IRVINGTON GENERATING STATION

COAL CONVERSION PROJECT

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ABSTRACT

The combination of the Mideast oil crisis which began in late 1973 and the increasing public concern over the nuclear energy option has caused coal to become increasingly important as the primary fuel for electric utility use. Based on this, nearly all oil and/or gas fired units in the U.S. and other parts of the world are, at one level or another, being considered for the possibility of direct conversion. However, any one or a combination of capital investments, load requirements (unit derating), selective coal specifications, environmental requirements, and even technical feasibility (physical limitations) may place in doubt or eliminate the realistic opportunity for conversion.

Tucson Electric Power Company's Irvington Generating Station is the first oil/gas conversion to coal in North America, and only the second in the world to the author's knowledge. The State Energy Commission of Western Australia's Kwinana Power Station Coal Conversion Project was the first major utility conversion.

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INTRODUCTION

December 1973 marked the beginning of the Mideast oil crisis with a decision by the OPEC Nations to dramatically increase the price of their crude oil to the World Marketplace. This decision has and continues to have dramatic effects on the American utilities' existing and future plans.

Following this crisis in 1974, Tucson Electric Power Company (TEP) experienced a period of sudden deceleration in its previously rapid rate of customer load growth. This caused a serious reassessment both of its prior long-term projections, and of its budgeting and plans then in progress for the construction of future generating capacity (which had been formulated on the basis of such prior projections). In light of such prior forecasts TEP had planned, and had become committed, to particilpitate with others in the joint construction of a number of new coalfired generating stations located far outside its service area, but close to necessary coal supplies, and also in the construction of new high-voltage transmission lines necessary to transport power from such stations to the vicinity of its service area.

The local Tucson generating facilities (which includes Irvington Generating Station) presently have an aggregate generating capacity of 738 MW; however, they are all older oil and gas-fired units, less efficient and far more costly to operate than TEP's newer coal-fired Remote Generating Stations. Irvington Generating Station is operated primarily at reduced capacity, partly to supply a regular source of energy to the local transmission and distribution system, and partly as "spinning reserve" available for rapid activation at full capacity in the event of sudden surges in demand or unscheduled outages of other facilities. The gas turbines are normally inoperative, but available for peaking use.

The above general criteria and realization of the fact that the Tucson area is on the periphery of the grid system has caused TEP to carefully evaluate and proceed with conversion of the Irvington Generating Station's four steam generating units from oil/gas firing to oil/gas/coal firing.

DEPARTMENT OF ENERGY PROHIBITION ORDER

The Economic Regulatory Administration (ERA) of the Department of Energy (DOE) has issued regulations applicable to existing facilities, 10 CFR Part 504 (Regulations), to implement the prohibitions contained in Section 301(c) of Fuel Use Act (FUA). 10 CFS 504.7 sets forth the the basis upon which ERA will propose to prohibit, by order, the amount of natural gas or petroleum that may be used by a power plant where ERA finds that it is technically feasible for the power plant to use a mixture of petroleum or natural gas and an alternate fuel as its primary energy source. The proposed orders further described the criteria which ERA would use for making the findings required by Section 301(c) of FUA prior to the issuance of final prohibition orders.

Based on a minimum oil consumption reduction of 2.0 million barrels annually on December 31, 1980, pursuant to Section 301 (c) of the Power Plant and Industrial Fuel Use Act of 1978, 42 U.S.C 8301 et seq. (FUA), the Economic Regulatory Administration (ERA) issued proposed prohibition orders which would prohibit TEP from burning natural gas or petroleum in a mixture with an alternate fuel in amounts in excess of the minimum amounts necessary to maintain reliability of operation of the Irvington Station, Units 1, 2, 3 and 4, consistent with maintaining reasonable fuel efficiency. This notice was published in the Federal Register on January 7, 1981 (46 FR 1769) in accordance with the requirements of Section 701(b) of FUA.

In May 1981 on the basis of the ERA staff's review and analysis of the information provided by TEP, and the stipulations made by TEP regarding the findings of technical and financial feasibility discussed herein, the ERA staff recommended that final prohibition orders be issued.

Upon completion of all necessary hearings and notifications, the DOE issued the final prohibition order in July of 1981.

DESCRIPTION OF EXISTING FACILITIES

Irvington Generating Station is located in Tucson, Arizona and consists of four oil/gas fired boilers generating steam for four condensing turbine generators. Units 1 and 2 have pressurized, natural circulation Combustion Engineering boilers designed in 1956 and rated for full load steam generation of 575,000 pounds per hour each. Unit 3 has a pressurized, natural circulation Combustion Engineering boiler designed in 1960 and rated for full load steam generation of 800,000 pounds per hour. Unit 4 had a pressurized, natural circulation Foster Wheeler boiler designed in 1965 and rated for full load steam generation of 1,140,000 pounds per hour. There is a total of approximately 900 acres on this site, most of which, if required, are available for new facilities such as coal handling.

CONVERSION ALTERNATIVES

During early phases of the project a review of all conversion alternatives listed in Table I indicated clearly to TEP that virtually any conversion alternative could easily be economically justified at Irvington. On the basis of near future generating needs at a reasonable cost TEP decided to proceed with straight coal conversion* and accept a station derating on coal while maintaining full capability on oil and gas.

TABLE I

OIL/GAS TO OIL/GAS/COAL BOILER
CONVERSION ALTERNATIVES

A. Build new boiler(s).

B. Build new boilers to commonly power two or more existing turbines.

C. Modify boilers to coal firing at full capacity.

D. Modify boiler(s) to burn coal, therefore, reducing generating capacity, plus build additional steam generating capacity to make up for derating (single unit concept).

E. Modify boiler(s) to burn coal and accept station derating of 25 to 50 percent and maintain oil or gas firing capability to 100 percent.

F. Modify boiler to burn coal-oil mixture.

G. Modify boiler to burn coal-water mixture.

H. Build a coal gasification plant to provide boiler with medium Btu gas.

I. For multiple units, a combination of crossing boilers and building new steam generating capacity.

TABLE 2

TUCSON ELECTRIC POWER COMPANY
IRVINGTON STATION COAL CONVERSION

COAL GENERATION DATA

	Units 1 & 2	Unit 3	Unit 4/Common
PROJECT SCHEDULE			
Start Construction	12-1-84	3-1-84	3-1-83
Plant Shutdown	11-1-86	11-1-85	11-1-84
Complete Construction	3-1-87	3-1-86	3-1-85
Commercial Operation	5-1-87	5-1-86	5-1-85
UNIT RATINGS			
Oil/Gas, MW	80 each	106	156
Coal, MW	40 each	82	98
BOILER DESIGN			
Type			
Manufacturer	Combustion Eng.	Combustion Eng.	Foster Wheeler
Coal Burn Rate, TPH	22	42	49
Steam, lbs/hr (coal)	300,000	600,000	722,000
(oil/gas)	575,000	800,000	1,140,000
Pressure, psia	1515	1515	1815
Temperature, °F	1010	1010	1010
POLLUTION CONTROL EQUIPMENT			
Particulate	Baghouse Filter	Baghouse Filter	Baghouse Filter
Gas Flow, ACFM	150,000	285,000	353,000
Inlet Loading, lbs/mm BTU	15.3	15.3	15.3
Guaranteed Outlet Loading, lbs/mm BTU	0.03	0.03	0.03
Guaranteed Opacity, %	10	10	10
Design Temperature °F	300	300	300
Expected Pressure Drop, W.G.	6"	6"	6"
Bag Cleaning	Reverse Air	Reverse Air	Reverse Air
Active Gas-to-Cloth Ratio	2.2;1	2.2;1	2.2;1
Overall Dimensions, W.L.H.	65', 65', 74'	65', 85', 74'	65', 125', 74'
COAL HANDLING SYSTEM			
Boiler Feed Storage Silos, Number	3	4	3
Pulverizers, Rate TPH	12.1	15.4	18.0

TABLE 2 (Continued)

COMMON EQUIPMENT

COAL HANDLING SYSTEM	
Unit Train, Tons	10,000
Type of Unloading	Rotary Car Dumpers
Unloading Rate, TPH	3,600
Live Storage, Type/Tons	Enclosed Shed/21,600
Dead Storage, Days	90
Recovery System	Rotary Plow
Recovery Rate, TPH	625
FLY ASH HANDLING SYSTEM	
Type	Pneumatic
Rate, TPH	Varies
Storage	Silos
Removal	Truck or Rail
BOTTOM ASH HANDLING SYSTEM	
Type	Mechanical Drag Bar
Rate, TPH	Varies
Storage	Silos
Removal	Truck

PROPOSED COAL AND ASH ANALYSIS (Average)

PROXIMATE ANALYSIS	
Moisture	14.5
Volatile Matter	36.3
Fixed Carbon	36.7
Ash	12.5
BTU per lb.	10,000
ULTIMATE ANALYSIS	
Moisture	14.5
Carbon	55.8
Hydrogen	4.2
Oxygen	11.5
Nitrogen	0.9
Sulfur	0.5
Ash	12.5
Chlorine	0.03

ASH ANALYSIS		
Phosphorous Pentoxide	P_2O_5	0.08
Silica	SIO_2	57.78
Ferric Oxide	Fe_2O_3	6.21
Alumina	AL_2O_3	21.64
Titania	TIO_2	1.19
Lime	CaO	4.99
Magnesia	MgO	1.14
Sulfur Trioxide	SO_3	4.33
Potassium Oxide	K_2O	0.52
Sodium Oxide	Na_2O	1.78
Undetermined		0.34
GRINDABILITY		50
ASH FUSION TEMPERATURE		
a) Reducing Atmosphere		
Initial Deformation		2190°
Ash Softening (H=W)		2320°
Ash Softening (H=1/2 W)		2340°
Fluid		2520°
b) Oxidizing Atmosphere		
Initial Deformation		2300°
Ash Softening (H=W)		2400°
Ash Softening (H=1/2 W)		2420°
Fluid		2600°

SCHEDULING

During Phase I of the evaluations a wide variation of possible final conversion alternatives were available. Therefore, a seven-year schedule was planned, which placed Unit 4 available for commercial operation on coal in April of 1986 prior to the summer peak load demand. Unit 3 would follow in 1987 and Units 1 & 2 in 1988.

On final selection of the direct coal conversion, a detailed review of TEP's load requirements and actual engineering, design and construction requirements indicatd that a six-year conversion schedule was possible. This schedule moved Unit 4's commercial availability on coal up to April, 1985; Unit 3 up to April, 1986; and Units 1 & 2 up to April, 1987.

After careful review of both the six and seven year schedule, TEP elected to proceed with the six-year schedule, highlights of which are presented in Table 2.

A detailed evaluation of the six-year conversion schedule points out considerable differences when compared with a new fossil unit schedule. The critical path on a new unit normally follows the boiler design, fabrication and construction. In this case, detailed scheduling analysis clearly indicates the critical path follows the new coal handling facilities up to the point that the "boiler proper" conversions begin. In setting up the six-year schedule, a major emphasis was placed on completing all common services and most boiler auxiliaries (mainly, the pulverizer bay) prior to initiating the "boiler proper" revisions. This scheduling feature will allow major emphasis on minimizing unit outage time which is currently scheduled for six months, but expected to be less.

NEW SITE LAYOUT

Property availability (approximately 900 acres) and existing plant layout at the Irvington site are unquestionaly favorable to a coal conversion. As indicated on the coal conversion proposed site layout (Figure 1), railroad, coal handling, ash handling and disposal, and wastewater treatment facility additions are to be added, basically without interferences with existing facilities.

Obviously, the arrangement of the boiler proper area will require substantial redesign to accommodate coal transport piping and bottom ash removal equipment. Relocation of the station condensate tanks from the Unit 1 & 2 pulverizer bay area, rerouting of fuel oil lines, and relocation of minor electrical equipment will also be required in the boiler area.

Optimization of the new baghouse and stack arrangement on each unit is currently being evaluated so as to minimize equipment space requirements, and maximize Units 1, 2 & 3 accessibility without relocating any existing equipment such as the gas turbines and the elevated water storage tank.

In evaluating a combination of existing and new facilities for both accessibility and constructability, it became apparent that a scale model for considering layout and construction sequencing is highly recommended.

BOILER REDESIGN

General

As conversion of each existing boiler to burn coal while maintaining full firing capability on oil and gas was considered the optimal solution to conversion, boiler redesign features have been kept to a minimum wherever possible so as not to affect oil and gas firing capability. Assessment of coal firing capabilities for determining unit derating requirements, along with modifications and additions required, was evaluated by each of the original boiler manufacturers.

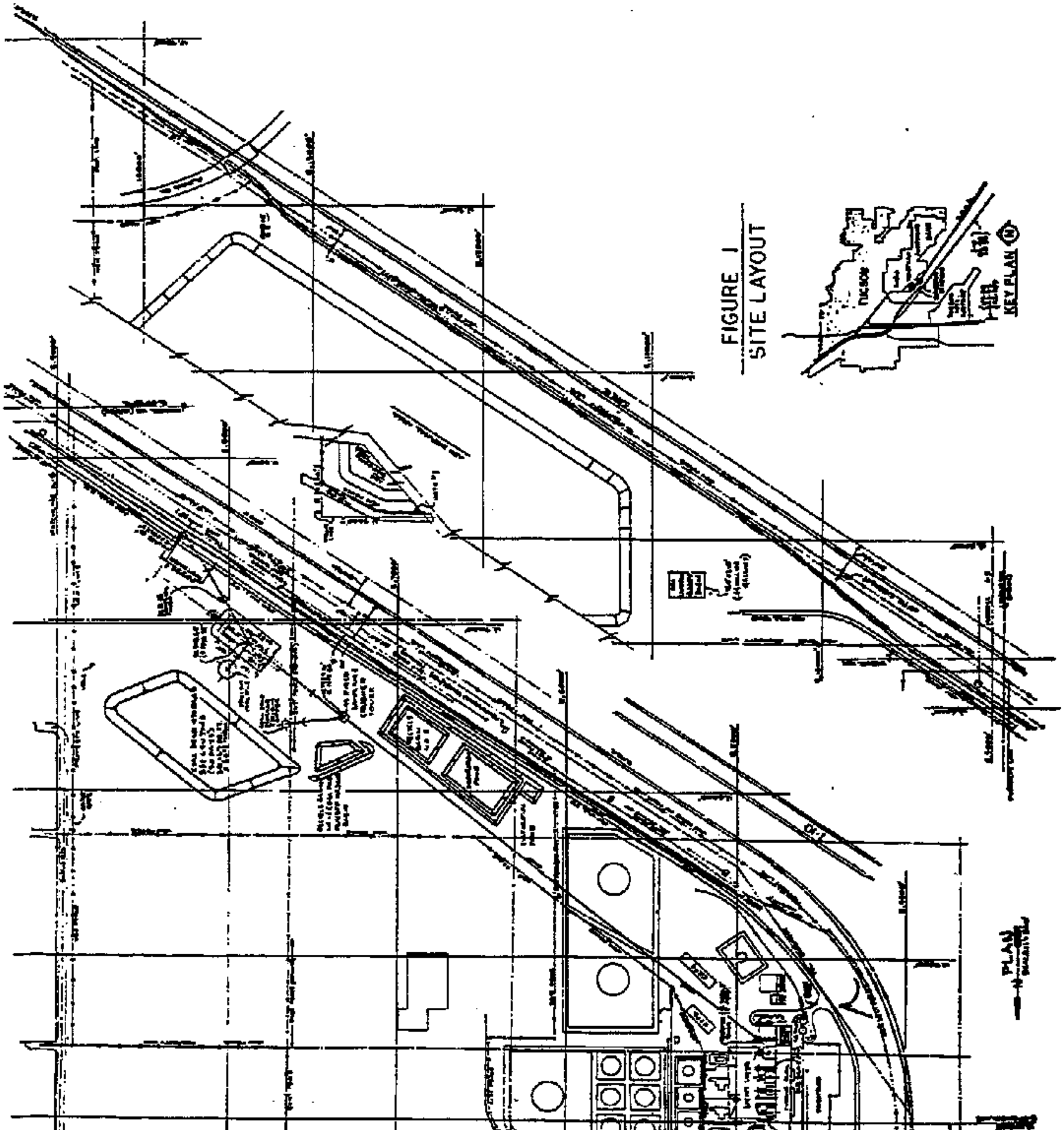

FIGURE 1
SITE LAYOUT

UNIT 4

Irvington Station, Unit 4, is a natural circulation front fired steam generator supplied by Foster Wheeler Energy Corporation (FWEC). The functional design of the unit is a single reheat with parallel gas pass steam temperature control in the recovery area. The general arrangement is shown in Figure No. 2. The unit has a normal capacity of 1065 Mlb/hr of 1875 psig, 1010F steam at the superheater outlet, and 845 Mlb/hr of reheat steam flow entering at 481 psig, 685F and leaving at 460 psig, 1010F.

There is a peak gas-fired load design condition for this unit. In this mode of operation, the two high pressure feedwater heaters are taken out of service. The superheater steam outlet conditions are 1140 Mlb/hr at a pressure of 1976 psig and a temperature of 1010F. The reheat steam flow is 1110 Mlb/hr with inlet conditions of 620 psig, 730F and outlet conditions of 593 psig, 1010F.

This peak load condition results in a lower feedwater temperature entering the economizer and, consequently, the unit must fire harder to produce a given steam flow. The furnace heat input for peak load operation is 22.6% (approximately 24 MW additional load) higher than the furnace heat input for the normal maximum continuous rated load. Many of the load restrictions for coal firing are based on unit input. Since the unit was designed for this peak load condition, certain restrictions do not seem to be as severe when expressed as a percentage of the normal capacity of the unit.

The unit was originally designed to burn natural gas or fuel oil with natural gas being the primary and guaranteed fuel.

As a result of FWEC's studies, the following modifications are being specified and incorporated into the boiler design:

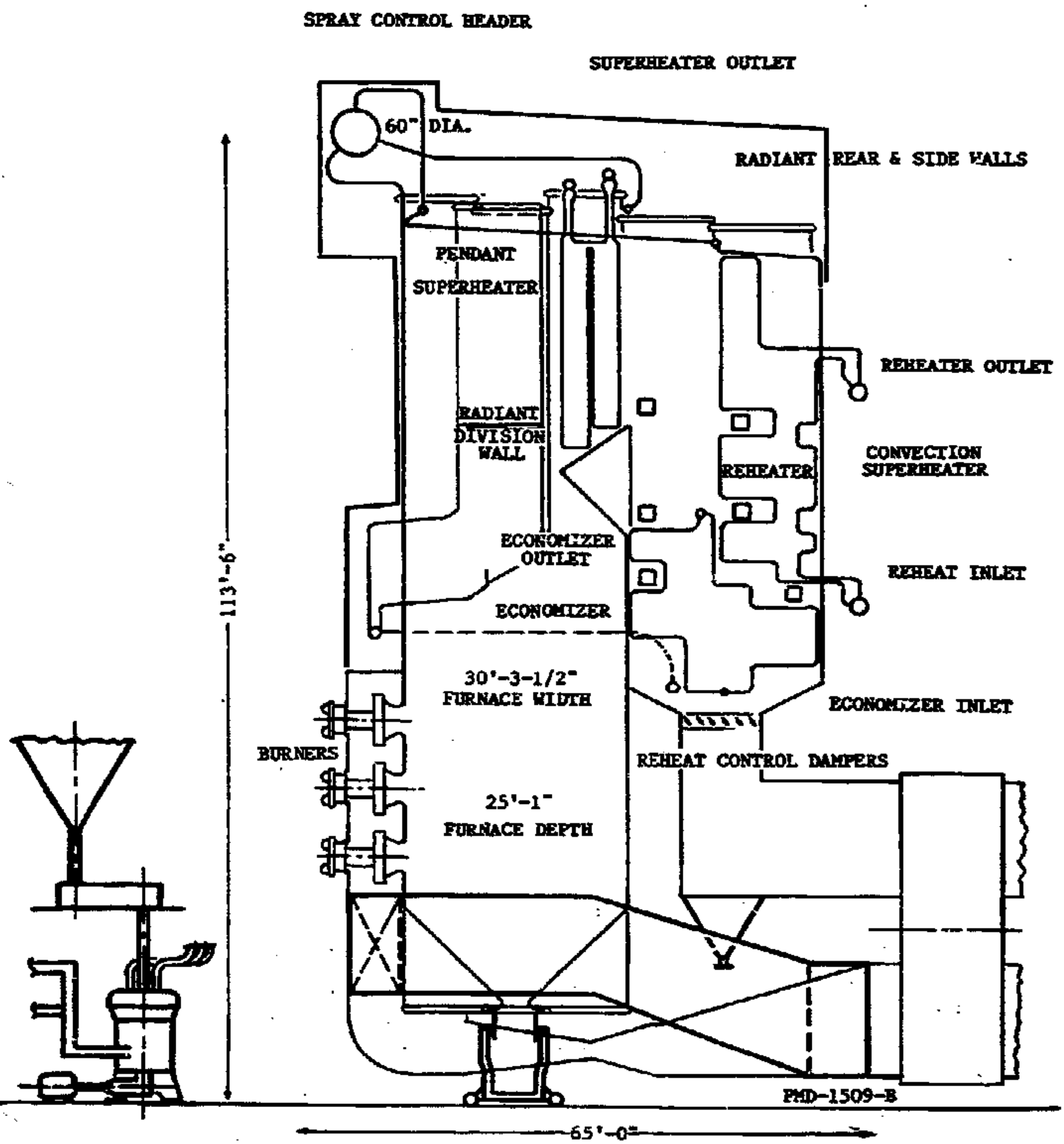

FIGURE 2
UNIT 4 - BOILER OUTLINE

1. The furnace hopper slope will be changed from 45° to 55°. Additionally, the hopper throat will be opened from 3'-2-1/2" to 4'.

2. The existing staggered gilled ring economizer will be replaced with an in-line, bare tube arrangement.

3. The leading tube (T-22 material) of the partial division walls will be replaced with 304 stainless steel tubing.

4. A coal firing system will be installed including pulverizers, feeders, burner conduits and a primary air system.

5. Additional sootblowers will be required in the furnace.

6. A boundary air system will be installed in the lower furnace to prevent excessive slagging and tube corrosion.

7. The secondary air duct must be re-routed from beneath the boiler to allow room for ash removal equipment.

8. A flyash hopper system will be installed in the economizer gas outlet flue.

9. The unit will be converted from a pressurized to a balanced draft furnace.

10. The burner management and combustion control systems will be modified to accommodate coal firing.

With the above modifications implemented, the unit will be operated at a guaranteed coal-fired load of 722,000 lb/hr of main steam flow (with all feedwater heaters in service) while firing coal. A turndown of 2:1 (360,000 lb/hr main steam) can be expected while maintaining the desired 1010F superheater and reheater steam outlet temperature.

UNITS 1, 2 & 3

Units 1, 2 & 3 are natural circulation, tangentially-fired steam generators supplied by Combustion Engineering. The units are all single reheat and their general arrangements are shown on Figures 3 & 4. Units 1 & 2 have full oil/gas fired load capabilities of 575 Mlb/hr of 1500 psig, 1010°F steam at the superheater outlet and 500 Mlb/hr of reheat steam flow entering at 403 psig, 711°F and leaving at 379 psig, 1010°F. Unit No. 3 has full oil/gas fired load capability of 800 Mlb/hr of 1500 psig, 1010°F steam at the superheater outlet and 707 Mlb/hr of reheat steam flow entering at 490 psig, 738°F and leaving at 459 psig, 1010°F.

As a result of Combustion Engineering's studies, the following modifications are being incorporated into the boiler conversion design:

1. The bottom of the furnace will be raised to accommodate addition of a bottom ash removal system.

2. The slope of the furnace hopper will be changed to 50° from 20°. water wall drums and downcomers will have to be modified to support the changes proposed for the furnace bottoms.

3. Larger windboxes will be provided for the burning of coal.

4. The water wall tubing forming the upper arch will be raised and its slope increased.

5. Wall blowers and retractable sootblowers will be added.

6. A coal firing system will be installed including pulverizers, feeders, burners burner conduits and a primary air system.

7. The existing staggered finned economizer will be completely replaced with a bare tube economizer.

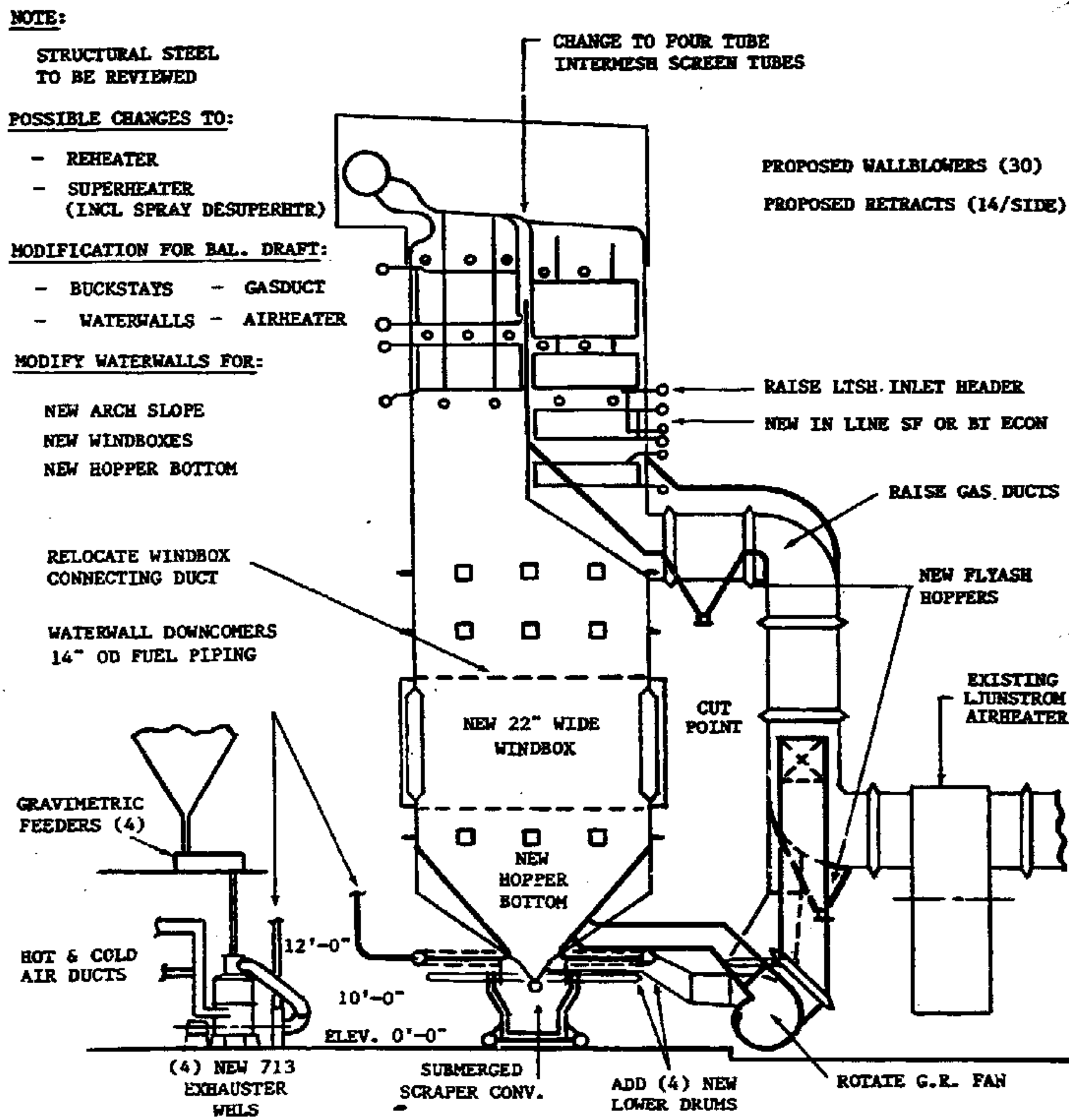

FIGURE 3

UNIT 3 - BOILER OUTLINE

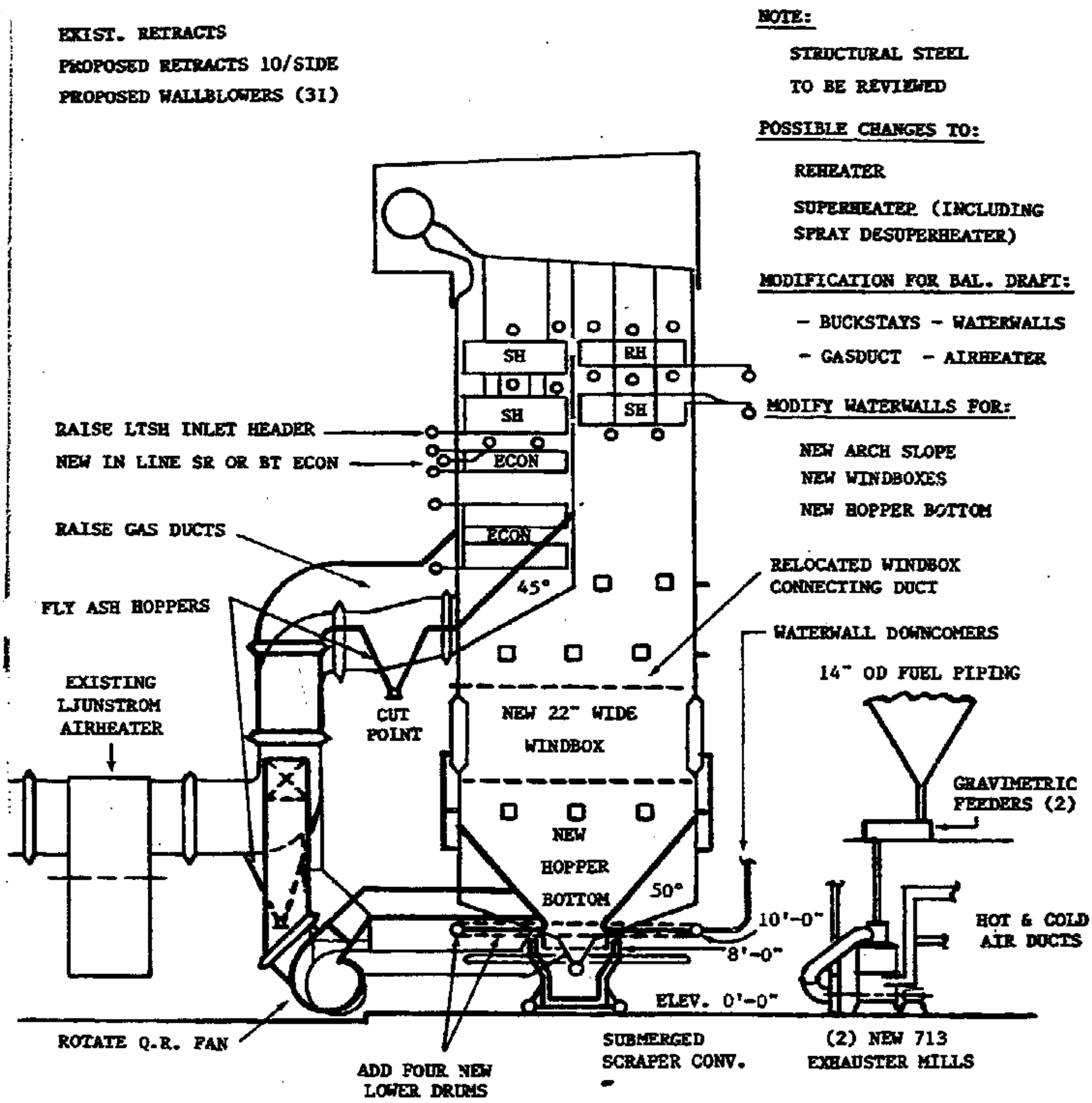

FIGURE 4

UNITS 1 & 2 - BOILER OUTLINE

8. Economizer inlet and outlet headers and the low temperature superheater inlet headers will be relocated.

9. The low temperature superheater horizontal inlet tubing will be modified.

10. Gas recirculation fans and ductwork will be relocated.

11. The gas ducts leaving the economizer will be raised.

12. Ash hoppers in the gas ducts after the economizer and before the air heater will be added.

13. The unit will be converted from a pressurized to a balanced draft furnace.

14. The burner management and combustion control systems will be modified to accommodate coal firing.

With the above modifications implemented, Combustion Engineering recommends that the units be operated at a maximum load of 600,000 lb/hr of main steam for Unit 3, and 300,000 lb/hr of main steam for Units 1 and 2 each. This corresponds roughly to 75% of the boiler output of gas fired MCR for Unit 3, and 50% for Units 1 and 2.

Units 1, 2 & 3 are below the limit of the reheat steam temperature control for the modifications proposed, whereby operation of the subject units firing coal will result in a loss of reheat steam temperature to below 990°F. Major modifications to raise temperature to 1010°F are currently being evaluated.

BAGHOUSES

Station particulate emissions are to be controlled with the use of baghouse filters, rather than precipitators, as operating experience with low sulfur western coal and consequent high resistivity fly ash has resulted in collection efficiency problems.

Structural baghouses designed for 99.8% removal efficiency on an inlet loading of 15.3 lbs/mm BTU will be used. The baghouse will be of a panel design, shipped to the site in the largest practical pieces to minimize field erection costs. The baghouses will be designed for an air-to-cloth ratio of 2.2:1 with one compartment out of service for maintenance and one compartment being cleaned. Units 1 and 2 baghouses will have eight compartments furnished with 8 inch diameter bags and Units 3 and 4 will have ten compartments furnished with 12 inch diameter bags.

Reverse air cleaning will be used to clean the bags. Reverse air cleaning was chosen over pulse jet cleaning because it maximizes bag life by minimizing bag flexing and abrasion. Two 100% reverse air fans per unit will be used to clean the bags. The bag fabric will be 13.5 ounce fiberglass with an acid resistant finish, enabling the bag to resist degradation due to acid attack.

The baghouse will be furnished with one hopper per compartment sized for a minimum of 12 hours storage. The hoppers will have 55° valley angles to prevent bridging of fly ash and to promote the free flow of fly ash out of the hoppers.

COAL HANDLING

Coal deliveries will be by 100 ± car unit trains from New Mexico. The station will have a rotary car dumper receiving system as TEP plans to share rail cars with their new units currently being constructed in Springerville, Arizona.

The rail facilities are designed to accommodate a minimum of 110 coal cars and 6 locomotives on either side of the rotary dumper without any main line interference, while allowing the front and slave (mid train) locomotives to be uncoupled and serviced (off site) during the unloading period. Existing site grades dictated track slopes of up to .75 percent on the unloading section of track. Due to this, the train is split into two sections for unloading in order to keep the rotary car positioner within commercially proven ratings.

On the basis of very stringent fugitive dust emission requirements at the site boundaries, the system facilities (Table 2) and components were carefully evaluated for optimization of capital cost, operation and maintenance while keeping fugitive dust emissions to an absolute minimum. This evaluation resulted in requiring the site active coal storage to be 6 days (approximately 21,600 tons) and enclosed so as to minimize heavy duty equipment activity in the yard. As sulfur emission limits from the units in Arizona are based on a three-hour rolling average, and run of the mine coal is expected to run very close to the maximum sulfur content allowed, blending capabilities are also required in the system.

On the basis of the above major requirements, a comparison of large concrete silos versus reinforced earth shed storage was made. The base comparison was between 3 silos 80 feet in diameter by 169 feet high vs. an optimized (below vs. above grade) reinforced slotted, covered shed storage. Historical data has shown that the shed storage normally becomes competitive with silos at or over approximately 50,000 tons. However, in this case, a combination of physical site conditions and design features desired resulted in the two systems being virtually equal with the silos being only slightly (less than $250,000) less in evaluated cost. The major tangible factors which allowed the slotted storage to compare favorably with silos in this case were:

1. Civil works for the slotted storage were much lower than normal, as excavation is in a loose soil with no dewatering or blasting required.

2. As excavation costs allowed the bottom portion of the slot to end close to grade, the enclosed building costs were also optimized.

3. In the case of silos, the optimum number of silos (with the minimum number being 3, based on system requirement) was three at 80 feet in diameter by 169 feet high. Although it was noted that this height requirement would be aesthetically unacceptable in the Tucson basin area, the base evaluation was completed with three silos so as to be completely fair to the silo design. It was clear that a multiple (more than 6) silo design, or lowering the big silos to maintain a maximum skyline height in the yard of 100 feet, would not compare favorably with the slotted storage.

The major intangible factor in favor of the slotted storage was:

(a) It will be desirable to store a large volume of better than specification coal in live storage on a continuous basis so that it will be available for blending without outside handling. With the slotted storage, it is expected that this portion of the live storage will have to be turned over a minimum of every 25 days to prevent fires. In the case of large silos, it is estimated that the maximum safe storage time is ten days. Also, smoldering is more easily detected in shed storage.

ASH HANDLING

As with coal handling, complete new ash handling facilities are required to accommodate the conversion. The facilities will be designed to allow either sale of all ash or disposal of all ash, or a combination of both. Although TEP expects to sell a majority of the ash, on site disposal facilities will be designed to be constructed in stages to protect against any possible difficulties in selling the ash.

Bottom Ash - As the existing boilers were designed for only oil and gas firing, no bottom ash facilities were planned for, and all the boilers are virtually sitting on the boiler slab. However, with the use of a submerged dragbar chain conveyor (SDBCC) and careful arrangement of the redesigned boiler bottom throat to remove the ash from the boiler, little or no pit will be required under the boilers. Use of a conventional U.S. water impounded storage hopper and removal system is considered virtually impossible on a civil/structural basis on these units. Economizer ash will be discharged to the SDBCC. The SDBCC will discharge to a belt conveyor system which discharged to two storage silos.

Fly Ash - The fly ash facilities are being considered for either rail or truck removal. On the basis of the distances involved being marginally within the design capacities of vacuum systems, vacuum, eductors/pressure tanks and drag chain/pressure tanks will be evaluated for the project.

WASTEWATER TREATMENT

The coal conversion project will result in no new wastewater releases from the site. New water users will for the most part use recycled wastewater and contaminated site runoff for makeup. All wastewater produced by the conversion will be lost through consumptive use or will be discharged to an evaporation pond.

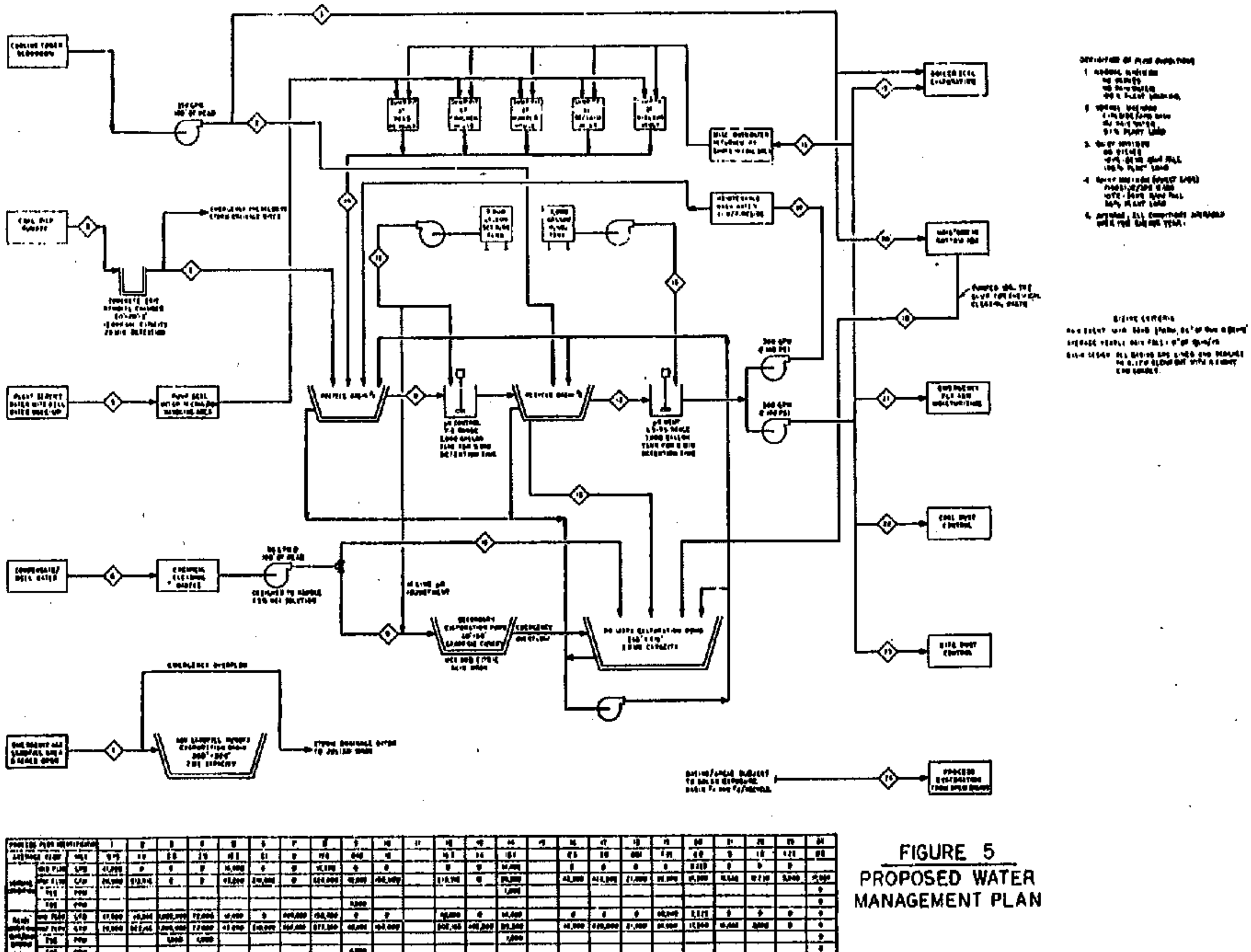

FIGURE 5
PROPOSED WATER
MANAGEMENT PLAN

The proposed water and wastewater systems related to conversion are shown on the accompanying Figure No. 5. The plan has three categories including water sources, water users, and water sinks.

New water sources are coal pile runoff and ash landfill runoff. New water users include boiler seal water and increased quantities of miscellaneous wash water, maintenance wash water, and miscellaneous service water. Water sinks are those water users with no waste water discharges and they include coal dust control, bottom ash hopper quench, fly ash moisturizing, and site dust suppression.

Also shown on the diagram are the major water handling facilities including the recycle basin and the evaporation pond. The recycle basins will provide holding volume for normal flows, and partial treatment for recirculated wastewaters.

A minimum storage volume will be maintained with makeup from cooling tower blowdown. This will provide sufficient volume for normal flows as well as maintenance washes. Sufficient extra holding capacity for storage of the 10 year, 24 hour runoff from the coal pile and ash landfill will be provided.

Facilities for pH adjustment will be provided to maintain the pH of the recycled water at or slightly above neutral. The recycle basin will be designed to provide settling and removal of suspended solids. The basin will be compartmentalized so part may be taken out of service for cleaning without affecting the operation of the rest.

CIVIL/STRUCTURAL/ARCHITECTURAL

Existing site where new coal handling and ash disposal facilities will be located is wide open and the civil design considerations for grading, drainage, paving, roads, railroad and waste disposal facilities in the yard are similar to those for any new utility station. However, existing grade variations, the Southern Pacific Railroad access, drainage structures waterways, narrow stretches of site areas bounded by properties of others, underground and overhead utilities and transmission lines and local flood plain ordinances make the civil works design interesting and challenging.

In the plant area, proper addition of mill feed system (pulverizer bays), ash handling systems, two new chimneys and additional boiler loads due to modifications require extensive interfacing with existing foundations, utilities, structures, grading and drainage.

In the case of the pulverizer bay on each unit interference with underground facilities, especially circulating water lines, will require detailed design which will allow reasonable installation without interrupting operating of existing facilities. Also, every effort is being made to minimize any modifications of the existing boiler mat and ring foundations.

CONTROLS

The existing combustion controls are pneumatic and of an obsolete line. As the instrument vendor would not guarantee parts availability, it was decided that the combustion controls would be replaced in their entirety with a current line of instrumentation.

The station has two control rooms, each containing the boiler, turbine, generator and electrical auxiliary controls for a pair of units. A study was made to evaluate the costs of centralizing all these controls into one common control room and to compare these costs against savings due to a reduction of operating personnel. Based on the results of this study, it was decided to centralize the controls.

Bids were received for new combustion control systems. The bids included three types of systems: pneumatic, discrete-component electronics and microprocessor-based. Based on the evaluation of installed costs, it was decided to procure the microprocessor-based systems.

The present boiler control vertical board will be replaced with a new combination benchboard-vertical panel which will include the baghouse controls in order to provide a logical interface between the operator and the process.

A new furnace safety system will be procured for all units.

ELECTRICAL

After reviewing the additional loads required for conversion and the one lines for the existing facilities, it was decided that a completely new electrical distribution system would be required. A further review revealed that the four existing unit auxiliary transformers were unusually lightly loaded and that by adding cooling to two of the unit auxiliary transformers and replacing two others, it is possible to add that load which is "unit related", i.e., mills, fans, feeder, etc., to the existing electrical distribution system for each unit, therefore, maintaining the standard utility unitized approach.

There is also to be added a new "Common Electrical Distribution System" to handle systems common to all four units, i.e., coal handling, fire protection, wastewater treatment, sootblowing air, etc. This new system is to be fed from the 13.8 kV tertiary of the auto transformer between the 13.8 kV and 46 kV switchyards and the 13.8 kV Irvington substation through two 16/21.5 MVA OA/FA, 13.8 kV/4160V tranformers to 4160V switchgear, 480V load centers and 480V motor control centers.

Due to the fact that there is no load on this common system, the loss of which would immediately result in a unit trip, the transfer of load from one source to another will be done on a manual dead bus basis as opposed to a "fast transfer" basis.

SUMMARY

In summary, TEP's conversion of Irvington Generating Station has received from DOE the final prohibition order and is, therefore, proceeding towards operation of Unit 4 on coal in May of 1985, with Unit 3 to follow in 1986, and units 1 & 2 in 1987. Although this is the first straight converson in a utility application in North America, the State Energy Commission of Western Australia at their Kwinana Power Station has successfully completed conversion of a unit very similar in original design, size and coal burned. Therefore, we do not expect any major unforeseen surprises at Irvington.

Also, to propose that direct coal conversion is justifiable or physically feasible at any other gas and/or oil-fired unit, based on the conditions at Irvington is virtually impossible. Although comparison of present and projected oil and/or gas costs to coal demands that conversion or re-conversion be evaluated in almost every utility application, any one or a combination of economics, load requirements, physical limitations and environmental requirements could easily eliminate realistic conversion opportunities. Each unit (or station) will have to be evaluated at length in its own merits before serious consideration to convert can be given.

REFERENCES

1. Department of Energy, Office of Fuels Conversion "Notice and Issuance of Proposed Prohibition Order", dated December 31, 1980.

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