ENHANCING THE USE OF EASTERN AND MIDWESTERN COALS BY GAS REBURNING–SORBENT INJECTION

ADDENDUM TO THE
ENVIRONMENTAL INFORMATION VOLUME
for
Illinois Power Company, Hennepin Station Boiler No. 1

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Introduction

This addendum is provided to support the Environmental Information Volume (EIV) for Illinois Power Company, Hennepin Station Boiler No. 1 submitted by Energy and Environmental Research Corporation (EER) in January, 1988. Both the EIV and this addendum are intended to facilitate DOE's preparation of the environmental documents required for compliance with the National Environmental Policy Act (NEPA). The following issues are clarified in this addendum:

- site selection criteria
- floodplain/wetlands requirements
- permitting requirements
- heron rookery
- material balances

1. Site Selection Criteria

EER's Gas Reburning-Sorbent Injection (GR-SI) field evaluation program is funded by the U.S. Department of Energy (DOE), the Gas Research Institute (GRI), and the State of Illinois Department of Energy and Natural Resources (ENR). Involvement of ENR was contingent upon two factors:

1. evaluations conducted within the State of Illinois.
2. host units must fire high-sulfur Illinois coals.

A major program objective is to demonstrate the NO_x and SO_2 control potential of GR-SI in full scale utility boilers representative of the pre-NSPS boiler population. Three boiler designs were identified as representative of the pre-NSPS population: wall-fired, tangentially-fired, and cyclone-fired. The current analysis is specific to tangentially-fired boilers; the other two designs are addressed in separate EIV's and will not be further discussed here. Thus, the third selection criterion was:

3. tangentially-fired boiler.

Based on the limiting constraints of population representativeness (setting the lower size limit) and program costs (setting the upper limit), the fourth selection criterion for the tangentially fired host boiler was established:

4. size range of approximately 75 to 120 MW_e.

A commercially available computerized data base of all fossil fuel fired utility boilers east of the Mississippi River (MEGABASE) was utilized to

identify potential host units satisfying the criteria listed above. The data base indicated that there were 67 operating fossil fuel fired utility boilers in Illinois as of January, 1980. Of those, 29 were tangentially-fired, with only 6 of them in the size range between 75 (including one unit rated at 74 MW_e) and 120 MW_e. One of those six units fires a low sulfur coal. Thus, five units operated by two Illinois utilities were identified as suitable for the field evaluation:

- Hutsonville No. 3 — Central Illinois Public Service (CIPS)
- Hutsonville No. 4 — CIPS
- Hennepin No. 1 — Illinois Power Company (IP)
- Vermilion No. 1 — IP
- Vermilion No. 2 — IP

An additional criterion of overriding importance in the selection among the five candidate units was the willingness of the utility to enter into a host agreement for this project. The Hutsonville units are not in a floodplain, but suitable host agreements could not be negotiated with CIPS in a timely manner. The IP Vermilion units also are not in a floodplain, but project costs would be significantly increased since natural gas is not available on site. Some parts of the Hennepin plant used for the GR-SI demonstration are in a floodplain, and others are not, but the existing ash disposal surface impoundments are in a floodplain. EER and IP entered negotiations on the basis of using Hennepin No. 1 as a field evaluation site, and a mutually satisfactory host agreement was executed in April, 1987.

2. Floodplain/Wetlands Requirements

Construction activities associated with modifications to the Hennepin boiler will not be conducted within the floodplain since the boiler elevations for gas and sorbent injection are above the 100 year flood elevation. The location of the sorbent storage silo is still unknown but based on current topographic information, it would be located within the floodplain. However, the silo would have negligible impact on floodway storage and conveyance. As stated above, the GR-SI ash disposal facility will be in the floodplain. The GR-SI ash management technology being planned for Hennepin Station (as discussed in the EIV) involves wet disposal to an existing surface

impoundment. The floodplain/ wetlands assessment conducted by DOE was based on the expected characteristics of the modified facility.

The IP Environmental Affairs Department (EAD) contacted the Federal, State, and local agencies having floodplain/wetlands jurisdiction to discuss permitting requirements associated with project construction and operation activities.

Federal. Mr. Dave Tipple, U.S. Army Corps of Engineers (COE), Rock Island District, was contacted to determine COE jurisdiction over the project. The COE has no regulatory powers over a floodplain unless all or part of the floodplain is a wetland. The existing ash disposal facility for Hennepin No. 1 is located in an area which is now considered a wetland, although the pond was permitted prior to designation of the area as a wetland. For wetlands activities, COE authority is provided by Section 404 of the Clean Water Act, which regulates discharge of dredged or fill material into the waters of the United States. Mr. Tipple stated that no permit would be needed for use of the existing wet disposal facility or construction of the sorbent storage silo. A "courtesy" notification will be provided by Illinois Power to the COE as part of their standard practice.

State. Mr. Mike Diedrichsen, Illinois Department of Transportation, Division of Water Resources (DWR) was contacted to determine DWR jurisdiction over floodplain/wetlands. Mr. Diedrichsen indicated that DWR has jurisdiction over floodways, and that the floodway is coincident with the federal floodplain at Hennepin Station. DWR's concern involves construction within the floodway. The underlying issue is the impact that the construction would have on flood flows. The constructed facility cannot obstruct the floodway storage or conveyance by ten percent or more and the elevation of the 100-year flood level cannot be raised by more than six inches. The GR-SI project will not impact floodway storage or conveyance by ten percent or more nor raise the 100-year flood level by more than six inches. Regarding ash disposal, Mr Diedrichsen indicated that if existing facilities are used, no permitting action will be required by the DWR. Illinois Power will provide DWR with a "courtesy" notification as part of their standard practice.

Local. Mr. Frank Drennen, Illinois Port Districts, was contacted to determine Port District jurisdiction over the project. He explained that the Port District must receive copies of all joint permit applications which are

submitted to the COE and DWR. The Port District automatically approves any permit that is approved by the COE. The Port District assesses a fee of $250.00 on the permittee once the permit is granted. Since no permit applications will need to be submitted to the COE or DWR for ash disposal using the existing surface impoundment, the Port District fee will not apply. Illinois Power will provide the Port District with a "courtesy" notification as part of their standard practice.

3. Permitting Requirements

A review of the GR-SI project permitting requirements was conducted by the Illinois Power Environmental Affairs Department (EAD). Two permits will be required for the project:

- joint construction/operating air permit
- National Pollutant Discharge Elimination System (NPDES) permit

Air permit modifications are discussed in Section 5.2.1 of the Hennepin Station EIV. The information below provides additional detail to the EIV discussion. NPDES permit modifications are discussed in Section 5.2.2 of the Hennepin Station EIV. No additional discussion is required. Based on the disposal assumption used to prepare this document, the EAD analysis determined that no other permits will be required for the project. Additional permitting areas reviewed by IP included floodplain/wetland concerns (as discussed in Section 2 of this addendum) and building permits.

Illinois Power, in conjunction with the other two host utilities, met with IEPA on March 10, 1988 to discuss the air permit modifications. IEPA reiterated their position that modifications to existing permits is an appropriate regulatory approach. An air permit modification application will be submitted to IEPA approximately 90 days prior to the GR-SI project Phase 1 completion date. The permit application will include detailed design information and anticipated operating information. IEPA is required to act on the permit application within 90 days. The resulting air permit includes two parts: permission to construct and permission to operate. Permit compliance requirements will be determined by IEPA on the basis of site-specific detailed designs, but these will be comparable to requirements for conventional permits. The existing Hennepin No. 1 permit requires submittal of quarterly

reports showing daily coal and coke usage, and sulfur, ash, Btu, and moisture contents.

Special permit conditions for startup, malfunction, and breakdowns such as are included in conventional operating permits, will also be included in the modified air permit. The existing Hennepin No. 1 air permit, effective February 19, 1987 through March 10, 1989, indicates that SO_2 emissions in excess of allowable limits (as determined by coal sulfur content) are allowed during startup, malfunction and breakdown. Excess emissions due to malfunctions or breakdowns must be reported to IEPA by telephone as soon as possible during normal working hours. Malfunction of the GR-SI system is not expected to result in excess emissions since the existing coal sulfur level will be maintained.

4. Heron Rookery

Ecological impacts of the project are discussed in Section 4.4 of the Hennepin Station EIV. The following information provides additional detail regarding potential impacts on the Spring Lake Heron Rookery.

In a letter dated January 12, 1988, the Illinois Department of Conservation (IDOC) Impact Analysis Section indicated that the additional load of contaminants resulting from the GR-SI evaluation and their cumulative impacts on the birds inhabiting the rookery needed to be addressed. The contaminants of concern are those listed in Illinois drinking water standards, particularly the metals. Fly ash generated by Hennepin Unit No. 1 is currently sluiced to an existing on-site surface impoundment. Effluent water from the impoundment is discharged to the Illinois River. Conventional coal fly ash contains considerable amounts of leachable metals. However, since literature data for the leachable fraction of metals in fly ash vary over a wide range, a meaningful estimation of the current metals loading to the river from conventional fly ash disposal at Hennepin was not attempted. Rather, a worst case analysis was conducted of the metals loading expected from GR-SI ash.

To calculate the loading of metals for the GR-SI case, analyses of the Hennepin coal and Marblehead River Rouge Michigan hydrated lime were conducted. Column 1 of Table 1 lists the levels of metals found in the hydrated lime in milligrams per kilogram (mg/kg or ppm) and Column 2 lists the

TABLE 1. CONTAMINANT LOADING TO THE ILLINOIS RIVER

Contaminant	Marblehead Hydrated Lime (mg/kg)	Hennepin Coal (mg/kg)	Coal/Lime Blend with GR-SI (ppm)	Correction Factor	Estimated Discharge to IL River with GR-SI (g/yr)	Metals in IL River (µg/l)	Increase in Metals with GR-SI (µg/l)
As	0.29	5.0	4.44	6.85×10^{-5}	28.6		4.61×10^{-6}
Cd	0.28	1.2	1.09	3.08×10^{-3}	315.7	9.0	5.09×10^{-5}
Cr	7.0	27.2	24.8	1.10×10^{-3}	2565.2	18.0	4.14×10^{-4}
Cu	7.0	9.5	9.2	4.86×10^{-4}	420.4	24.0	6.78×10^{-5}
Pb	4.3	15.4	14.1	8.93×10^{-5}	118.4	50.0	1.91×10^{-5}
Ni	78.0*	20.1	26.9	1.01×10^{-4}	255.5	24.0	4.12×10^{-5}
Zn	26.0	97.0	88.6	7.79×10^{-5}	649.0	150.0	1.05×10^{-4}

* suspected contamination

levels of the same metals found in the Hennepin coal. Column 3 lists the calculated levels of metals in a blend containing 88.2 percent coal and 11.8 percent hydrated lime, which are the relative proportions required for a Ca:S molar ratio of 2.0 during GR-SI operation. Column 4 lists correction factors for the metals. These correction factors represent the ratio of leachable metals to total trace metals in LIMB ash samples, as determined by Radian Corporation and EPRI (Eklund, et al., "Design Considerations for Waste Management Systems for Advanced SO_2 Control Technologies", presented at 2nd Joint (EPA/EPRI) Symposium on Dry SO_2 and Simultaneous SO_2/NO_x Control Technologies, Raleigh, NC, February 1986). Using these correction factors along with the projected capacity factor of 40 percent and full load coal firing rate, the estimated discharge of metals to the Illinois River as a result of GR-SI operation was calculated. The results are provided in Column 5. Column 6 lists the metals concentrations in the river from the Illinois State Water Survey. Using the lowest reported flow for the river near Hennepin Station (6990 ft^3/sec), the metals discharges of Column 5 have been converted to worst case estimates of the increase in metals concentrations in the Illinois River due to GR-SI application in Hennepin No. 1 boiler. Note that this worst case increase in metals concentrations is negligible compared to current concentrations. Therefore, no adverse impact on the Heron Rookery is expected, subject to confirmation by the Illinois Department of Conservation.

While not used for the above evaluation, other sources show that the fraction of leachable metals in coal fly ash is approximately the same order of magnitude as, or larger than, the leachable fraction in lime injection wastes. One source reports leachable fractions from fly ash of 3.1×10^{-3} and 1.0×10^{-3} for chromium and lead respectively (Neice, J.E. and Di Gioia, A.M., "Fly Ash Disposal and Groundwater Quality", Water Quality Issues at Fossil Fuel Plants, ASCE, 1985, pp. 36–43). The leachable fraction of chromium is a factor of three times greater than that from sorbent injection waste, and the leachable fraction of lead is more than two orders of magnitude greater than from sorbent injection waste. Since the coal has higher concentrations of contaminants than the coal/lime mixture (as seen by comparing columns 2 and 3 of Table 1), it is reasonable to assume that GR-SI operation will result in

actual decreases in the contaminant loading to the Illinois River when compared with current operation.

The results of the above analysis are being provided to IDOC by IP as verification that additional contaminant loadings due to the GR-SI project will not impact the heron rookery or the birds which inhabit the rookery.

5. Material Balances

5.1 Coal Utilization Information

The following information is based on information provided by Illinois Power:

baseline case	full load firing rate	67,106 lb/hr
	1986 capacity factor	62.4 percent
	1986 average firing rate	56,164 lb/hr
	1986 annual coal usage	178,600 tons

The baseline full load firing rate is based on the average heating value of the coal (10,822 Btu/lb) and the maximum heat input rating of the boiler (7.3374×10^8 Btu/hr). Capacity factor is based on 8520 hours in a year, which allows for ten outage days per year. The 1986 average firing rate was determined by dividing the total unit coal usage by the total number of hours (6360) that the unit was on line during the year. Coal usage data for 1986 were provided by Illinois Power.

GR-SI case	full load firing rate	55,309 lb/hr
	projected capacity factor	40 percent
	projected avg. firing rate	46,290 lb/hr
	projected coal usage rate	94,313 tons/yr

It should be noted that the coal firing rate with GR-SI is a different value than what is contained in the EIV. The value indicated above represents the actual full load firing rate. The 40 percent capacity factor was projected by IP. Average firing rate is difficult to project since it is based on the number of operating hours per year, which are not necessarily at full load. The value provided above is a simple assumption based on maintaining the 1986 ratio of average to full load firing rate. The projected coal usage is based on the projected capacity factor and the full load firing rate.

5.2 Sorbent Utilization Information

The following information is based on an assumed sulfur capture of 50 percent during the operation of GR-SI, with a calcium to sulfur molar ratio of two.

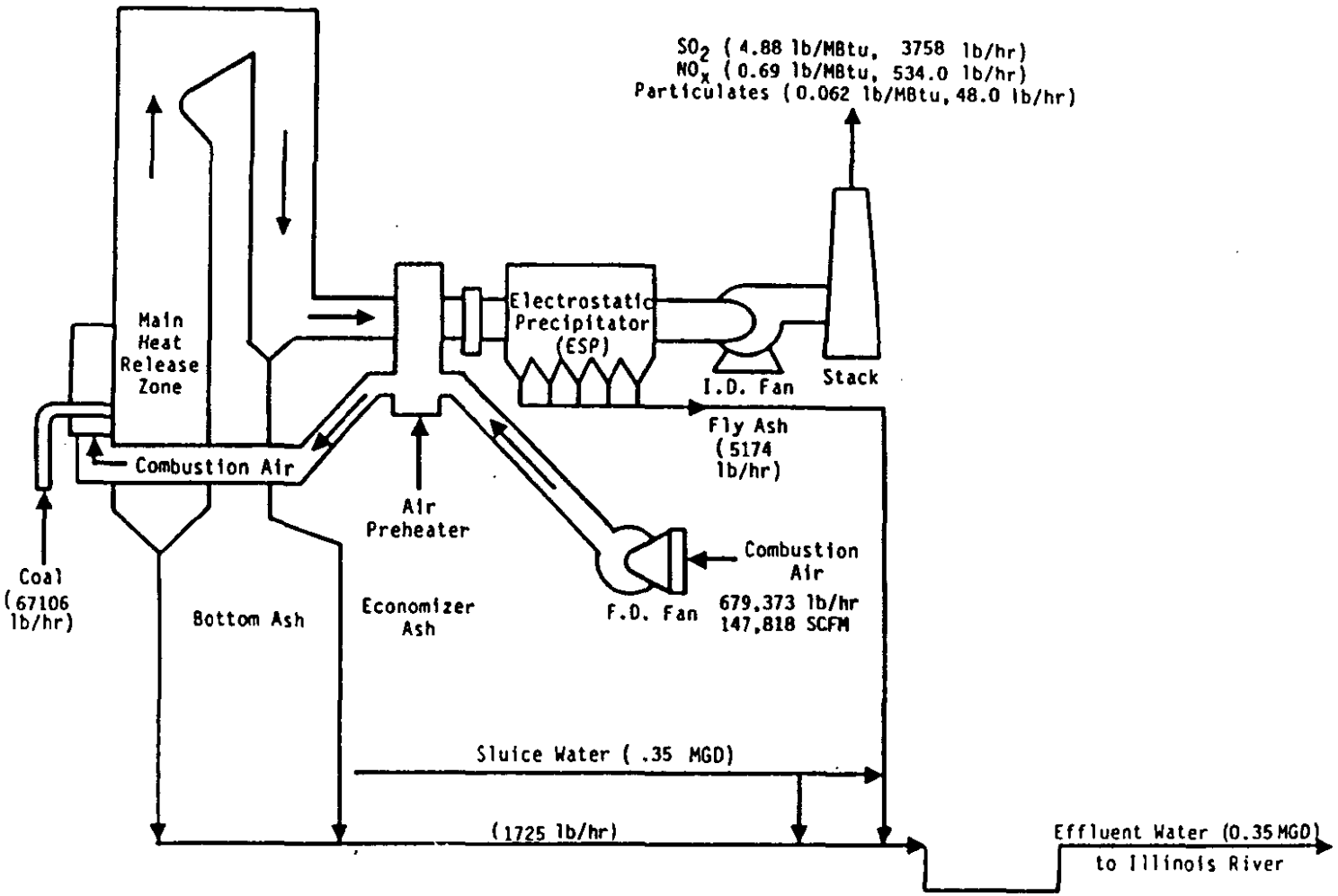
baseline case	no sorbent used	
GR-SI case	full load sorbent rate	7163 lb/hr
	projected capacity factor	40 percent
	projected sorbent use rate	12,212 tons/yr

5.3 Process Flow Diagrams

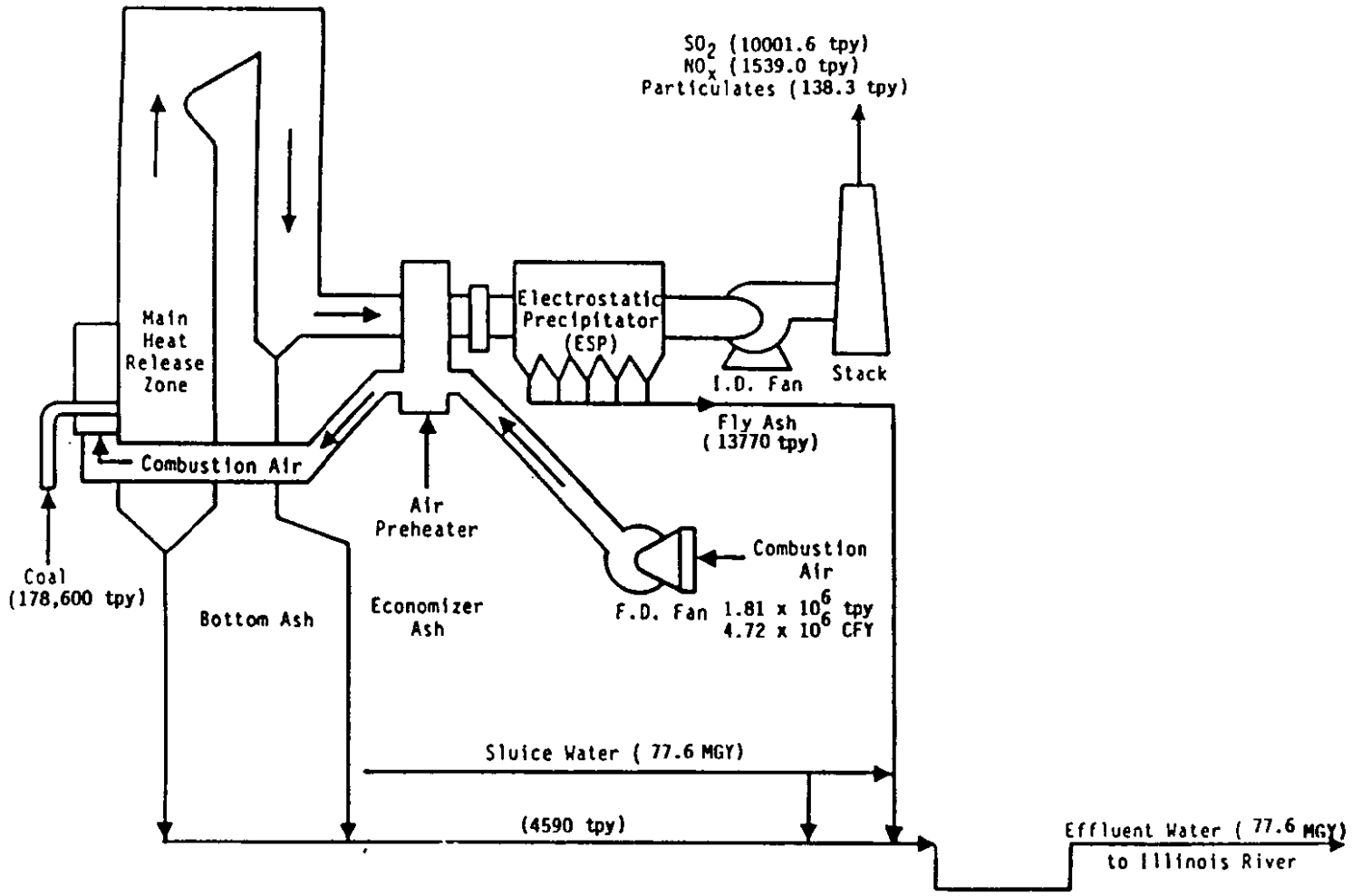
Process flow diagrams are attached for Hennepin Unit 1, under both baseline and GR-SI conditions. The five diagrams include:

1. Baseline case - hourly rates at full load
2. Baseline case - yearly rates based on 1986 data
3. Baseline case - yearly rates based on projected capacity factor
4. GR-SI case - hourly rates at full load
5. GR-SI case - yearly rates based on projected capacity factor

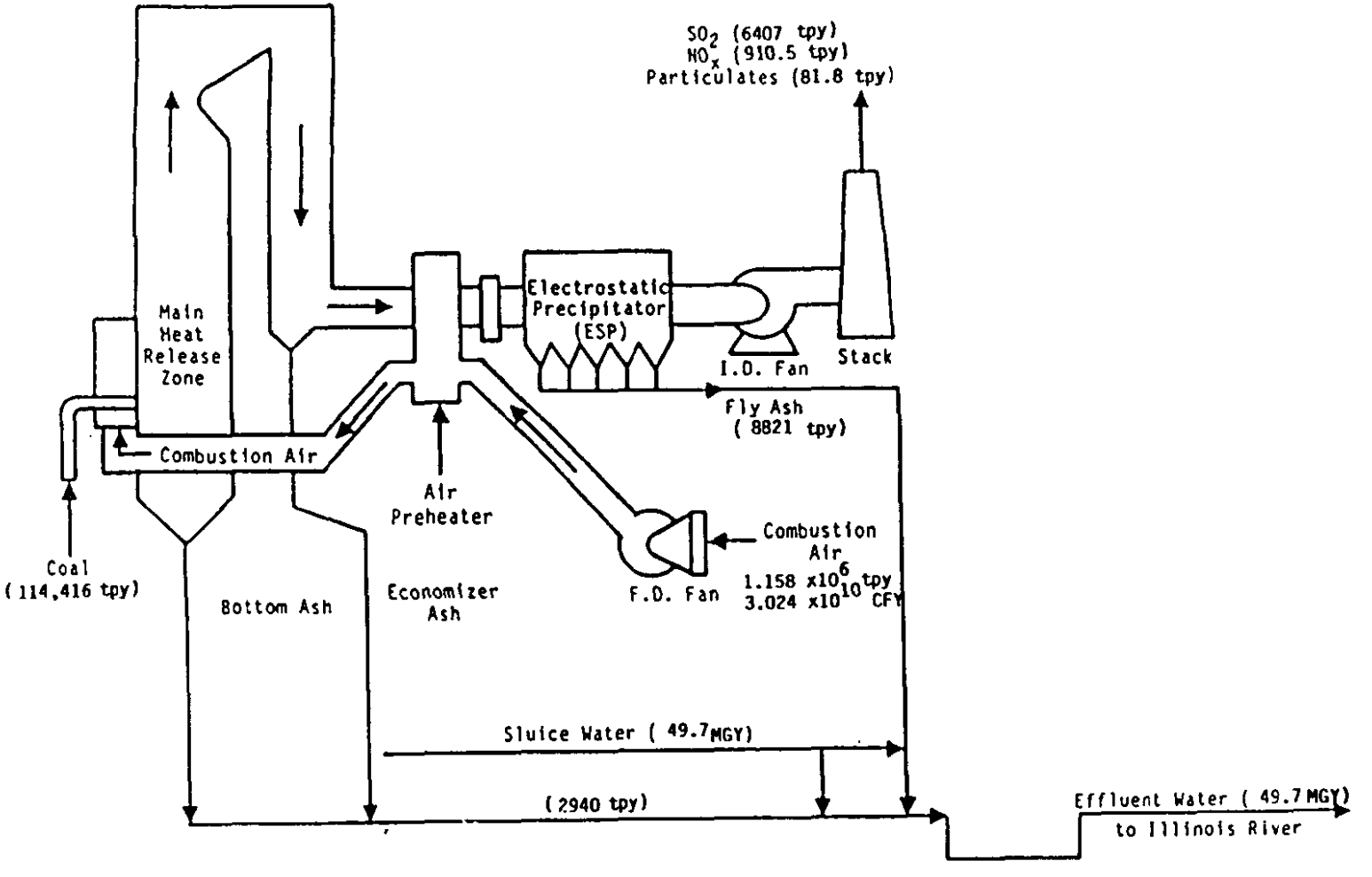
During 1986, the capacity factor for Hennepin Unit 1 was 62.4 percent. This is equivalent to 5323 hours of full load operation. The capacity factor during the GR-SI demonstration is projected by IP to be 40 percent. This is equivalent to 3410 hours of full load operation. In 1986, Hennepin Unit 1 was in operation 284 days. Based on the operating hours reported by IP, Unit 1 was in operation an average of 22.4 hours each day it was on line.



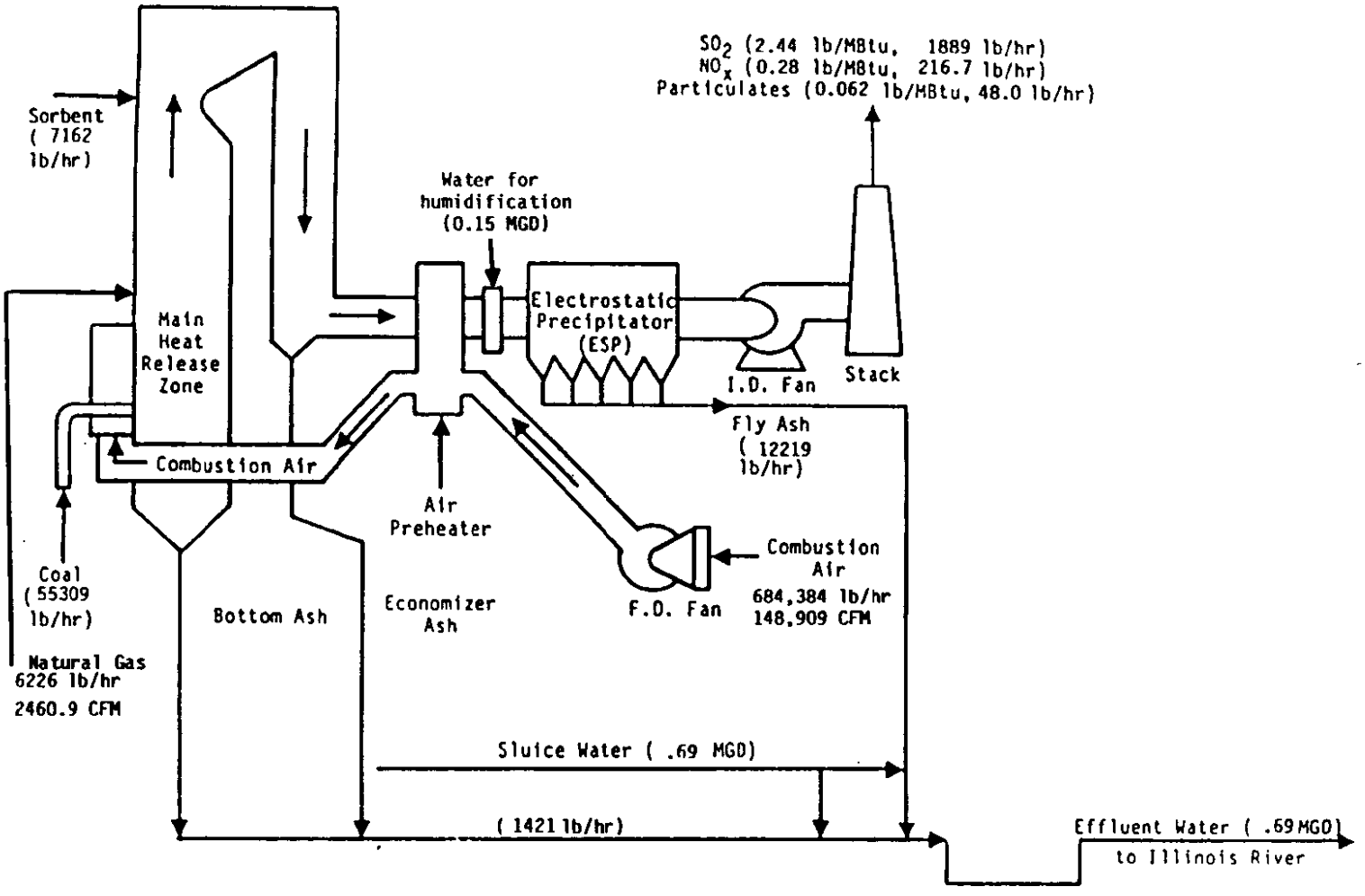
Process flow diagram for baseline operation during full load output



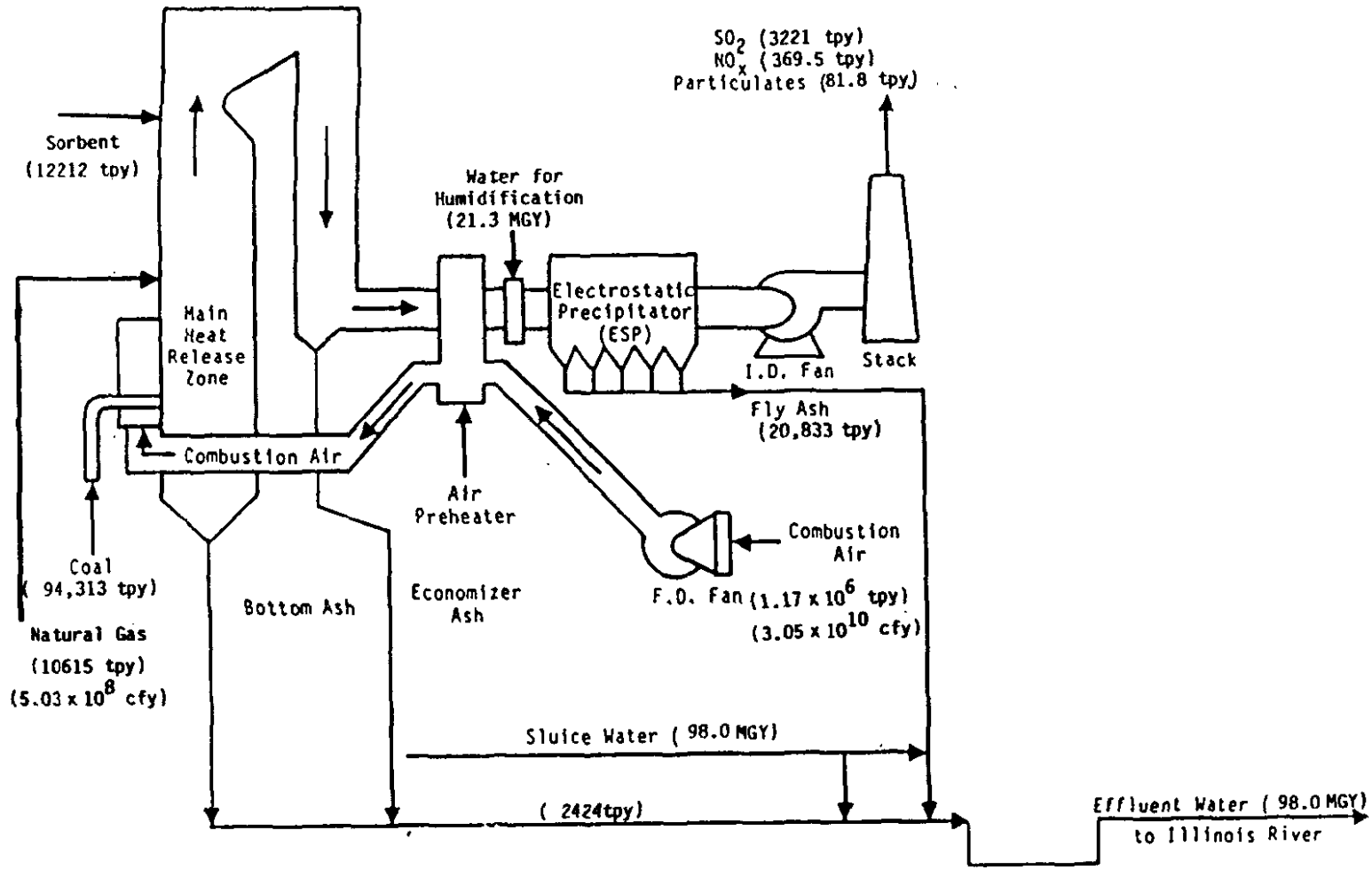
Process flow diagram for baseline operation - 1986 annual data



Process flow diagram for baseline operation - 1990 projected data



Process flow diagram for GR-SI operation during full load output



Process flow diagram for GR-SI operation - 1990 projected data