	1.038
Carbon Dioxide	85,000	.299	25415
Aldehydes	7.5	.299	2.24
AIR			
Thermal Rejection (Btu)	-		
Occupational Death (Men)	.0007		.0002
Occupational Injuries (Men)	.049		.015
Occupational Man Day Lost (Man-day)	2.52		.753
Solid Waste Tons	48.02		14.36

Note: Data courtesy of FEA.

TABLE VII-8

TITLE: SPACE HEAT, COMMERCIAL, COAL (26.2×10^6 Btu/ton) (1% Sulfur)
 (Environmental Impact per 10^{12} Btu)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	-		
Bases	.99	0	
Dissolved Solids, Mis.	26.7		
Suspended Solids	5.77		
Non-Degradable Org.	-		
Biological Oxygen Dem.	-		
Chemical Oxygen Demand	-		
AIR (TONS)			
Particulates	443.9		
Oxides of Nitrogen	125.8		
Sulfur Dioxide	755.4		
Hydrocarbons	48.34		
Carbon Monoxide	206.1		
Carbon Dioxide	111000.		
Aldehydes	1.33		
OTHER			
Thermal Rejection (Btu)	-		
Occupational Death (Men)	.07		
Occupational Injuries (Men)	1.22		
Occupational Man Day Lost (Man-day)	92.2		
Solid Waste Tons	8,696		

Note: Data courtesy of FEA.

TABLE VII- 9

TITLE: SPACE HEAT, RESIDENTIAL, NATURAL GAS
(Environmental Impact per 10^{12} Btu)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	-		
Bases	-		
Dissolved Solids, Mis.	-		
Suspended Solids	-		
Non-Degradable Org.	.02	3.416	.068
Biological Oxygen Dem.	-		
Chemical Oxygen Demand	-		
AIR (TONS)			
Particulates	9.24	3.416	31.6
Oxides of Nitrogen	127.5	3.416	435.5
Sulfur Dioxide	.31	3.416	1.1
Hydrocarbons	3.96	3.416	13.5
Carbon Monoxide	9.68	3.416	33.1
Carbon Dioxide	61,000	3.416	208,376.0
Ammonydes	4.86	3.416	16.6
OTHER			
Thermal Rejection (Btu) $\times 10^9$	.890	3.416	3.0
Occupational Death (Men)	.0002	3.416	.0007
Occupational Injuries (Men)	.03	3.416	.10
Occupational Man Day Lost (Man-day)	.90	3.416	3.1
Solid Waste Tons	-		

Note: Data courtesy of FEA.

TABLE VII-15

TITLE: ELECTRIC GENERATION, STEAM (COAL-FIRED)
(Environmental Impact per 10^{12} Btu)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	12.1	6.99	84.6
Bases	1.0	6.99	7.0
Dissolved Solids, Mis.	62.5	6.99	436.9
Suspended Solids	9.0	6.99	62.9
Non-Degradable Org.	1.3	6.99	9.1
Biological Oxygen Dem.			
Chemical Oxygen Demand			
AIR (TONS)			
Particulates	7.35*	6.99	51.4
Oxides of Nitrogen	348	6.99	2432.5
Sulfur Dioxide	160*	6.99	1118.4
Hydrocarbons	8.4	6.99	58.7
Carbon Monoxide	23.1	6.99	161.5
Carbon Dioxide	104000	6.99	726,960.0
Aldehydes	0.68	6.99	4.8
OTHER			
Thermal Rejection (Btu) $\times 10^9$	249	6.99	1740.5
Occupational Death (Men)	0.0759	6.99	.53
Occupational Injuries (Men)	1.32	6.99	9.2
Occupational Man Day Lost (Man-day)	96.26	6.99	672.9
Solid Waste Tons	1394	6.99	9744.1

*Local utilities must be consulted to take account of abatement factors for particulates and sulfur emissions.

Note: Data courtesy of FEA.

TABLE VII-1C

TITLE: SPACE HEAT, RESIDENTIAL, DISTILLATE OIL
(Environmental Impact per 10^{12} Btu)

Impact	Col. A Coefficient for Reduction	Col. B Energy Reduction	Col. C Resultant Emission Reduction
WATER (TONS)			
Acids	-		
Bases	-		
Dissolved Solids, Mis.	.4	.352	.14
Suspended Solids	.76	.352	.27
Non-Degradable Org.	2.41	.352	.85
Biological Oxygen Dem.	.76	.352	.27
Chemical Oxygen Demand	4.66	.352	1.64
AIR (TONS)			
Particulates	39.16	.352	13.78
Oxides of Nitrogen	69.18	.352	24.35
Sulfur Dioxide	136.45	.352	48.03
Hydrocarbons	37.17	.352	13.08
Carbon Monoxide	20.80	.352	7.32
Carbon Dioxide	85,000	.352	29,920
Aldehydes	11.34	.352	3.99
OTHER			
Thermal Rejection (Btu)	-		
Occupational Death (Men)	.0007	.352	.0002
Occupational Injuries (Men)	.05	.352	.018
Occupational Man Day Lost (Man-day)	2.5	.352	.88
Solid Waste Tons	48	.352	16.90

Note: Data courtesy of FEA.

TALLY SHEET
OF REDUCTIONS IN EMISSIONS, ETC.
(OTHER)

	Thermal Reject	Occupational Death	Occupational Injury	Occupational Man-day Lost	Solid Waste
1					
2 GASOLINE VEH.					
3 DIESEL BUS					
4 REFINERY, VEH. FUEL	_____	.004	.278	13.9	- 266.4
5 S.H. COMMERCIAL GAS	2.04	.0005	.069	212.4	- _____
6 S.H. COMMERCIAL D. OIL		.0004	.0298	1.49	- 28.61
7 S.H. COMMERCIAL R. OIL		.0002	.015	753	- 14.36
8 S.H. COMMERCIAL, COAL					
9 S.H. RESIDENTIAL, GAS	- 3.0	.0007	.10	3.1	0
10 S.H. RESIDENTIAL, D. OIL		.0002	.018	.88	- 16.90
11 ELEC. GEN - GAS T. - GAS					
12 ELEC. GEN - GAS T. - OIL					
13 ELEC. GEN - STEAM - GAS					
14 ELEC. GEN - STEAM - OIL					
15 ELEC. GEN - STEAM - COAL	1740.5	.53	9.2	672.9	- 9744.1
	1745.5	.54	9.71	905.4	-10,070.4

Note: Data courtesy of FEA.

TALLY SHEET
OF REDUCTIONS IN EMISSIONS, ETC.
(WATER)

	ACIDS	BASES	DIS. SOLIDS	SUS. SOLIDS	NON-DEG. ORG	BIO. O.D.	CHEM. O.D.
1							
2 GASOLINE VEH.							
3 DIESEL BUS							
4 REFINERY, VEH. FUEL			- 2.2	- 4.2	- 13.4	- 4.2	- 25.9
5 S.H. COMMERCIAL GAS					- .046		
6 S.H. COMMERCIAL D. OIL			- .238	- .453	- 1.430	- .453	- 2.78
7 S.H. COMMERCIAL R. OIL			- .117	- .227	- .721	- .227	- 1.39
8 S.H. COMMERCIAL, COAL	0	0	0	0	0	0	0
9 S.H. RESIDENTIAL, GAS	0	0	0	0	- .068	0	0
10 S.H. RESIDENTIAL, D. OIL	0	0	- .14	- .27	- .85	.27	1.64
11 ELEC. GEN - GAS T. - GAS							
12 ELEC. GEN - GAS T. - OIL							
13 ELEC. GEN - STEAM - GAS							
14 ELEC. GEN - STEAM - OIL							
15 ELEC. GEN - STEAM - COAL	- 84.6	- 7.0	- 436.9	- 62.9	- 9.1		
	- 84.6	- 7.0	- 439.6	- 68.1	- 25.6	- 5.2	- 31.7

Note: Data courtesy of FEA.

TALLY SHEET
OF REDUCTIONS IN EMISSIONS, ETC.
(AIR)

	Particulates	Ox. of Nitro.	Sulfur Dioxide	Hydro-Carbons	CO	CO ₂	Aldehydes
1 TOTAL	- 538.1	-5241.3	-1624.7	-1277.0	-12,066.0	-1,594,330	-68.421
2 GASOLINE, VEH.	- 344.7	-1656.9	- 83.4	-1117.6	-11,787.2	-1,414,220	
3 DIESEL BUS	+ .5	+ 13.0	+ .9	+ 1.3	+ 7.9	850.0	.2
4 REFINERY, VEH. FUEL	- 17.8	- 144.3	- 130.4	- 33.3	- 16.7		-23.0
5 S.H. COMMERCIAL GAS	- 21.2	- 348.1	- .719	- 9.04	- 22.3	-139,629	- 11.22
6 S.H. COMMERCIAL D. OIL	- 34.13	- 144.8	- 81.92	- 22.15	- 44.7	-50660	- 6.79
7 S.H. COMMERCIAL R. OIL	- 32.94	- 67.84	- 161.62	- 10.88	- 104	-25415	- 2.24
8 S.H. COMMERCIAL, COAL	_____	_____	_____	_____	_____	_____	_____
9 S.H. RESIDENTIAL, GAS	- 31.6	- 435.5	- 1.1	- 13.5	- 33.1	208,376	- 16.6
10 S.H. RESIDENTIAL D. OIL	- 13.78	- 24.35	- 48.03	- 13.08	- 7.32	-29,920	- 3.99
11 ELEC. GEN - GAS T. - GAS	_____	_____	_____	_____	_____	_____	_____
12 ELEC. GEN. - GAS T. - OIL	_____	_____	_____	_____	_____	_____	_____
13 ELEC. GEN - STEAM - GAS	_____	_____	_____	_____	_____	_____	_____
14 ELEC. GEN - STEAM - OIL	_____	_____	_____	_____	_____	_____	_____
15 ELEC. GEN - STEAM - COAL	- 51.4	-2432.5	1118.4	- 58.7	-161.5	-726,960	4.8

*includes program measures 3,5,5a,5b,5c, 10

**includes program measures 1,2,3,3a, 9&10 and industrial sector

***includes program measures 1,6,7,8,9,10

+includes LPG

Note: Data courtesy of FEA.

E. A VISION FOR THE FUTURE

The need for energy conservation has been made clear in the last few days by the natural gas crisis in the eastern United States. While Montana fortunately has been spared the disastrous effects which are occurring right now on the east coast and in the midwest, the lesson is clear. Energy conservation is essentially the only alternative that can immediately free additional supplies of energy. Increasing energy supplies from other sources often takes years of development and planning.

While the eastern United States has been deluged with snow and cold weather, Montana and the Pacific Northwest, areas that produce a great deal of energy through hydroelectric generation, have been unusually dry. Thus, a weather caused energy crisis in the east simply may be the forerunner of a drought related energy crisis in the northwest. Through conservation, Montana can act now to insure that future supplies of energy are available. By postponing action, the state will only insure that the "energy crisis," when it does strike Montana, will be even more severe.

Energy conservation and renewable energy development both are decentralized in application. They are implemented at the individual, community, or local government level. Both can develop a community spirit and a sense of participation, thrift, and cooperation. Conservation is, in many respects, a personal option. In fact, it is the ultimate of public participation in energy planning. Conservation is something that everyone can do to help secure their individual energy supplies. Conservation is a way to bring the various sectors of Montana's society together with the common purpose of supplying more energy to keep Montana prosperous. Jobs will not be lost by conserving energy. As is obvious presently, jobs are lost by wasting energy.

In addition, we have concluded that energy conservation is much more than a short term "crisis" stop gap measure. A number of reputable nationwide studies have shown that up to 50 percent of the energy currently used in the United States is wasted. If this 50 percent waste is seen as an energy supply, total energy consumption in the United States could be doubled through conservation without requiring energy to be supplied by any other source. Thus, conservation is seen as a long term energy supply source.

It is the long term analysis that we do not want to lose sight of. FEA guidelines require short term energy savings of 5 percent by 1980; but looking out toward the future, much more substantial savings are obtainable. Our proposed conservation loan program, the statewide building code, the transportation trust fund, public utility measures, the renewable energy tax credit, and educational programs are all long range programs. The energy savings from implementing some of these measures will accumulate slowly and not reach full impact for 10 to 20 years (or more).

A stringent energy conservation building code coupled with more efficient lighting and hot water heating could save 45 percent of the energy used in the residential sector in 20 years. A conservation building code applied to the commercial sector would reduce energy consumption in that sector by 50 percent by the year 2000. Montana industry, through process changes, housekeeping, co-generation of electricity and process steam, and other conservation measures likewise could save up to 30 percent of the energy consumed in that sector within 20 years.

Our investigation indicates that renewable energy also can be very important in Montana's future. Eighty nine percent of the energy currently used in the residential sector and 53 percent of the current commercial

energy use in Montana is converted to low grade heat ($<100^{\circ}\text{C}$). Solar radiation easily could supply energy of this quality. The Lockheed Corporation recently determined that the wind electric generation potential of eastern Montana was 25 times Montana's current total energy consumption. The energy potential of Montana's wood waste and forest residues annually exceeds 51 trillion Btu's, and agricultural crop residues nearly have the same energy potential. Our proposed renewable energy tax credit and conservation loan program will foster renewable energy development in Montana. They will stimulate investment now in energy sources which likely will be indispensable in the future. A renewable energy industry may develop within Montana and thus promote economic development. There is absolutely no reason why wind mills or solar collectors cannot be produced here. Montana's enormous renewable energy base, coupled with its favorable economic incentives, could make it a leader in renewable resource development. Montana has enormous reserves of coal--enough to supply the state's own needs for thousands of years. Montana is meeting its obligation to share this coal with the rest of the nation as is demonstrated by the state's exponentially increasing rate of coal production. Montana citizens also have both a sense of history and the realization that exponential growth cannot continue forever.

If the United States decides to produce most of its energy from coal, Montana's enormous reserves of coal will be used in a very short time, perhaps within 50 to 100 years. Montana's history is rich with "ghost towns" from past mining days; the state now must insure that we do not become a "ghost state" in the not too distant future. Montana's coal can supply our posterity with energy, plastics, pharmaceuticals, and petrochemicals for centuries if it is managed wisely. Since all fossil fuels

are finite, we realize that we face a future without their use as energy sources. Oil and gas reserves already are well on the road to depletion. Coal must be used wisely and efficiently as our last "transition fuel" bridge to a non-fossil fueled energy future. To consume all of the coal in a short period of time and thus deprive our future generations of the many benefits and utilities of its use would be a terrible mistake.

Thus, Montana must take the lead and be an example to other states in demonstrating that other sources of energy supply are available, namely, conservation and renewable energy. Ultimately, the United States and Montana will have to seek alternate sources of energy. Why not begin to develop these alternatives now while we still have those enormous reserves of coal which will be so valuable in the future?

Now is the time to begin a coordinated program to both conserve energy and develop renewable energy supplies. Such a program will insure the availability of near term energy supplies and, perhaps more importantly, aid in securing a stable economic future. If the state does not begin such a program soon, we most assuredly will look back and wish we had.

PLEASE NOTE: THE PRECEDING PAGES WERE TREATED
AS A UNIT IN THE ORIGINAL DOCUMENT.

~~RE~~
RE

DRAFT
PROPOSED MONTANA RENEWABLE ENERGY PROGRAM

from

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Butte, Montana 59701

for comments or questions contact:
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January 28, 1979

Brian - this is
excellent & well
reading. Very
ambitious program,
with the best
of intentions.

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INTRODUCTION: MONTANA RENEWABLE ENERGY PROGRAM

Montana, through state government leadership and state policy, leads the United States in its commitment to financial support of alternate renewable energy resource development and utilization. Public support of this program is widespread and based upon a sophisticated understanding of the logical match between the values and lifestyles of Montana with the positive social, economic, and environmental impacts of extended development of those renewable energy resources of sun, wind, water, and plant residues that already contribute so much to Montana's agriculture and lifestyle. It is recognized that the on-going national energy problem offers a great opportunity to integrate new energy production systems into the economy of Montana in such a way that they will enhance job opportunities for labor, expand economic opportunity for old and new businesses, and enrich the people by providing new technical, scientific, and business challenges. The colleges, universities, technical organizations, and businesses, as well as the emerging generation of young men and women will participate in and benefit from this program. The Montana Renewable Energy Program represents an unique way to simultaneously develop and enrich the state without compromising the quality of life or degrade the environment.

The Montana Department of Natural Resources and Conservation (DNRC) has had a very active program since 1975 which has supported numerous research, development, and demonstration projects throughout the state. To date, the key accomplishments of this program have been the creation of a very healthy public awareness, understanding, and support of alternate

renewable energy, widespread demonstration of the potential of solar space heating throughout the state, and the initiation of limited research and development activities in other renewable resource areas.

Montana has made a significant contribution to the overall United States energy R&D activities through the DNRC program. In turn, the state program has received considerable benefit from the national programs; however, the national program by its very nature will not satisfy all of Montana's needs. There are unique economic and environmental problems in Montana which must be addressed before full use can be made of national program information and results. Furthermore, the national energy R&D effort has received the benefits of Montana's developments that with various degrees of adoption can be used in other states and regions. Much of the past state program support has had this as one of its objectives. Now, however, is the time for a significant expansion, integration, and extension of the program. A properly structured, funded, and managed plan of research, development, demonstration, and commercialization is necessary in order for the state to fully benefit from the renewable resources available.

The Montana Alternative Renewable Energy R&D program must be more fully and formally integrated into the national U.S. Department of Energy programs. It must also be extended to include a strong commercialization effort and be expanded in terms of resources devoted to the total program activities.

This document contains seven specific subprograms for wind, biomass (agriculture and forest products and residues used for direct combustion, the production of alcohol, and the generation of methane), geothermal, solar,

and small scale hydroelectric renewable energy sources. The proposed duration of each of these subprograms is six years if the funding level requested is provided. At the end of this time, the technologies and supporting Montana business structure will have been developed for those renewable energies which have proven to be economically viable. State support beyond the six years will be minimal and will be limited mainly to coordination and information exchange. No large scale funding of development or demonstration projects should be necessary.

The support for this program is based upon a match of almost five federal dollars for every state dollar contributed. This match is not arbitrary but is based upon the concept that there is at least five times as many opportunities to use the results of this program outside Montana as within the state. Simple equity dictates that the division of funds for support be based upon the probable benefits to be obtained by each of the parties participating in the program.

The long range objective of this proposed Renewable Energy Program is to ensure the proper place of these resources in Montana's future economy. Diversification of energy sources will be just as important in the future as it is now. The utilities and their electric distribution system will become more valuable. Eventually, replacements for natural gas and liquid fuels must be found either by a complete energy form replacement or from gases and liquid fuels derived from biomass or from coal for some finite time period. Here again, the large energy companies and their distribution systems will continue to play a leading role. A new and important member of the energy team, the farmer/rancher and communities, is developed by this program.

Montana is an agricultural state with very little in-state processing of the products of beef and grain. Furthermore, our ranchers and farmers pay high transportation costs to get these products to the processing points and markets. The proposed program will provide some energy self-sufficiency and a significant extension of the agricultural activity into the processing area. The economic diversity of the farm, ranch, and forest communities will be expanded by energy "crop" growth and processing. The program provides Montana the opportunity to produce new, needed energy products and to participate in the processing of the products--a double economic impact.

The proposed subprograms are to be integrated into the Montana Department of Natural Resources and Conservation, Energy Division's "Montana Alternative Renewable Energy Sources Program Plan" published in January 1979. This present DNRC plan is for a two year program using funds from the coal severance tax as provided under the present allocation scheme. The DNRC plan projects funding of approximately \$800 and \$1,100 thousand for the next two years and will require additional funding in future years, before all objectives are met. What is proposed here is a significant expansion in effort of the DNRC plan while maintaining its program philosophy, management, and control. This expanded effort will answer the question of the usefulness to Montana of its renewable energies and, at the same time, will develop the necessary Montana businesses so that future state energy planning can be based upon technical and economic experience in renewable energy sources.

A primary motivation for the continuation and significant expansion of the present DNRC program is based upon the projected economic return to the people of Montana. The great majority of the important renewable energy resources are owned or controlled by individual land owners in Montana, e.g., biomass, solar, wind, and geothermal. A statewide program using these resources will, in addition to directly benefiting the resource owner, create the supporting businesses and manufacturing activity. Thus, one objective of the Renewable Energy Program is increased economic activity within the state at the individual and small-to-intermediate business level. This program is not dependent upon large corporations moving into the state, but rather, the creation within Montana of new businesses. By the year 1985, this expanded program has the potential of generating business activity in the millions of dollars which will directly benefit the citizens of Montana.

Agricultural/forest products and residues (biomass), geothermal, and wind are the three renewable resources with major subprograms that will be fully developed and commercialized under this plan. Farm and forest residues will be used for production of alcohol and methane and for direct combustion to produce heat and possibly electricity. Wind will be used for electricity generation. Geothermal resources will be used for space and industrial/agricultural heat. Full commercialization means to perfect the applicable technologies for Montana, establish the economics of utilization, create the supporting industrial base, and finally manufacture/build and install the system/facilities throughout the state. Montana capital and Montana citizens can do this via indigenous internal growth and with only a relatively minimum initial funding from the state and national government.

One element of the biomass portion of this program is directed to community- or county-size alcohol plants of a nominal 10^6 gallons/year output which would be fully integrated into the local community. A plant of this size can be built, owned, and operated by the community or individuals with minimal outside assistance. The initial market for the alcohol and the by-products would be the community and surrounding region. Support for five plants is proposed.

The second major element of the biomass program is the direct combustion of forest or farm residues in community-size heating plants and for individual residential-size heating units. Many regions within the state have residues which because of climate, soil, or harvesting practices must be disposed of frequently at some expense to the land owner. These residues can be converted into an additional cash crop. Support for four plants is proposed.

During the six years of the program, alcohol plants and direct combustion plants will be partially funded, and testing and evaluation of home size furnaces and stoves will be continued. The degree of state financial support will be limited to design and 90 percent or less of the construction costs of the facilities. At the end, the technology and operating costs will be established to such a degree that the succeeding plants established in the state can be fully financed by private funds.

The last element of the biomass program is biogas generation. Three sizes of biogas (approximately 65 percent methane) facilities will be developed under the biogas subprogram. One community waste, supplemented with agriculture or forest residues, biogas generator facility will be designed and constructed. Two dairy farm or feed lot size facilities will be installed, and finally a smaller farm or ranch size model will be developed. Three design iterations are provided for in the small size and a total of nineteen units will be purchased for ranch and farm testing and evaluation.

The integration of a community-size biomass program will also include appropriate supporting agricultural activities. For example: alcohol production creates high protein feed which can be used to feed cattle, and the manure from the cattle can be used to generate methane which in turn can be the heat source for the alcohol production.

The wind element has two major portions--first, the individual land owner wind generation concept and secondly, the large utility-owned wind farm concept. The land owners in Montana possess an enormous wind energy potential which, with the development of properly scaled and designed wind electric or direct mechanical generators, can be "harvested" for farm and ranch use. In addition, it can be fed back into the electric grid system. The farmers would be paid for any excess electricity they generated by the utility company; hence, the land would provide a second cash crop. Support for 60 farm-size (20 KW) wind generators is proposed. In addition to the siting of individual wind generators, Montana possesses numerous prime sites, some in conjunction with hydroelectric generation facilities that could be used for large wind farms with a generation capacity of as high as a few hundred megawatts. The Bureau of Reclamation, Corps of Engineers, and the utility companies will be encouraged to establish wind farms with a generating capacity of 250 MW by 1986, an amount equal to that to be generated on farms and ranches. Besides this electric generating capacity, this commercialization plan will create the manufacturing, erection, and maintenance industries in the state to support this renewable energy re-use.

The geothermal hot water resources of the state will be evaluated for community and industry-size facilities for space heating and industry/agricultural applications. A prime site in the state will be developed to provide a central community heating system. If an appropriate user can be identified,

a program will be developed that will demonstrate the use of geothermal heat in industry or agriculture. Support for two geothermal sites is proposed.

The solar and small scale hydroelectric subprograms are funded at less than one million dollars each for the four year period. These subprograms require less state support because of state-of-the-technology due to past state and federal funding. Three tasks remain to be completed in the solar subprogram. These are: the evaluation of the solar demonstrations that have been funded, assistance in providing commercially available low cost solar panels for homes, and assistance in the design of solar heating systems for commercial buildings, apartments, or communities. The small scale hydroelectric subprogram will provide for the design and cost analysis of up to twenty hydroelectric generation sites in the state and funding to support up to 90 percent of the construction for ten sites. The electricity output from these sites will be limited to no more than 20 KW.

It is recommended that the Energy Division of DNRC continue the management of this expanded renewable energy program with assistance from major subcontractors for each of the renewable energy resources. By properly structuring the contractual responsibility and work, this program can be managed without an increase in the permanent staff of DNRC. One program objective is to establish within the state the technology and management capability for renewable energy sources. This is to be done by building up Montana private industry and business and not by an expansion in the number of state employees. The major portion of the work will be performed competitively in response to "Requests for Proposals" (RFP) and only a limited amount will be by unsolicited proposals. During the first three years, three or four temporary staff personnel will be needed in the Energy Division to

start the program, establish office operating procedures and policies for the expanded effort, and provide the necessary close subcontractor direction required during the initial phases of the subprograms.

The key to program control in this plan is the annual in-depth total program review by subprogram element performed by a review team composed of legislators, DNRC subcontractors, and nationally renown experts. All activities will be reviewed, and any necessary budget adjustments will be proposed to the Montana state legislature and the U.S. Department of Energy for the coming year. It is vital that the program remain dynamic and that adjustments in expenditures be allowed and encouraged in a public policy directed manner so that advantage can be taken of unexpected program accomplishments or opportunities. In the same respect, expenditures should be cut or terminated in any subprogram that does not meet the projected economic pay off for the state.

The total funding recommended for these programs is \$46,800 thousand. This is the amount obtained by adding all the subprogram totals in this plan plus an additional \$5,225 K for DNRC management during the six years of the program. Montana's share is \$8,600 K and is based upon projected return from the coal tax revenue. It is recognized that the state legislature can only make a two year commitment, and that is all that is necessary from the state and the U.S. Department of Energy to start the program. If successful, the remaining funds would be requested from the 1981 and 1983 legislature and the U.S. DOE. For full funding of the first two years, the state must provide \$900 K in 1979 and 1,100 K in 1980 and the federal government \$2,700 K and \$4,400 K in each of the two years. The funding level requested is significant, but the program is structured so that each succeeding year's budget is spent only if the prior year's activities were successful.

The program will be coordinated with the Department of Agriculture and Small Business Administration Energy Loan programs. The USDA Business and Industrial loan program can become a vital part of this program in supporting the development of the required industrial base in Montana. In addition, the products developed must be "approved" by the USDA so that the farmers and ranchers can obtain FHA loans in support of purchase. Public Law 95-315 changes the Small Business Act to provide funds for energy related activities and facilities.

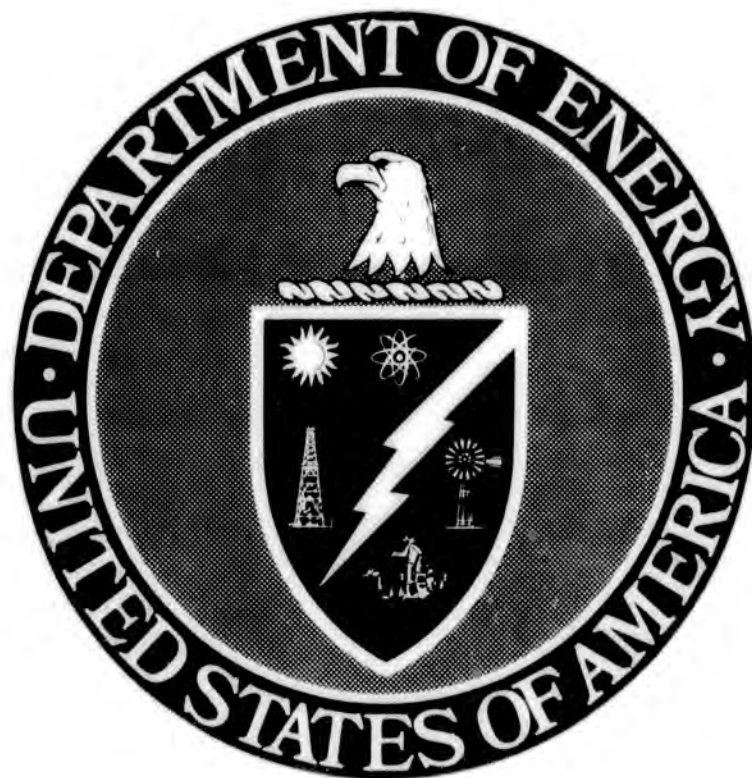
This document details a flexible, diverse but integrated expanded alternative renewable energy program that simultaneously addresses major national needs as well as the unique requirements of Montana. This program is designed to serve the broad public policy needs of Montana through stimulation of development in the private sector. Furthermore, this program recognizes and addresses the needs for new community scale technology that will allow the communities to have at their command technology that will not be imposed from outside the state by organizations that have optimized the production for their benefit. Moreover, these technologies and energy sources will reverse the long term trend of Montana's economy of being based upon exporting unprocessed agricultural and natural resources. Unlike coal, where processing involves significant environmental impacts with existing technology, the development of alternate renewable energy resources can be developed with minimal negative impacts.



FOSSIL ENERGY
U.S. Department of Energy

ELECTRIC POWER FROM COAL

AN INTRODUCTION TO MAGNETOHYDRODYNAMICS



NOTICE

Material contained herein was prepared by the Division of Magnetohydrodynamics, Fossil Energy Programs, Energy Technology Secretariat, U.S. Department of Energy.

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August 1979

This booklet presents, in simplified form, a basic description of coal-fired MHD power generation: what it is, how it works, its commercial potential, what's being done to develop the technology, and prospects for the future.

FOSSIL ENERGY PROGRAMS

Division of Magnetohydrodynamics
U.S. Department of Energy



QUESTION: WHAT IS MHD?

Magnetohydrodynamics (MHD) is the science underlying the interaction of an electrically conducting fluid with a magnetic field.

In practical terms, MHD means the generation of electric power by passing a fluid conductor through a magnetic field. Conventional generators use a solid conductor.

MHD converts the energy of the moving fluid to electrical energy directly. The conventional intermediate mechanical step is eliminated. The MHD converter combines the conventional "turbine" and "generator" in a single unit. In essence, it's an electromagnetic turbine.

The idea of substituting a fluid conductor for a solid conductor in power generation is not new. Michael Faraday conducted experiments in 1831 in which he passed mercury through a magnetic field to demonstrate the principle. He speculated that the Thames, flowing in the Earth's magnetic field, might be capable of generating power.

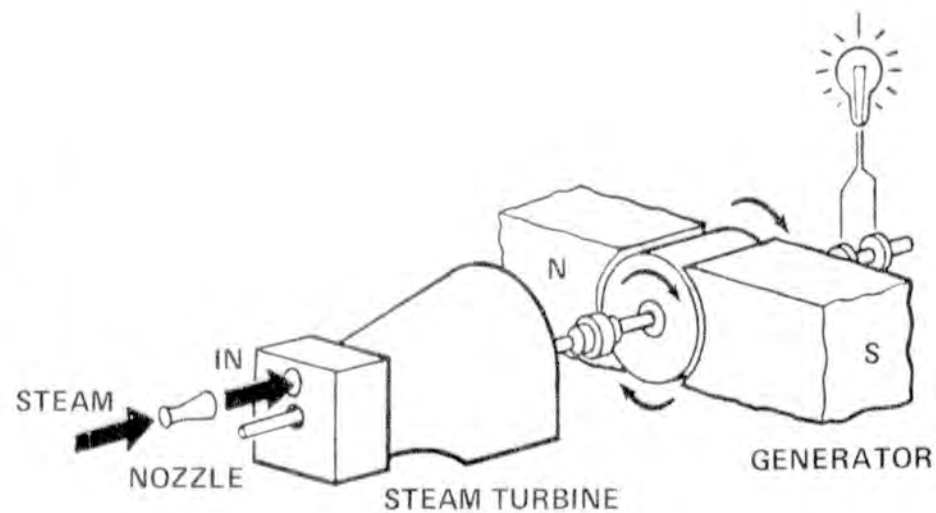
The MHD generator performs the functions of both the turbine and generator and has no moving parts. Consequently, it can operate at temperatures which would quickly destroy the materials of a conventional turbine. This increase in upper cycle temperature limit gives MHD a significant advantage over other Rankine/Brayton power conversion devices.

MHD's importance to the U.S. fuel economy thus lies in its potential capability to produce more power from the direct combustion of a ton of coal than any currently available power conversion system. It further provides environmental advantages that derive not only from the fact that less coal is burned for a given amount of electricity produced, but also from the specific MHD process conditions which suppress SO_x and NO_x emissions.

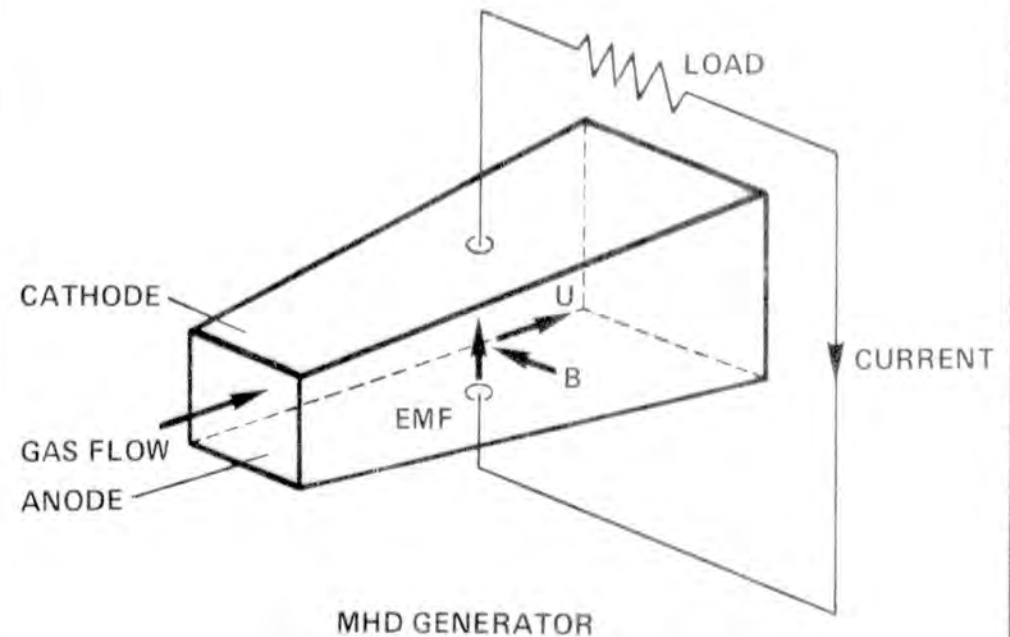
QUESTION: HOW DOES MHD WORK?

A conducting fluid flowing at velocity, U , through a magnetic field, B , induces an electric field, E , in a direction perpendicular to both the flow direction and the field direction.

If the flow is contained in a duct, the two walls perpendicular to the induced field, E , will be at different electrical potentials. If these two walls, or elements thereof, are connected through an external electric load, the induced field, E , will cause electric currents to flow through the fluid and external load in a closed path, as shown in the accompanying sketch.



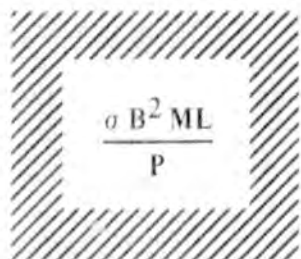
CONVENTIONAL STEAM GENERATOR



MHD GENERATOR

QUESTION: WHAT DETERMINES THE PERFORMANCE OF AN MHD GENERATOR?

Enthalpy extraction is proportional to:


$$\frac{\sigma B^2 ML}{P}$$

where:

σ = conductivity, Mhos/meter

B = magnetic field, Tesla

M = Mach number

L = channel length, meters

P = pressure, atmospheres

Typical values required to achieve a 20% enthalpy extraction from the channel are:

$\sigma \sim 8$ Mhos/meter

$B \sim 6$ Tesla

$M \sim 0.8$

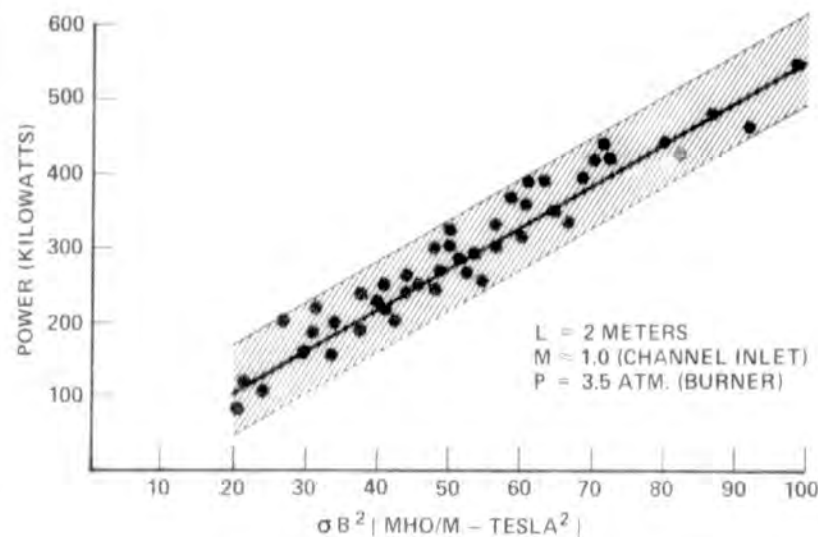
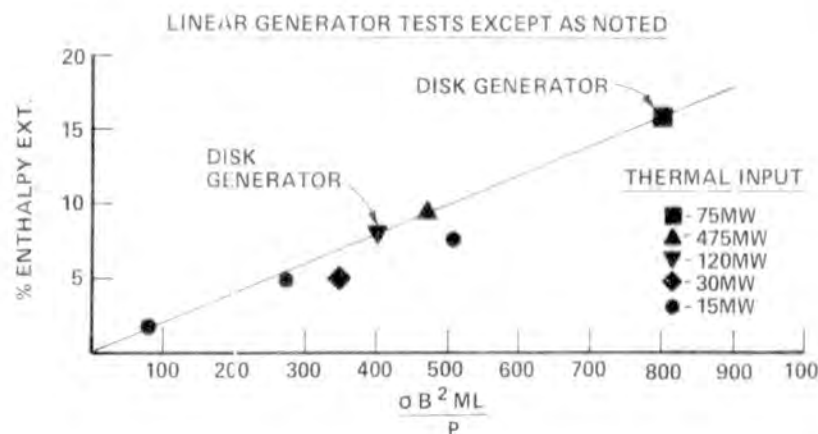
$L \sim 20$ meters

Conversion of the thermal energy of the conducting fluid to electrical energy (enthalpy extraction) is proportional to the product of the fluid conductivity, the square of the magnetic field strength, the fluid velocity, and the channel length divided by the pressure.

High temperature combustion and potassium "seeding" are required to attain the necessary conductivity level. High magnetic field strengths are produced by superconducting, cryogenically cooled, magnets. Wall losses must be minimized by maintaining a sufficiently large volume to area ratio in the duct. Enthalpy extractions of 20% or more would be necessary for commercialization. Theoretical analyses substantiated by experimental data have been applied to project design and operating conditions required to achieve this.

QUESTION: HAS PERFORMANCE BEEN VERIFIED EXPERIMENTALLY?

If the performance data of random tests are plotted against the parameter explained on the previous page, they fall on a reasonably straight line. These data represent a considerable range of test conditions relating to conductivity, magnetic field strength, power input, channel length, and, to lesser extent, velocity. Large generators with magnetic fields of 6 Tesla, under conditions indicated for σ , M , and P , are expected to provide enthalpy extractions in excess of 20%. (See figure below.)



This plot demonstrates the reproducibility of performance data. A total of forty-seven (47) test points fall within the scatter band shown between values of 20 and 100 for σB^2 . Performance dependency on conductivity and magnetic field is illustrated under relatively constant conditions of M , L , and P . (See figure above.)

QUESTION: HOW DOES MHD INCREASE POWER CONVERSION EFFICIENCY?

The amount of energy available for power conversion depends fundamentally on the temperature difference between the heat source and the heat sink as first suggested by Sadi Carnot in 1824. The ideal Carnot efficiency can thus be expressed as:

$$\frac{T_1 - T_2}{T_1} \quad \text{or} \quad 1 - \frac{T_2}{T_1}$$

T_1 = the absolute temperature of the heat source

T_2 = the absolute temperature of the heat sink

This basic expression may be extended to cover all reversible cycles where the two temperatures are defined as mean temperatures found by dividing the heats added and rejected reversibly by the change in entropy in each case.

In conventional turbines, T_1 is limited by the ability of rotating components to withstand high stresses at high temperatures. But because MHD has no rotating parts, it can survive temperatures which would destroy a conventional turbine. Thus, by coupling an MHD "electromagnetic" turbine, operating at a very high temperature, with a Rankine steam turbine, operating at conventional temperatures, overall plant efficiencies can be raised from the 25-35% range to the 45-50% range.

QUESTION: WHAT ARE THE PRINCIPAL DESIGN CHOICES?

The basic system design choice for large scale, coal-fired MHD power plants is between open cycle and closed cycle systems.

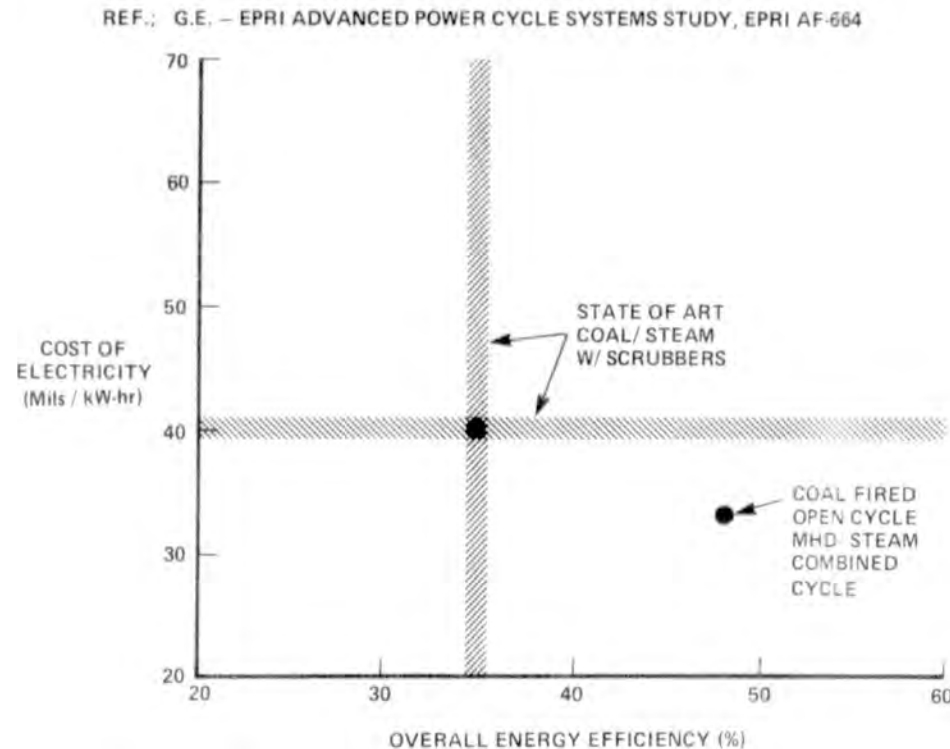
In an **open cycle** system, the working fluid for the MHD flow train is the high temperature (4500°F) combustion products of coal burned with preheated air. Oxygen enrichment may be used to lower required oxidizer pre-heat temperatures. Potassium is added to provide a combustion gas of high electrical conductivity. The potassium "seed", which is recovered, also serves as a scavenger for sulphur in the coal fuel.

Closed cycle plasma MHD employs a cesium seeded noble gas, such as argon, as the MHD working fluid. A two-flow-path system is employed. In the first flow path, which is open, a heat exchanger is coal-fired to approximately 2900°F. Then, by appropriate valving, the noble gas in the second, closed loop is circulated through the heat exchanger to heat the MHD working fluid to operating temperature. Relative to open cycle, the lower operating temperature of closed cycle plasma MHD is possible because of non-equilibrium ionization of the seed material which results in comparable gas electrical conductivity.

Closed cycle liquid metal MHD also uses a two-flow-path system, analogous to closed cycle plasma MHD. The principal difference is that in the liquid concept, the MHD working fluid is initially a two-phase mixture (liquid/vapor) of an alkali metal, from which the vapor phase is separated before entering the MHD channel. Both phases are then recirculated.

Currently, the **open cycle** system concept using linear MHD channels is favored for MHD electric power plants. The closed cycle concept together with other channel design concepts, such as the disk, are viewed as alternatives for second generation MHD power plants.

QUESTION: HOW MUCH WILL MHD POWER COST?



Cost and performance studies of advanced coal-fired power generating systems indicate the potential superiority of MHD. These studies,⁽¹⁾ federally funded, were conducted by major U.S. commercial power system manufacturers. The combined cycle MHD-steam plant was shown to be the only directly-fired coal-based cycle capable of achieving efficiencies in the 45-50% range. Cost of electricity for the MHD system was estimated at 32 mils/kwh. These projections are significantly better than the 35% efficiency and 37 mils/kwh capability of a modern, coal-fired steam plant as calculated under the same set of assumptions.

A study⁽²⁾ conducted by the General Electric Company for the Electric Power Research Institute showed MHD with the lowest cost of electricity (33.7 mils) and the highest efficiency (~50%).

(1) NASA TM-73871, Sept. 1977

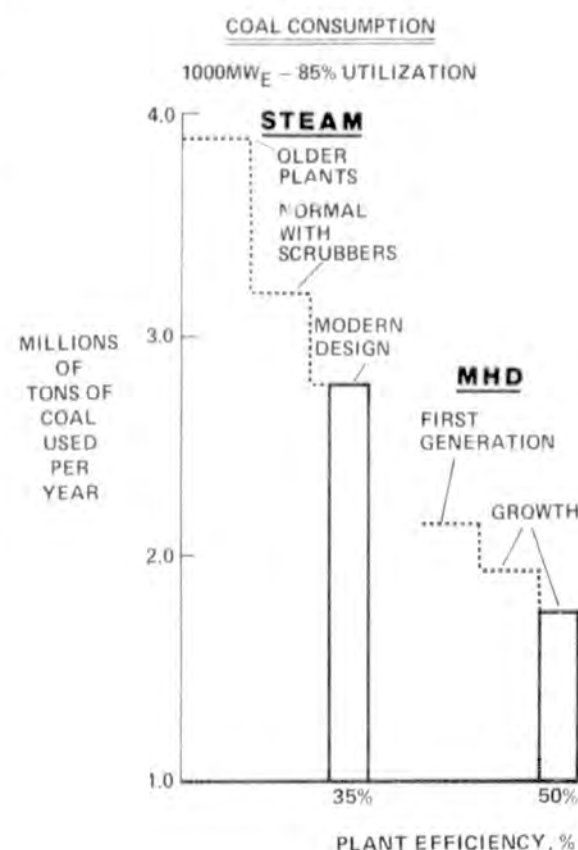
(2) EPRI Report AF-664, Feb. 1978

QUESTION: WHAT COULD MHD DO FOR THE U.S. ENERGY ECONOMY?

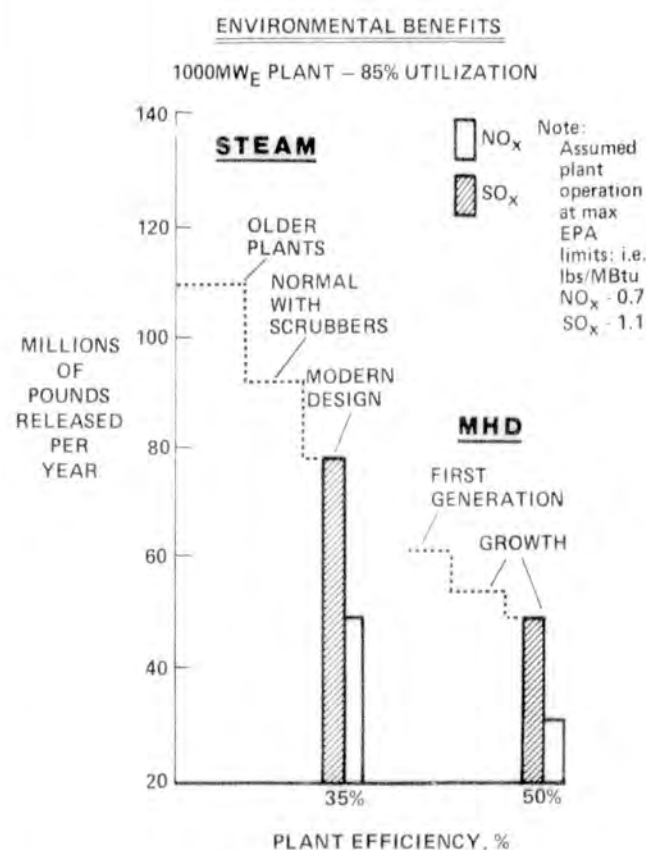
A combined MHD-steam plant is potentially capable of producing up to 50% more power from a ton of coal than a modern base load steam plant. A "mature" 1000 MW_E MHD-steam combined cycle plant operating at 85% availability (7446×10^3 MWH/yr) would require about 800,000 tons of coal a year less than the conventional plant. Even an early commercial "first generation" version, conservatively designed, would save between 300 and 700 thousand tons. By exploiting inherent MHD growth capabilities, a single advanced 1000 MW_E MHD commercial plant could be expected to save up to 1 million tons of coal per year.

The economic implications of MHD power lie in the strong national need to replace foreign oil with domestic coal in the production of utility power. The opportunities for conservation, transportation savings, mining benefits, and environmental improvements are underscored by the efficiency advantages of MHD in central station power generation.

A secondary advantage of MHD could become an important factor in the future of the industrial economy. Because MHD operates at high cycle temperatures, it provides opportunities for co-generation, i.e., production of both electrical and thermal energy. This is a primary concern of energy intensive industries like primary metals and chemicals.



QUESTION: DOES MHD POWER PROVIDE ANY ENVIRONMENTAL ADVANTAGES?



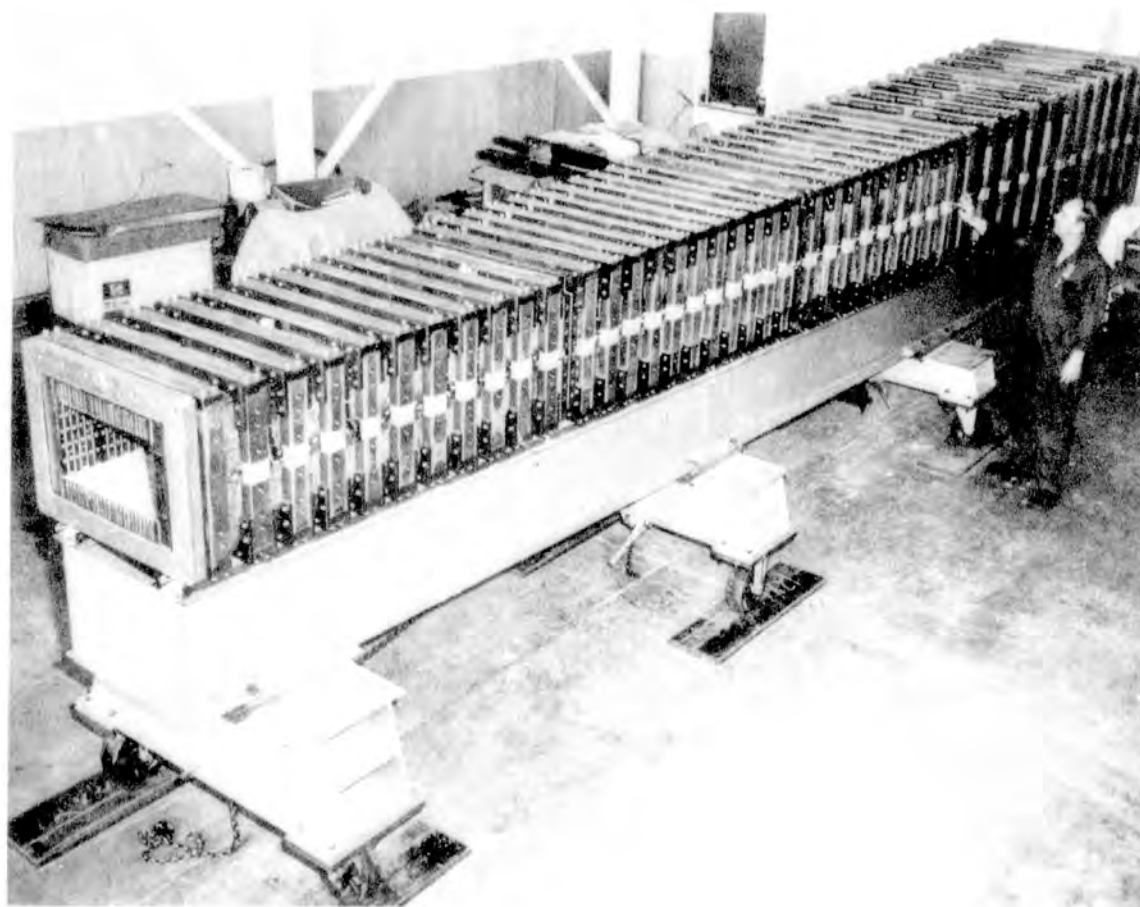
A basic environmental advantage of MHD derives from its higher efficiency. Coal savings were described on the preceding page. These savings translate directly to reduced environmental intrusion. If we assume two plants of identical power generating capacity, side by side, one a first generation MHD-steam plant and the other a modern steam-only plant, both operating at present maximum permissible EPA emission limits, the MHD plant will produce about 1/3 less SO_x, NO_x, particulate, and CO₂ than the conventional plant.

MHD offers further environmental benefits. The potassium which is added to the coal combustion gases as a carbonate salt combines with the sulphur compounds from the coal to form potassium sulphate. This can be recovered in the steam bottoming plant and regenerated to the carbonate for reuse. Experimental data indicates that SO_x emissions may be virtually eliminated with coals of less than 1% sulphur. Even with high sulphur coals (4%), SO_x emissions could be cut to about one half of the EPA maximum standard.

Controlled combustion in the MHD system permits close management of NO_x emissions - about 1/5th of the EPA limit. Particulates also can be maintained well below federal requirements. The high efficiency of MHD energy conversions also reduces thermal pollution - water and air - significantly.

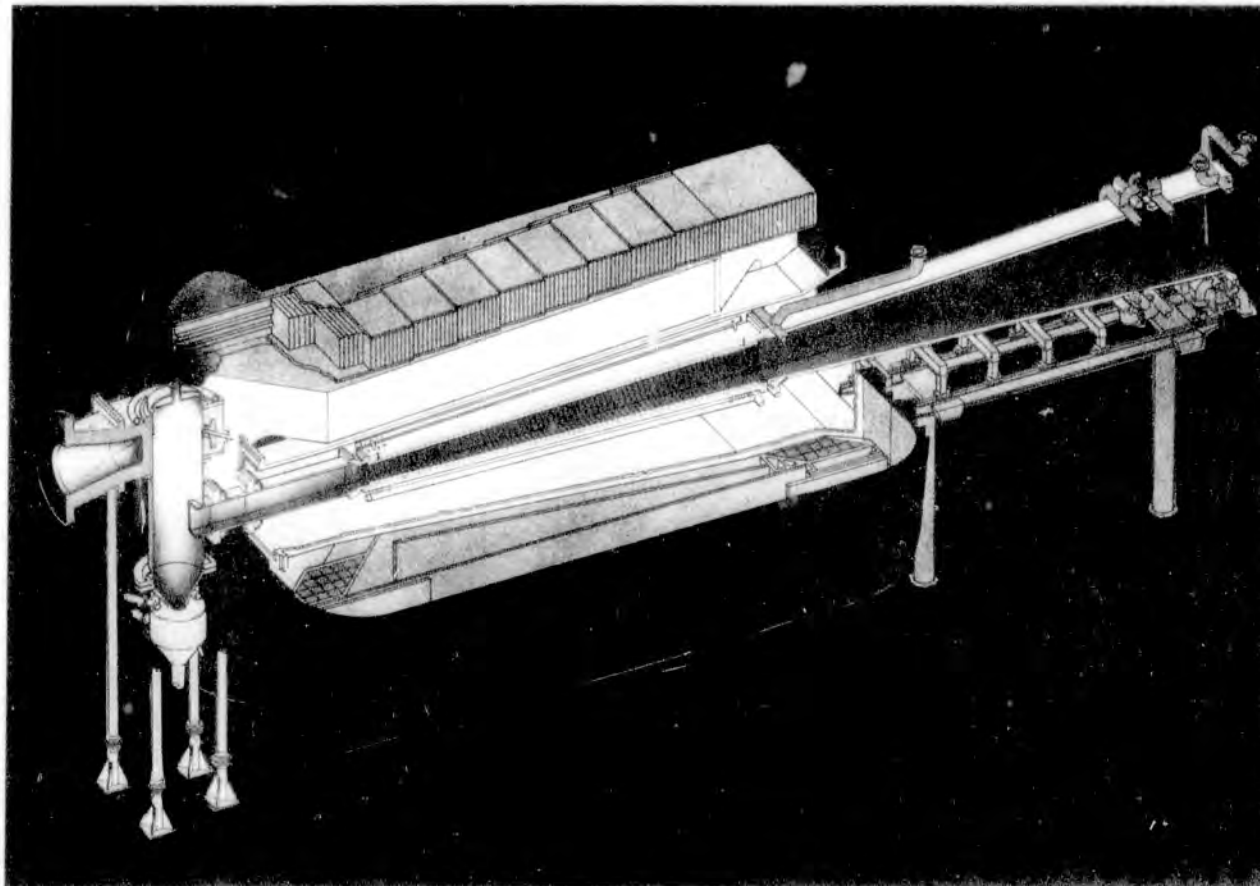
QUESTION: WHAT WOULD AN MHD CHANNEL LOOK LIKE?

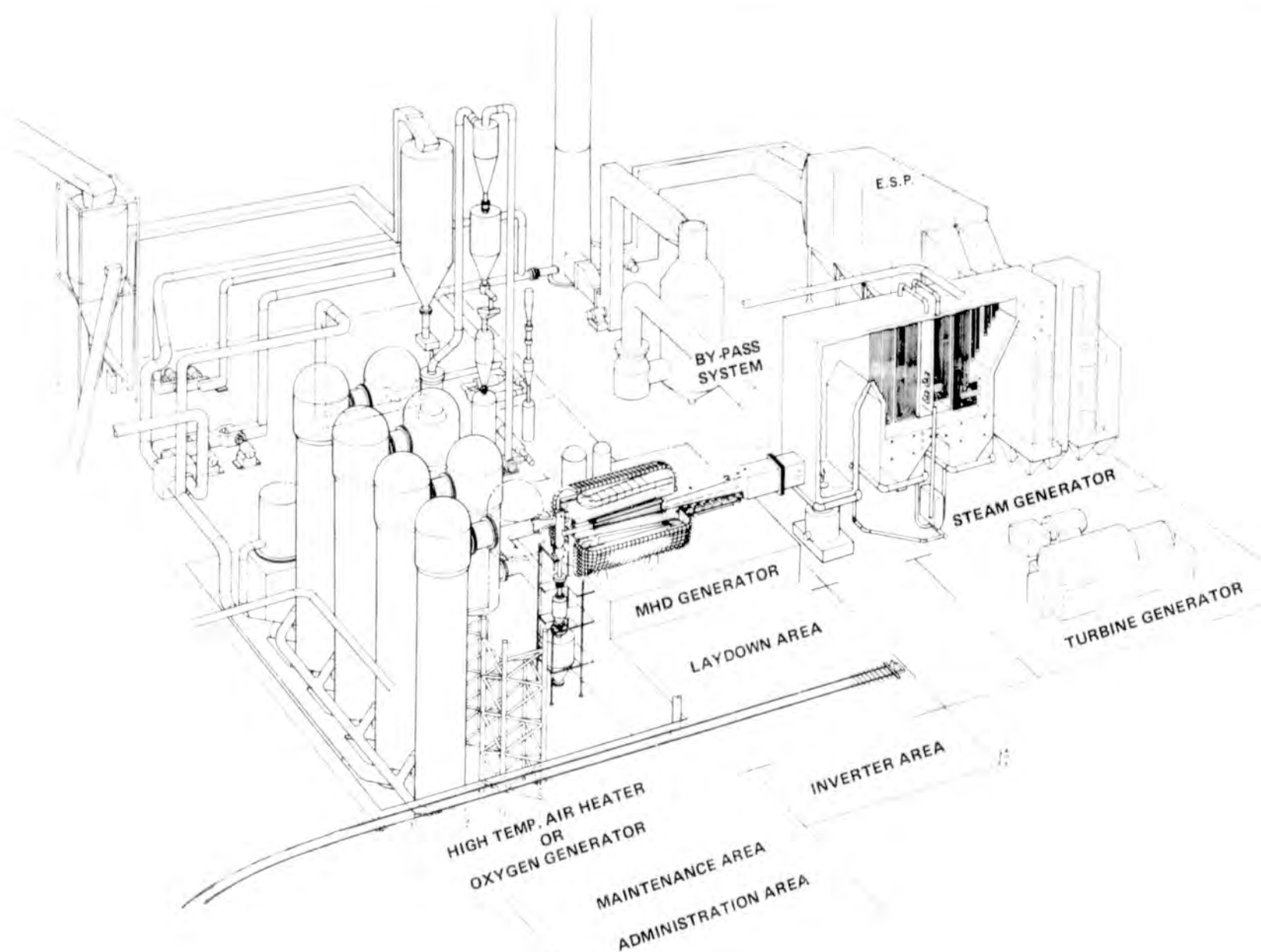
The figure below is a photograph of an experimental channel which will be used in a series of experiments to study size effects on channel performance characteristics. (Courtesy of USAF, Arnold Engineering Development Center.)



QUESTION: WHAT WOULD AN MHD GENERATOR LOOK LIKE?

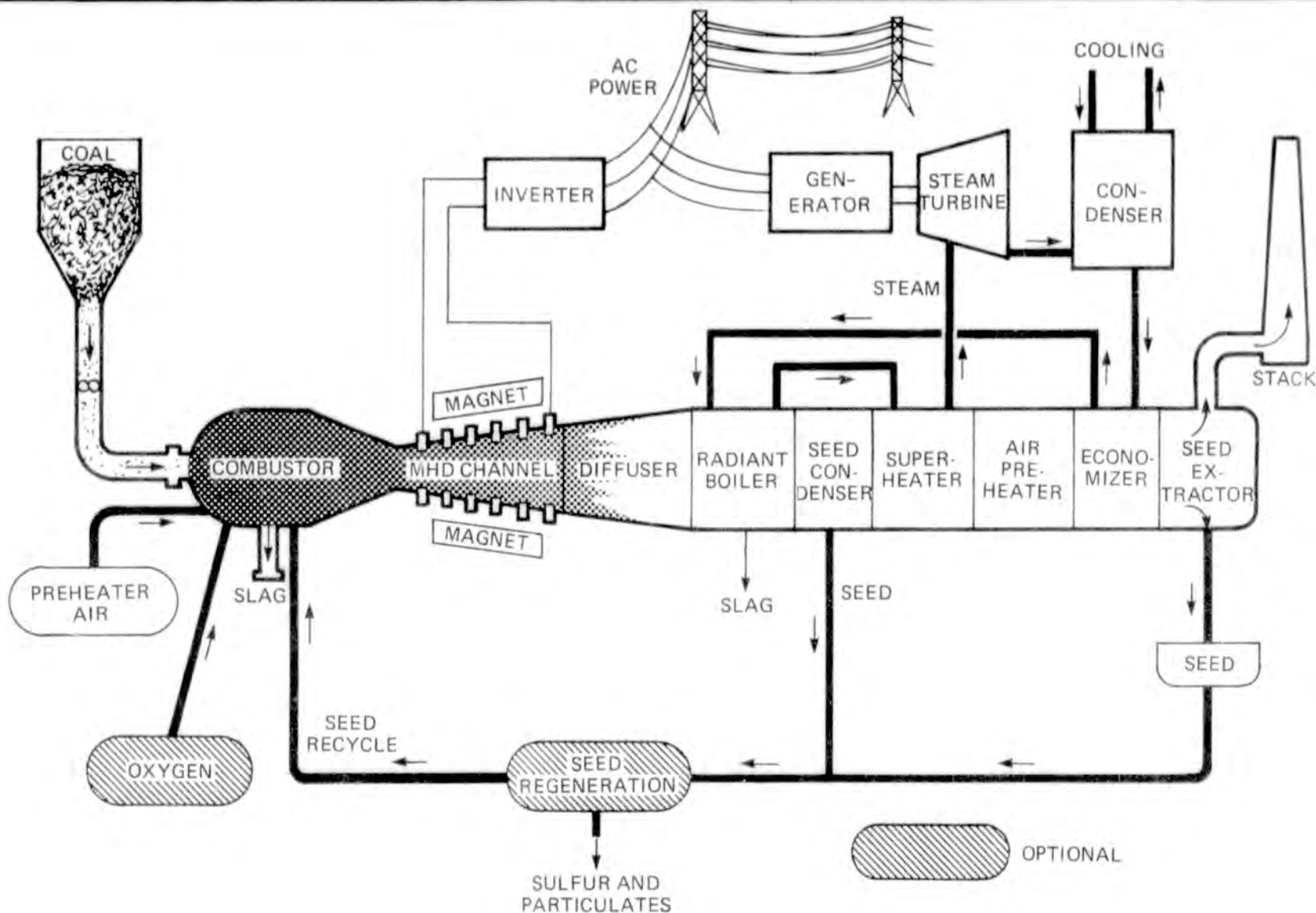
The figure below is an artist's sketch of a 250 MWT generator assembly, including the coal combustor, channel, magnet and diffuser. The sketch is based upon preliminary design and performance studies of a plant of this scale. (Courtesy of Avco Everett Research Labs.)





This is an artist's drawing, based upon preliminary design studies, of the possible arrangement of a 250 MWT experimental plant. (Courtesy of Avco Everett Research Labs.)

QUESTION: WHAT WOULD AN MHD POWER PLANT LOOK LIKE?



This schematic shows one possible arrangement of the major components of a combined cycle MHD-steam power station. Basic cost and performance tradeoff studies are being conducted on air heating, oxygen enrichment, and seed recycling conditions. (Courtesy of TRW.)

QUESTION: WHAT IS THE STATUS OF MHD DEVELOPMENT?

COAL COMBUSTOR

Development has progressed to the testing of 20 MWT prototypes. Three different designs capable of rejecting from 70 to 90% of the coal ash as molten slag are being evaluated. Another design which carries all of the ash product in the combustion gas stream is under development by the University of Tennessee Space Institute (UTSI) using the DOE Coal-Fired Flow Facility (CFFF). Selected designs will be scaled up to 50 MWT for integrated generator testing at the DOE Component Development and Integration Test Facility (CDIF) in Butte, Montana.

CHANNEL

Principal development effort is being conducted at the 20 MWT scale under conditions closely simulating those anticipated in commercial systems. Steady design improvements of critical life-limiting elements (electrodes, insulators, side wall structures) has improved durability by two orders of magnitude over the past four years. Channel life expectancies in excess of 2000 hours are indicated. Preliminary design tests of 50 MWT prototypes is expected to commence at the CDIF in 1980.

MAGNET

A forty ton superconducting magnet, designed and built by the Argonne National Laboratory, is being operated successfully in conjunction with the MHD generator tests under the joint U.S. — U.S.S.R. program at the U-25 B Facility near Moscow. Performance has met design predictions. Superconducting magnets are under design and construction for installation in the CDIF, CFFF, and the MHD facility at Stanford University. Performance and cost studies of commercial scale magnets are being pursued.

INVERTER

Development is proceeding in parallel with channel loading and control circuitry development. A new force commutated design recently inverted the full power output of an experimental channel for over 12 hours. Average power fed into the 480V line was 200 kw. This design possesses significant efficiency and control advantages over standard line commutated systems. Improved versions of the advanced design will be integrated in experimental 50 MWT generator subsystems for CDIF tests in the 1982–1985 period. This work is funded by the Electric Power Research Institute (EPRI).

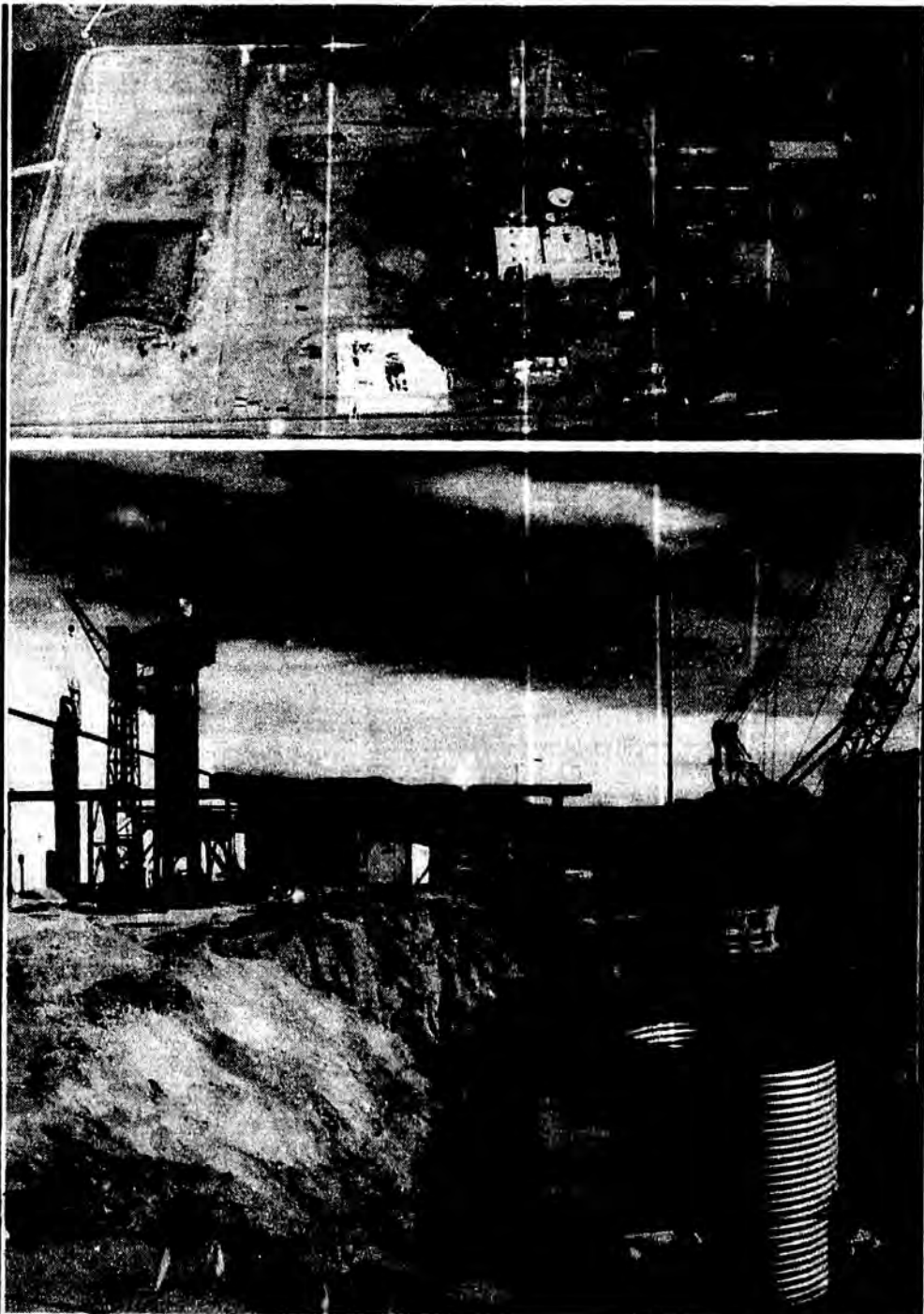
mhd and the cdif

MERDI has devoted much of its time and talents in the past three years to studying magnetohydrodynamics (MHD) — its generation, the impacts of its development — and to assuming an important role in the national MHD program.

MHD is an energy conversion process that generates electricity by passing an electrically-conductive fluid through a magnetic field. While the concept of MHD originated more than 140 years ago, MHD technology is relatively new and still in the research, development and demonstration stage. The MHD process, coupled with a conventional steam turbine electrical generation system, has the potential to substantially increase the efficiency of the overall process of converting a fossil fuel into electrical energy.

The MHD process is based on the interaction between a strong magnetic field and a hot (approximately 5000° F) highly ionized gas (plasma) flowing at near or above sonic velocity. This interaction produces an electrical current. A combined MHD-conventional electrical generation process has the advantage of being able to utilize America's abundant coal reserves in a manner that produces less air and water pollution than existing electrical generation systems, and uses less water.

Major efforts in MHD research have been made by the United States, the Soviet Union, Great Britain, Japan, Germany and the Netherlands. The Soviet program has concentrated on a natural gas fired, open-cycle process; the Department of Energy is directing an



MHD technological exchange program with the Soviets.

An open-cycle process is one in which the hot gases from the combustion of the fossil fuel directly form the power-producing plasma, pass through the process once (including the heat recovery and bottoming cycle) and then are exhausted in the atmosphere. The technical advantages of open-cycle, coal fired MHD plants include increased efficiency, less thermal pollution, less particulate emissions, reduced water consumption, reduced nitrogen oxide and sulphur dioxide emissions and no moving mechanical parts in the MHD power-producing section.

It appears possible to increase the efficiency of a conventional power plant from 30 or 35 percent to nearly 60 percent by adding an MHD cycle. In the MHD process, the hot gases leaving the magnetic field exceed 3000° F, and total electrical generation depends on the use of this remaining heat to generate additional electrical power. This can be accomplished by using these hot gases to power a steam turbine generating plant; the coupling of a conventional power plant with an MHD cycle is known as a topping and bottoming cycle.

The major components in the open-cycle MHD process include a combustor, a channel (or generator), a magnet and an electrical converter (inverter). The combustor is a device similar to a rocket engine which produces a very high-temperature, electrically-conductive plasma through the combustion of a fossil fuel and the injection of an alkaline salt.

To provide satisfactory ionization, the plasma should remain in a 4500° to 5000° temperature range. And since power generation is directly proportional to the plasma velocity, a nozzle attached to the combustor accelerates the plasma to supersonic or slightly subsonic conditions, depending on the design of the channel.

Upon leaving the combustor and nozzle, the plasma enters the generator. This channel is enclosed in a magnet that creates a magnetic field perpendicular to the flow of plasma; the result is an electromotive force mutually perpendicular to both the plasma flow and the magnetic field directions.

To take advantage of this force, the generator is built with a rectangular cross-section. The top and bottom walls are lined with electrodes to provide an electrical circuit for the induced potential voltage in the plasma; the two side walls are insulators to prevent short circuits between the two electrode walls (anode and cathode).

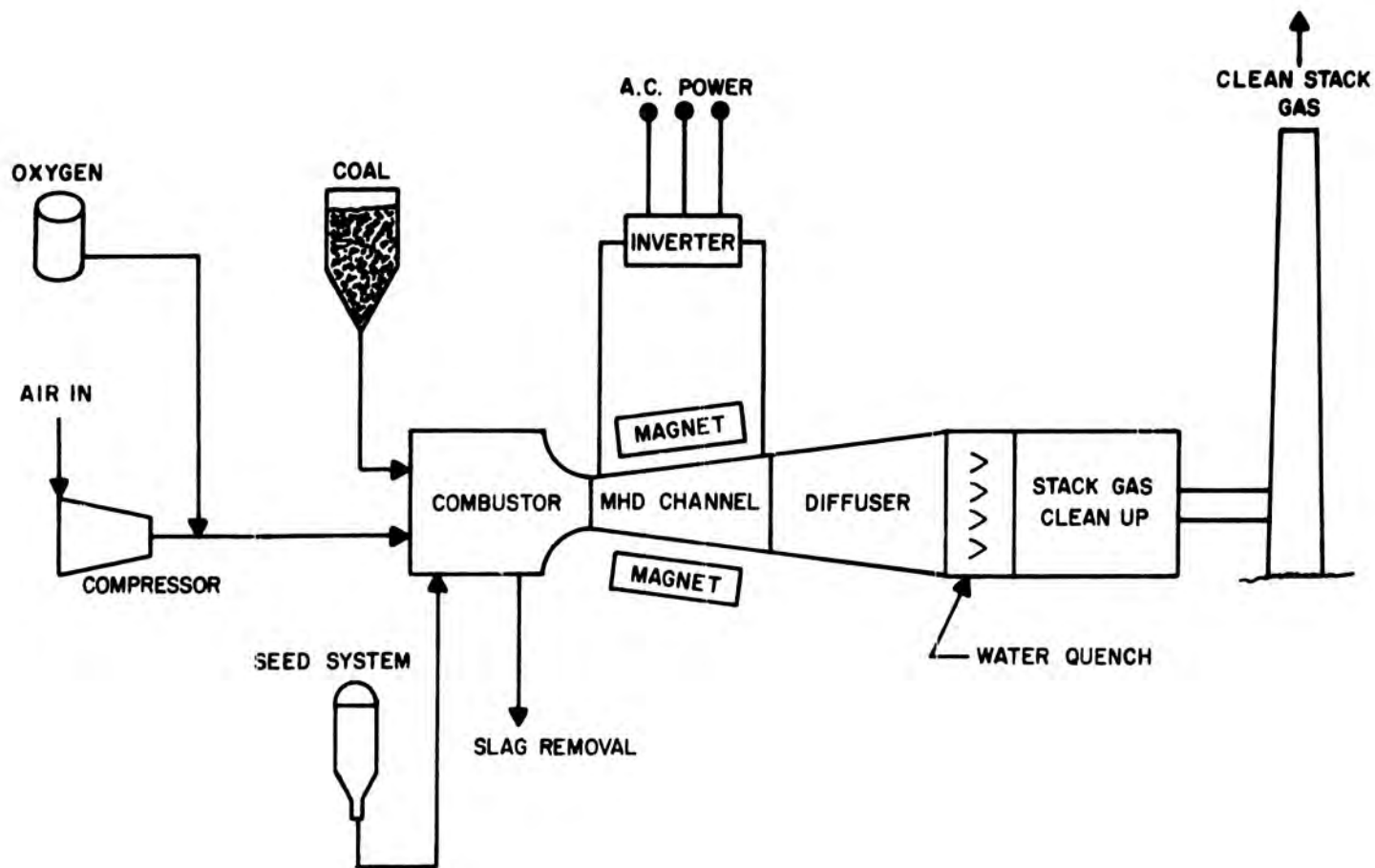
The inverter receives direct current from the electrodes and converts it into alternating current compatible with

existing power grids. At this point, the MHD portion of the process is complete and the electricity is ready for transmission to the customer.

MERDI is actively involved in the MHD research and development program in the United States. The first phase of the program includes systems engineering and analysis, facility design and construction, and component development testing. Future efforts involving the Engineering Test Facility (ETF) will stress the testing of complete power trains, performance optimization, durability testing and the verification of major design and scale-up factors.

The ultimate goal is to demonstrate the commercial feasibility of full-scale combination MHD/steam turbine electrical power generation systems.

The Department of Energy Component Development and Integration Facility (CDIF) is being built in Butte as part of the first phase for the purpose of conducting component development and systems performance tests on the key hot gas components of an MHD power train. The CDIF is designed to test not only coal fired combustors and MHD channels at a 50 megawatt thermal (MW_t) power input level, but also to test related support equipment such as a 6 tesla superconducting magnet and an inverter system. The construction of this facility is under the management of the Department of Energy Idaho Operations Office.



CDIF EXPERIMENTAL FACILITY

Located on a 53-acre site in the Butte Industrial Park, the CDIF is scheduled to begin testing operations in late 1979. Plans include five tests of 100-hour duration during the first year, with tests eventually reaching 1000 hours in length. These initial tests will use a 50 MW_i combustor and a 3 tesla iron core magnet, while later tests will include coal fired combustors, a 6 tesla superconducting magnet and an inverter to convert direct current from the MHD channel into alternating current compatible with a commercial power grid.

MERDI/CDIF, the Institute organization dedicated exclusively to CDIF functions, has been designated by the Department of Energy to manage the operation, maintenance and testing activities. Included in these responsibilities are the procurement and management of services from subcontractors, as necessary, to ensure the safe and efficient conduct of facility and experimental test operations at the CDIF site.

To adequately provide the management and support services required, MERDI/CDIF is organized into four basic divisions in addition to having groups working on safety and quality assurance. The four divisions include Project Control, Test and Systems Engineering, Operations and Technical Support. These divisions and groups are staffed with highly technical personnel educated and experienced in a wide range of engineering and related fields.

The Project Control Division is responsible for the planning, scheduling, budgeting and control of activities for MERDI/CDIF, subcontractors and support groups. This division also provides a central liaison function to coordinate efforts between MERDI/CDIF and other companies involved in CDIF testing.

Providing basic analytical engineering capabilities, the Test and System Engineering Division also prepares test specifications and procedures, test data analyses, system simulation modeling and technical evaluations, and provides support to other MERDI/CDIF divisions. Project engineering functions are performed as necessary to install and operate MHD test trains; technical liaisons are also provided with vendors and experimentors.

The Operations Division manages those activities inherent in experimental test operations — the calibration of instrumentation, facility and test train operations, data acquisition and the assurance of safe and efficient test runs. The Technical Support Division ensures that facility and test train components are properly maintained, and this staff manages corrective maintenance and facility modifications as required.

Safety and Quality Assurance personnel see that all activities, procedures and operations associated with MERDI/CDIF comply with established standards.

Outside of the MERDI/CDIF divisions, support on CDIF work is received from the Socioeconomic, Environmental, Engineering, Applied Research, Computer Support and Communication Services divisions; tasks range from the Butte-Silver Bow Community Attitudinal Survey and other socioeconomic work to monitoring and evaluating ambient air and water quality.

With a well-rounded staff and duties properly delegated, MERDI/CDIF can well accept its responsibility to manage activities at the CDIF site and to represent the Institute in its contribution to the national MHD effort.

QUESTION: WHAT IS THE STATUS OF MHD DEVELOPMENT? (CONTINUED)

STEAM PLANT

Steam "bottoming" plant development work has centered mainly on seed recovery, NO_x control, and "slagging" problems. Design feasibility has been demonstrated with regard to principal system requirements. Work is now being initiated to establish a firm engineering base for the design of a commercial prototype boiler of about 300-500 MWT capability. Preliminary 20 MWT integrated subsystem development tests will commence in the 1981-1982 period. Early 5 MWT scale subsystem test results have been encouraging.

SCALING

Experiments intended to establish data essential for design scale-up allowances are being conducted at 20 MWT, 50 MWT, and 250 MWT. Experiments to date have confirmed existing scale models. Important additional 250 MWT experiments are scheduled for the 1980-1981 period.

AIR HEATING

Development has focussed principally on heat transfer, slagging behavior, design, durability, system studies, and materials testing. Directly-fired conditions have been simulated by injecting fly ash slag and seed products into representative heat-transfer sections. Indirect firing has been demonstrated in a small-scale, prototype, clean-gas fired regenerative heater. Accumulated test times of approximately 1000 hours under the directly-fired test conditions and 2000 hours with the indirectly-fired prototype, both at temperatures up to 3000°F, indicate the technical feasibility of high temperature air heaters.

ANALYTICAL AND RESEARCH SUPPORT

Computer codes have been developed and experimentally verified to predict design and operational effects on generator performance. This work is being continued in close coordination with the experimental development program. Critical support research has provided basic design information relating, especially, to generator performance.



QUESTION: WHAT IS THE MHD PROGRAM DOING?

OBJECTIVE

The objective of the program is to develop the MHD technology required to determine the commercial viability of MHD/steam power generation systems. The goal is to develop basic component and subsystem technology required for the design, construction, and operation of an MHD commercial demonstration plant.

REQUIREMENTS

Specific development requirements are being defined by analyses of cost and performance demands projected for commercial acceptance.

IMPLEMENTATION

Development work is being directed towards the analytically-derived commercial requirements, and qualification (milestone) test performance requirements are being specified to progressively validate the technology basis necessary for the design of commercial-scale components and subsystems.

FACILITIES

Essential development and test facilities are being constructed for qualification testing and to accelerate development of critical components, i.e., the DOE Component Development and Test Facility (CDIF) in Butte, Montana, and the DOE Coal Fired Flow Facility (CFFF) in Tullahoma, Tennessee.

INDUSTRIAL PARTICIPATION

Necessary industrial participation is being sought through competitive solicitation of critical component and subsystem engineering development work.

SUPPORT RESEARCH

Relevant research, in support of the development program, is being conducted in materials, diagnostics, combustion, fluidynamics, magnetohydrodynamics, analytical modeling, and scaling.

SYSTEM ANALYSES

Analytical studies are being conducted to (a) determine development requirements, (b) evaluate basic cost and performance tradeoffs, (c) evaluate major design and operating sensitivities in relation to commercial requirements, and (d) define alternative design and operational conditions for possible first generation commercial demonstration.

SUMMARY

- MHD is potentially capable of producing 50% more electricity from a ton of coal than any other existing direct combustion power cycles.
- Studies indicate that MHD power would cost less than modern coal-fired steam plant power.
- The inherently high efficiency of MHD power generation means less environmental intrusion. Also, the MHD cycle is compatible with high sulphur coal.
- Encouraging progress has been made in channel design, coal combustion, power output, power management, magnet design and construction, air preheating, and seed recovery. No fundamental technical problems have been identified which would preclude ultimate commercialization.
- Commercialization depends upon continuing development success in the resolution of component and subsystem design issues, particularly regarding boiler performance, scaling uncertainties, and systems compatibility.
- The MHD program is directed toward these issues. Specific performance requirements are being derived from analyses of projected commercial plant applications and needs. Necessary facilities are being constructed to validate development progress and to qualify selected prototype designs.
- Basic component and subsystems technology, essential to the design of a scaled-up commercial prototype plant, is expected to be available in the 1983–1984 period. System studies are being conducted to allow trade-off comparisons of potential “commercial demonstration” prototypic plant concepts.





FOSSIL ENERGY PROGRAMS

**Division of Magnetohydrodynamics
U.S. Department of Energy
Washington, D.C. 20545**

MEMORANDUM

To: Representatives Brian Rogers and Hugh Malone, Co-Chairman, Power Alternatives Study Committee
From: Mark Wittow
Re: My trip to the Montana Energy Research and Development Institute (MERDI) in Butte

A. Summary

I spent twenty-four hours in Butte at MERDI. Jerry Plunkett, the director of the Institute, arranged the details of my visit. I spent a great deal of time talking with Dr. Plunkett about the guiding ideas of the Institute as well as their actual operations.

Ed O'Hair, who authored Montana's renewable energy development plan, discussed that plan and his work with the Center for Innovation (a MERDI offshoot) with me. I toured the coal "magnetohydrodynamic (MHD) component development and integration facility (CDIF)", which is a two hundred million dollar project funded by the U.S. Dept. of Energy and administered by MERDI. I spent a couple hours at the National Center for Appropriate Technology (NCAT), another MERDI offshoot, and talked with technical staff working in the areas of agriculture, solar technologies, weatherization and small hydro, as well as the deputy director for policy development. I also had a number of shorter conversations with other MERDI staff, which I will discuss below.

The staff at the Montana Energy Research and Development Institute possess a wide range of government, business and industrial experience. They are directed towards seeing their programs put into practice and run well, as opposed to an orientation towards general research work. During the past two years, they have developed what I feel are excellent renewable energy and conservation programs for Montana, as well as being national leaders in stimulating technological innovation and coal research.

The energy problems of Montana parallel those of Alaska in a number of ways. Both states export a large portion of their energy reserves, have a widely dispersed population and are seeking a stable economic base and long-term jobs. The Montana Institute programs are oriented towards those development goals, and we would be wise to seek their advice on our own programs for that reason alone. MERDI's directors are very interested in seeing Alaska develop energy programs similar to their own. They have great confidence in what they are doing, and would like to share their experience with a kindred state. They expressed interest in helping Alaska in the following areas:

1. offering occasional advice on the Committee's study of the potential for conservation and renewable energy use in ~~Alaska~~ Railbelt Alaska.
2. contributing to a study of the potential of coal in meeting the power needs of the Railbelt area. They have done a great deal of work on the development of Montana's coal reserves, and are the national leader for the MHD project, which burns coal at 50% greater efficiency than conventional methods of power generation at much lower levels of pollution. They are also pursuing the development of an efficient, clean coal furnace for home heating needs.
3. advice on the possible establishment of an Alaska Center for Innovation, which would ~~be~~ help inventors and small businessmen determine the commercial feasibility of their ideas and provide marketing assistance.
4. advice on the possible establishment of an Alaska Energy Development ~~Institute~~ Institute, which would provide a stable, independent basis for expertise in energy development.

The following sections detail some of the specifics of my visit.

B. Origins of MERDI

The Institute was established under the leadership of former Senator Mike Mansfield (now U.S. Ambassador to Japan), with a \$15,000 grant. Mansfield recruited Jerry Plunkett to run the Institute. Its expressed mission was to work for the kinds of energy development that would provide ~~many~~ long-term jobs in the private sector. With this mission in mind, MERDI was located in Butte, where a once-huge copper mining operation had left nothing behind but unemployment and a big hole in the ground.

Plunkett told me that he had designed the Institute in reaction to abstract, academic research that had little effect on actual problems. He discussed work he had done in Guatemala, Africa and various universities, and his dissatisfactions with most research work in the energy field. He pointed out the huge commitment of time and money that has gone into nuclear power during the past twenty-five years, with very little power ^{production} ~~xxx~~ to show for it. Little attention has been paid to the usefulness of applied, practical work, since that work has no place in the academic journals. Plunkett was critical of the lack of marketing experience in the U.S. Dept. of Energy, and their orientation towards a small number of huge, advanced technology projects to the ~~the~~ detriment of more attainable goals.

6. National Center for Appropriate Technology (NCAT)

NCAT was set up by Plunkett during the first years of MERDI. He told me that he had founded the Center to provide the training programs and technical work necessary to achieve proper conservation practices in the homes of the ten million low-income families in the U.S. These homes are among those with the highest energy costs in the country, but an investment of approximately two thousand dollars per home would cut annual energy costs in half. Although NCAT has begun work in this area, they have taken a broader path, doing technical work and information gathering in ~~xxxxxxxxxxxx~~ agriculture, biomass, building technology and solar energy. There seems to be some mild tensions between the older staff at MERDI and the younger staff at NCAT, with the MERDI people feeling that NCAT is too-enamored of individual small-scale technology development and is paying insufficient attention to the need for training and larger projects. Some NCAT staff scoffed that MERDI wasn't interested in work that wasn't big. Plunkett explained that his definition of "appropriate technology" included all sizes and complexities, depending on the use.

Because of the brief nature of my visit, as well as the national nature of NCAT's efforts, I had a hard time evaluating the success of their work. They have a tremendous variety of projects going, oriented around a concept of small-scale, community technology. They are doing very useful work in evaluating the efficiency of various forms of insulation and solar collectors, and are disseminating a lot of information on small hydro technology and weatherization.

NCAT runs on a budget of about 3.2 million dollars a year, which they receive from the federal Community Services Agency. In addition to their own work, they distribute about 650,000 dollars a year to other groups through grants for program assistance. The technical research staff of NCAT

(32 people) are employed by MERDI, although they work at the NCAT building. The Center pays MERDI \$838,000 a year for their services.

D. Coal--the Magnetohydrodynamic (MHD) Generation project

MERDI is administering a Dept. of Energy program to develop a facility that will use the MHD process for large-scale generation of electric power. In the MHD process, coal is treated, then super-heated in a magnetized field. The resulting ionization gives off direct electricity; the hot gases that are produced in the process then turn more standard power turbines. Almost no waste products are left after the process is complete. The MHD process produces anywhere from 25-60% more power than conventional methods using coal, and uses a great deal less than water than the synfuel production process. Work on the project began in 1977 and will continue through 1986; total funding will be something over 200 million dollars. Some results will begin coming in next year.

E. Center for Innovation

The Center was established as a MERDI spinoff with grants from Montana and neighboring states. It receives its operating funds from the U.S. Economic Development Administration and the Dept. of Energy. The Center aids small businessmen and inventors in taking their ideas from conception to market, by providing help with patent work, detailed technical and marketing analyses, publicity, marketing and sales approaches and assembling start-up funds.

The Center for Innovation has reviewed 1300 proposals since beginning operation in June 1977. They have helped over 100 proposals -- about 15 have achieved commercial success, and almost one hundred are receiving active support. The Center attributes ~~the~~ success to the fact that the program is administered through part-time field representatives who have a variety of contacts in business and industry. The director of the Center also felt that they ^{have} managed to work with the inventor at his or her level while providing needed technical, administrative and commercial help. MERDI would like to see more Centers for Innovation started, since having them dispersed in different regions would improve each Center's effectiveness.

F. Power Facility Siting

MERDI is working to establish criteria for studying the social, economic and environmental impacts of siting major power facilities. They expressed dissatisfaction with the quality of work done in most impact statements by groups such as Dames and Moore. The director of their efforts, Terry Kirkland, would like to see their work used in Alaska. I did not have time to discuss the details of their work in this area but Mr. Kirkland has promised to send us materials.

G. Renewable Energy Development (a summary of comments by Ed O'Hair and Jerry Plunkett)

MERDI's goal is to use renewable energy development as an economic development tool. Projects need to be community-sized, and structured in a way that will provide incentives for stable economic growth. In Montana, wind power and

alcohol-based fuels are the best options.

The focus of renewable energy efforts needs to be on the reliability of the technologies, as well as simply putting them into place. The key is to create enough demand for the technologies to enable mass production at low costs, under conditions that will benefit the state. If projects are designed at a modest scale, duplication can be built in, enabling a second contractor to learn from the mistakes of the first without failures ruining the project for good. All work on renewable energy should be integrated, and directed to the needs of the local communities.

Montana is favoring renewable energy development because, in the long run, it is the only path of energy development that fits in with desired ways of life. Since coal is only an intermediate solution to the energy problem, fission and fusion are the only other alternatives. Both those forms would result in a highly centralized power system with social and security effects repulsive to a democratic society.

H. Conservation and General Energy Planning (again, a summary of the ideas of O'Hair and Plunkett)

MERDI's efforts have been directed towards the goal of efficiency and not self-sufficiency; energy resources should be traded freely for best advantage. The entire energy system should be addressed. A large, diverse system, allowing for interchange, cogeneration, waste heat use, etc. is desirable. Where electric distribution is cheap and efficient, it is a desirable source of energy. Electricity is best used for industry, not as a primary source for home heating.

An efficient energy system also needs to be designed in a way that won't adversely impact chosen lifestyles -- just as you can't force good nutritional habits, proper uses of energy can't be forced.

Retrofitting projects should be contracted out to the private sector to build up their capabilities. The costs of conservation should be compared to the cost of new increments of power (marginal cost analysis). The four foundations of a good energy study:

1. economic impacts of technologies -- marginal cost analysis
2. social " " " -- desirability of decentralization, etc.
3. end use of energy analysis
4. system efficiency in delivering energy resources to end use.

I. Relationship Between the Academic World and Possible Institutes, Centers.

O'Hair and Plunkett both stressed the need for independence from university ties if energy development programs are to be successful. Both have worked in universities, and feel that their differing orientations and lack of understanding about economic development prevent the possibility of a good program operating under university auspices. They discussed the National Science Foundation Innovations program. They were critical of it, stating that it accomplished nothing more than having engineers take business courses and businessmen take engineering courses.

Log of trip to Butte, Montana -- Mark Wittow for Power Alternatives Study
Committee

October 25 and 26, 1979

Oct. 25

10:20 am -- arrive in Butte

10:30-noon -- conversation with Jerry Plunkett on general goals of the Montana Energy Research and Development Institute and state and federal energy policy.

noon-1:30pm -- Lunch with MERDI division directors, broad overview of MERDI's work, scheduling of the rest of the day.

1:30-3pm -- Explanation and tour of the MHD facility with Frank Fogarty and Ed Wong.

3-5pm -- Meeting Ed O'Hair on Montana renewable energy programs and their Center for Innovation.

5-6pm -- Discussion with O'Hair and Plunkett on Structure of MERDI, ties with the university, possible options for Alaska.

6-7pm -- informal talks with Dept of Energy and MERDI staff.

7-10pm -- dinner with Plunkett and a Westinghouse electric power engineer

Oct. 26

7-8am -- Breakfast with Plunkett and John Orth, Deputy Director of MERDI. Discussed role of MERDI in Alaska, possible work on coal.

8-10am -- Visit to National Center for Appropriate Technology
general policy -- John McBride
operations, microhydro -- Sherr Eisenbart
conservation -- Toby Benson
Solar technologies -- Larry Palmiter and Bill Wadsworth
agriculture -- Suzanne Merriam

11 am -- departed Butte

SCOMM

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PLEASE NOTE: THE FOLLOWING PAGES WERE TREATED
AS A UNIT IN THE ORIGINAL DOCUMENT.

Attn: Mark Wittow
Rm. 121 Cap. Bldg.
Rep. Brian Rogers. Cfc.

Administrative Committee on
Renewable Resources Development

October 12, 1977

AVRUM M. GROSS
ATTORNEY GENERAL

Renewable Resources
Funds

By:
Rodger W. Pegues
Assistant Attorney General

This confirms our recent discussions on this subject.

First, "renewable resources" are whatever the Alaska Supreme Court says they are. It is our best judgment that, as with "capital improvements," the court would not adopt a general definition but rather would judge each proposition on its own merits. Cf., City of Juneau v. Hixson, 373 P.2d 743 (Alaska 1962). As will be explained later, however, we doubt any ruling will ever be made. The administration, however, should use the same ad hoc test as the court would.

Second, investments are governed by the prudent man rule, i.e., to make money. AS 37.11.020, 060 and AS 37.10.070 (investment of surplus funds).

Third, expenditures may be made only by way of the budget-appropriation process. AS 37.11.030, 070.

The Alaska Renewable Resources Development Fund and Permanent Fund are not true dedications of revenues, i.e., there is no fund which is actually dedicated for a special purpose. There is a conditional, standing appropriation of surpluses, if any, from the development fund to the permanent fund. AS 37.11.040, 060. But that merely moves money from one fund to another, without expending it on a special purpose. Except for replacement of losses of principal from fund income (also a conditional, standing appropriation), that is the only source of income for the latter fund. If there is no surplus in a given year, there is no income to the fund for that year. A true dedicated fund has a regular source of income and the authority to expend money, without further appropriation, on its special purpose, e.g., education.

Additionally, there is no legal impediment against any legislature's appropriating from either fund for any public purpose whatsoever, without regard to its contributing to the development or management of a renewable natural resource. No legislature, with an exception not applicable here, may bind another to a given law or policy. With or without an express

Administrative Committee on
Renewable Resources Development
October 12, 1977
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amendment to AS 37.11, any future legislature may appropriate as it sees fit, subject only to an item veto. That includes appropriations from the principal of the permanent fund.

Legally, the funds may be viewed as special accounts to facilitate a legislative policy. So long as succeeding legislatures are in accord with the policy, the funds afford a way of providing fairly substantial amounts of money for the management of renewable natural resources without having to overcome the annual inertial resistance of the budget-appropriation process. The executive is bound by the policy as long as it remains law. But each and every legislature possesses the plenary power to annul the policy -- expressly by repeal or impliedly by not following it.

If the legislature changes the policy by not following it, e.g., appropriates from the development fund to build a road to exploit mineral resources of the Seward Peninsula, we doubt that a court would overturn the legislature's action. We believe, rather, that it would rule that the establishment of the fund and its terms by the Eighth State Legislature does not bind, say, the Eleventh State Legislature. There is a rule to the effect that the constitutional limitation of appropriation bills to appropriations precludes their being used to enact or amend other substantive law. E.g., Opinion to the Governor, 239 So.2d 1, 11 (Fla. 1960). However, we apprehend this rule to apply solely to conditions or restrictions attached to appropriations and not to the appropriations themselves.

Accordingly, it is unlikely -- so long as expenditures require an appropriation -- that the courts will ever rule on what is or is not a "renewable natural resource." Of course, if AS 37.11 were amended so as not to require appropriations for future expenditures, then it probably would be a true dedication of revenues and become unconstitutional. Alaska Const., art. IX, §7; Op. Atty. Gen., Dedication of Revenues Derived from Lease or Sale of State Natural Resources (May 2, 1975).

RWP/pjg

STATE OF ALASKA

DEPARTMENT OF LAW

JAY S. HAMMOND, GOVERNOR

OFFICE OF THE ATTORNEY GENERAL

POUCH K - STATE CAPITOL
JUNEAU 99811

May 2, 1975

The Honorable Jay S. Hammond
Governor
State of Alaska
Pouch A
Juneau, Alaska 99811

Re: Dedication of Revenues Derived
from the Lease or Sale of
State Natural Resources

Dear Governor Hammond:

You have asked if dedication of the revenues from the lease or sale of state natural resources offends the state constitutional prohibition against dedicated funds. Art. IX, §7, Alaska Constitution.

The short answer is yes.

DISCUSSION

The constitutional prohibition against dedicated funds is as follows:

The proceeds of any state tax or license shall not be dedicated to any special purpose, except when required by the federal government for state participation in federal programs. This provision shall not prohibit the continuance of any dedication for special purposes existing upon the date of ratification of this constitution by the people of Alaska. Id.

It may be suggested that the phrase "proceeds of any state tax or license" is not ambiguous or doubtful and, there-

fore, is not subject to judicial construction, Application of Babcock, 387 P.2d 694, 696 (Alaska 1963). However, whether the phrase includes royalties from oil and gas leases is a valid question and does require that the phrase be interpreted. 1/ Since there is a valid question as to whether a royalty or a bonus-royalty exacted by the government is a tax or license, an ambiguity or uncertainty exists and we should resort to the records of the Convention to determine intent. Alaska Public Employees Ass'n. v. State, 525 P.2d 12, 1415 (Alaska 1974). By examining this record, we may construe the words used in the Constitution with reference to their purpose and the purpose of Section 7. State v. City of Anchorage, 513 P.2d 1104, 1110 (Alaska 1973).

Section 7 of Article IX had two interrelated purposes: (1) to prevent any future dedication of revenues for special purposes, and (2) to prevent the creation of new special funds separate from the general fund. Public Adm. Sv., Constitutional

1/ 1969 Op. Atty. Gen. No. 3 and No. 5 took the view that the dedication of oil and gas royalty and bonus-related payments was not prohibited by Section 7 of Article IX of the State Constitution. They are expressly overruled insofar as they are inconsistent with this opinion. They erred in relying principally on legal lexicons and prior decisions to define "proceeds", "taxes", and "licenses" and in relying too little on the files and minutes of the Constitutional Convention. Their analysis of dedicated funds is otherwise excellent, and except for their conclusion with respect to revenues derived from the lease or sale of natural resources, they remain excellent statements of the law.

The Honorable Jay S. Hammond
Governor

May 2, 1975
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Studies, v. 3, 2730 (1955); Minutes of Meetings of Com. on Finance & Taxation, Legislative Affairs Agency Files, 211, Constitutional Convention, Nov. 25, 1955 (hereinafter, Files); Preliminary Drafts of Article on Finance & Taxation and Memorandum of the Finance Com., Dec. 4, 1955, Files.

The rationale for the purpose is found in the Constitutional Studies, id., and, more succinctly, in the committee's commentary, 6 MINUTES, CONSTITUTIONAL CONVENTION, App. V, 111 (1956) (hereinafter, MINUTES). In essence, it is that the widespread existence of dedicated revenues lodged in special funds deprives both the governor and the legislature of "any real control over the finances of the state." Id.

The progression of Section 7 from its original draft to final version is worth following. It first appears in the committee minutes of November 24, 1955, as follows:

All tax revenues shall be deposited in a general fund to be established and maintained by the state. This provision shall not prohibit the continuance of any special fund for special purposes existing at the effective date of the constitution. Files.

At the December 2nd meeting of the committee, it was advised of certain requirements for federal funding in fish and wildlife programs which required dedication of license revenues.

The Honorable Jay S. Hammond
Governor

May 2, 1975
- 4 -

The committee thereupon amended its "tentatively adopted section" to include the phrase:

except as State participation in Federal programs might thereby be denied. Files.

The committee's markup of the December 9th draft shows several changes entered by hand. For one, the word "tax" is deleted as a modifier of the word "revenues". For another, the term "general fund" is deleted and the phrase "in the state treasury without allocation for special purposes" is inserted. Files. A subsequent, undated, working draft reads in pertinent part as follows:

All revenues shall be deposited in the State treasury without allocation for special purposes, except where state participation in Federal programs will thereby be denied. Files.

This version was the same as that of December 16, 1955, submitted, December 19, 1955, to the Convention. 6 MINUTES, App. V, 106-07.

Prior to the Convention's consideration and debate of the committee proposal, the committee prepared several changes, one of which was to insert the word "public" after the word "all" so that it would read: "All public revenues shall be deposited" 3 MINUTES 2297.

The purpose of this change was to "eliminate the question regarding such things as donations or bequests . . . that might