APPENDIX H

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APPENDIX H

MASTER INSTRUMENT INDEX

NOTES:

1. Only field mounted devices are listed at this time. Because of the expected use of a process controller package, most devices usually installed in control panels will exist only in electronic logic form.
2. Drawing numbers listed under flow should all be preceded by ED-371-.
3. Drawing numbers listed under misc. should all be preceded by EE-271-.

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP	---		/	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

PHILA GAS WORKS

MASTER INSTRUMENT INDEX

DATE: 9/9/81

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	DRAWING NUMBER: PIPING	DRAWING NUMBER: MOUNTING	DRAWING NUMBER: MISC.	REMARKS
FE-03	Oxygen to Mixers						023	1¼" Pipe
FT-03	〃 〃 〃						〃	DP Cell
FY-03B	〃 〃 〃						〃	I to P Conv.
FV-03	〃 〃 〃						〃	
TT-03	〃 〃 〃						〃	
PT-03	〃 〃 〃						〃	
FE-04	〃 〃 〃						〃	1¼" Pipe
FT-04	〃 〃 〃						〃	DP Cell
FY-04B	〃 〃 〃						〃	I to P Conv.
FV-04	〃 〃 〃						〃	
TT-04	〃 〃 〃						〃	
PT-04	〃 〃 〃						〃	

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PHILA GAS WORKS

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP			2	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
FE-13	Oxygen and Steam Mixture			001			022	3" Pipe
FT-13	" " " "			"			"	
FE-12	" " " "			"			"	" "
FT-12	" " " "			"			"	
FE-15	" " " "			"			"	" "
FT-15	" " " "			"			"	
FE-14	" " " "			"			"	" "
FT-14	" " " "			"			"	
FE-16	" " " "			"			"	" "
FT-16	" " " "			"			"	
FE-17	" " " "			"			"	" "
FT-17	" " " "			"			"	
FE-18	" " " "			"			"	" "
FT-18	" " " "			"			"	
FE-19	" " " "			"			"	" "
FT-19	" " " "			"			"	" "

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PHILA GAS WORKS

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP	---		3	

GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS. READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FY-13	Oxygen and Steam Mixture			001			022	I to P Conv.
FV-13	" " " "			"			"	
FY-12	" " " "			"			"	I to P Conv.
FV-12	" " " "			"			"	
FY-15	" " " "			"			"	I to P Conv.
FV-15	" " " "			"			"	
FY-14	" " " "			"			"	I to P Conv.
FV-14	" " " "			"			"	
FY-16	" " " "			"			"	I to P Conv.
FV-16	" " " "			"			"	
FY-17	" " " "			"			"	I to P Conv.
FV-17	" " " "			"			"	
FY-18	" " " "			"			"	I to P Conv.
FV-18	" " " "			"			"	
FY-19	" " " "			"			"	I to P Conv.
FV-19	" " " "			"			"	

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PHILA GAS WORKS

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP			4	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	PIPING	MOUNTING	MISC.	REMARKS
ST-51	COAL FEED GASIFIERS						022	By Coal Screw Feed Vendor
ST-52	" " "						"	"
ST-53	" " "						"	"
ST-54	" " "						"	"
ST-61	" " "						"	"
ST-62	" " "						"	"
ST-63	" " "						"	"
ST-63	" " "						"	"

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PHILA GAS WORKS

MADE: RLE | SH. NO. 5

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FE-103	Oxygen To Mixers			001			023	1¼" Pipe
FT-103	" " "			"			"	DP Cell
FY-103B	" " "			"			"	I to P Conv.
FV-103	" " "			"			"	
TT-103	" " "			"			"	
PT-103	" " "			"			"	
FE-104	" " "			"			"	1¼" Pipe
FT-104	" " "			"			"	DP Cell
FY-104B								I to P Conv.
FV-104								
TT-104	" " "			"			"	
PT-104	" " "			"			"	

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PHILA GAS WORKS

MADE: RLP — SH. NO. 6

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
PT-107	Oxygen and Steam Mixture			001			023	
TT-107	" " " "			"			"	
FE-107	" " " "			"			"	6" Pipe
FT-107	" " " "			"			"	DP Cell
PT-108	" " " "			"			"	
TT-108	" " " "			"			"	6" Pipe
FE-108	" " " "			"			"	DP Cell
PT-07	" " " "						"	
TT-07	" " " "						"	
FE-07	" " " "						"	6" Pipe
FT-07	" " " "						"	DP Cell
PT-08	" " " "						"	
TT-08	" " " "						"	
FE-08	" " " "						"	6" Pipe
FT-08	" " " "						"	DP Cell
PT-1668	Mixer Steam Header			016			"	
PY-1668	" " "			"			"	I to P Conv.
PV-1668	" " "			"			"	

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PHILA GAS WORKS

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP			7	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	DRAWING NUMBER: PIPING	DRAWING NUMBER: MOUNTING	DRAWING NUMBER: MISC.	REMARKS
FE-113	Oxygen and Steam Mixture			001			022	3" Pipe
FT-113	" " " "			"			"	
FE-112	" " " "			"			"	" "
FT-112	" " " "			"			"	
FE-115	" " " "			"			"	" "
FT-115	" " " "			"			"	
FE-114	" " " "			"			"	" "
FT-114	" " " "			"			"	
FE-116	" " " "			"			"	" "
FT-116	" " " "			"			"	
FE-117	" " " "			"			"	" "
FT-117	" " " "			"			"	
FE-118	" " " "			"			"	" "
FT-118	" " " "			"			"	
FE-119	" " " "			"			"	" "
FT-119	" " " "			"			"	

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PHILA GAS WORKS

MADE: RLP | CHKD | DRAWING NO. | SH NO. 8 | REV

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

SCALE | W.O. | ENGINEER APPROVAL | DEPT | DATE

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FY-113	Oxygen and Steam Mixture			001			022	I to P Conv.
FV-113	" " " "			"			"	
FY-112	" " " "			"			"	I to P Conv.
FV-112	" " " "			"			"	
FY-115	" " " "			"			"	I to P Conv.
FV-115	" " " "			"			"	
FY-114	" " " "			"			"	I to P Conv.
FV-114	" " " "			"			"	
FY-116	" " " "			"			"	I to P Conv.
FV-116	" " " "			"			"	
FY-117	" " " "			"			"	I to P Conv.
FV-117	" " " "			"			"	
FY-118	" " " "			"			"	I to P Conv.
FV-118	" " " "			"			"	
FY-119	" " " "			"			"	I to P Conv.
FV-119	" " " "			"			"	

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PHILA GAS WORKS

MADE: RL | SH. NO. 9

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER				REMARKS
				FLOW	PIPING	MOUNTING	MISC.	
TT-121	Gasifier Outlet Gas			001			024	
TT-141	" " "			"			"	
TT-21	" " "			"			"	
TT-41	" " "			"			"	

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PHILA GAS WORKS

MADE: RLP | SH. NO. 10

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
LC-132	Pulverized Coal Bin			001			024	
LC-133	" " " "			"			"	
LC-134	" " " "			"			"	
LC-135	" " " "			"			"	
LC-136	" " " "			"			"	
LC-137	" " " "			"			"	
LC-138	" " " "			"			"	
LC-139	" " " "			"			"	
LC-32	" " " "			"			"	
LC-33	" " " "			"			"	
LC-34	" " " "			"			"	
LC-35	" " " "			"			"	
LC-36	" " " "			"			"	
LC-37	" " " "			"			"	
LC-38	" " " "			"			"	
LC-39	" " " "			"			"	

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PHILA GAS WORKS

MADE: RLP | SH. NO.: 11

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
ST-151	Coal Feed - Gasifier A			001			022	By Coal Screw Feed Vendor
ST-152	" " " "			"			"	"
ST-153	" " " "			"			"	"
ST-154	" " " "			"			"	"
ST-161	" " " "			"			"	"
ST-162	" " " "			"			"	"
ST-163	" " " "			"			"	"
ST-164	" " " "			"			"	"

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PHILA GAS WORKS

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

MADE: RCP

SH. NO. /2

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FE-201	Waste Water			002			025	3" Pipe
FCR-201	" "			"			"	
FY-201A	" "			"			"	P to V Conv.
FY-201B	" "			"			"	P to V Conv.
FV-201	" "			"			"	
LS-201A	" "			"			"	
LS-201B	" "			"			"	
LS-201C	" "			"			"	
LS-203A	Sump Water			"			"	
LS-203B	" "			"			"	
LS-203C	" "			"			"	
PS-204	" "			"			"	

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PHILA GAS WORKS

MADE: RLP | SH. NO. 13

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	PIPING	MOUNTING	MISC.	REMARKS
PHT-207A	Sump Water			002			026	
PHT-207B	" "			"			"	
PHC-207	" "			"			"	
PHY-207A	" "			"			"	
PHV-207	" "			"			"	
PHT-221A	Neutralization Tank			"			"	
PHT-221B	" "			"			"	
PHC-221	" "			"			"	
PHY-221A	" "			"			"	
PHV-221	" "			"			"	
FE-251	Waste Water			"			"	Wastewater flow
FT-251	" "			"			"	Measuring and
FY-251	" "			"			"	Sampling Unit.
FE-252	" "			"			"	
FT-252	" "			"			"	
FY-252	" "			"			"	

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PHILA GAS WORKS

MADE: RLP | SH. NO. 14

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	PIPING	MOUNTING	MISC.	REMARKS
WE-353A	Coal Handling Equipment			003			022	
WE-353B	" " "			"			"	
WE-353C	" " "			"			"	
WT-353	" " "			"			"	
WE-354A	" " "			"			"	
WE-354B	" " "			"			"	
WE-354C	" " "			"			"	
WT-354	" " "			"			"	

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PHILA GAS WORKS

GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS · READING, PA.

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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
PT-320	Coal Dryer Air			003			018	
PY-320	" " "			"			"	I to P Conv.
PT-330	" " "			"			"	
PY-330	" " "			"			"	I to P Conv.
WE-351A	Coal Handling Equipment			"			"	
WE-351B	" " "			"			"	
WE-351C	" " "			"			"	
WT-351	" " "			"			"	
WE-352A	" " "			"			"	
WE-352B	" " "			"			"	
WE-352C	" " "			"			"	
WT-352	" " "			"			"	

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PHILA GAS WORKS

MADE: RLP | SH. NO. 16

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
PS-300	Fuel Gas			003				
TT-301	Air Heater			"			017	
TT-302	" "			"			"	
TT-303	" "			"			"	
PS-311	Nitrogen			"				
PS-312	"			"				
PT-321	Coal Dryer Air			"			018	
PY-321A	" " "			"			"	I to P Conv.
PT-331	" " "			"			"	
PY-331A	" " "			"			"	I to P.Conv.

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PHILA GAS WORKS

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP	---		17	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
TT-415	Wash Water							
TY-415	" "			004			027	
TV-415	" "			"			"	I to P Conv.
				"			"	
TT-416	" "							
TY-416	" "			"			"	
TV-416	" "			"			"	I to P Conv.
				"			"	
LS-421	" "							
LS-422	" "			"			"	
LS-423	" "			"			"	
LS-424	" "			"			"	
				"			"	
PS-425	" "							
				"			"	
LS-431	" "							
LS-432	" "			"			"	
LS-433	" "			"			"	
LS-434	" "			"			"	
				"			028	
PS-435	" "			"			"	

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PHILA GAS WORKS

MADE: RLP | CHKD: | DRAWING NO.: | SH. NO.: 18 | REV:

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	DRAWING NUMBER: PIPING	DRAWING NUMBER: MOUNTING	DRAWING NUMBER: MISC.	REMARKS
LT-500	Demineralized water			005			015	DP Cell
LY-500	" "			"			"	Relay
SV-500	" "			"			"	
LV-500A	" "			"			"	
LV-500B	" "			"			"	
FE-504	" "			"				3" Pipe
FI-504	" "			"				Local Indicator

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MADE: RLP | CHKD: --- | SH. NO. 19

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
LT-505	Deaerator			005			015	DP Cell
LY-505A	"			"			"	I TOP CONV.
LY-505B	"			"			"	" "
LY-505C	"			"			"	Relay
LV-505A	"			"			"	
LV-505B	"			"			"	
LV-505C	"			"			"	
LI-506	"			"				SIGHT GLASS
LT-509	Condensate Storage			"			"	DP CELL
LY-509	" "			"			"	RELAY
LV-509D	" "			"			"	

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PHILA GAS WORKS

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

SQ LD | ENG INT CHK | SCALE | W.O. | ENGINEER APPROVAL | DEPT | DATE | REV | MADE | CH | SQL | APP | DATE

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FE-510	Condensate			005			015	3" Pipe
FI-510	"			"			"	Local Indicator
CE-511	Condensate			"			"	Conductivity Cell
CT-511	"			"			"	
CY-511	"			"			"	I to P Conv.
CV-511	"			"			"	
CE-512	"			"			"	Conductivity Cell
CT-512	"			"			"	
CY-512	"			"			"	I to P Conv.
CV-512	"			"			"	
CE-516	"			"			"	Conductivity Cell
CT-516	"			"			"	
CY-516	"			"			"	I to P Conv.
CV-516	"			"			"	

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PHILA GAS WORKS

MADE: RLP | CHKD: --- | SH. NO. 21

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
PS-515	Condensate			005			016	Low Vacuum Sw.
LT-515	"			"			"	
LY-515	"			"			"	I to P Conv.
LV-515	"			"			"	
FE-527	"			"				4" Pipe
FI-527	"			"				Local Indication
FE-528	"			"				4" Pipe
FI-528	"			"				Local Indication

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PHILA GAS WORKS

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RLP	---		22	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

SCALE
W.O.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER				REMARKS
				FLOW	PIPING	MOUNTING	MISC.	
FE-536	Condensate			005				3" Pipe
FI-536	"			"				Local Indication
FE-537	"			"				3" Pipe
FI-537	"			"				Local Indication
FE-550	"			"				4" Pipe
FI-550	"			"				Local Indication

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PHILA GAS WORKS

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP	---		23	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
PT-624	Gas Booster Compressor			006			016	
PY-624A	" " "			"			"	I to P Conv.
PY-624B	" " "			"			"	" " " "
PV-624A	" " "			"			"	
PV-624	" " "			"			"	

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PHILA GAS WORKS

MADE	CHKD	DRAWING NO.	SH. NO.	REV
RLP	---		241	

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

SQ LD — ENG INT CHK — SCALE — W.O. — ENGINEER APPROVAL — DEPT — DATE — REV — MADE — CH — SQL — APP — DATE

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
TIC-1041	Produce Gas Aftercooler			010			028	Pneumatic
TV-1041	" " "			"			"	
TIC-1043	" " "			"			"	
TV-1043	" " "			"			"	
TIC-1046	" " "			"			"	
TV-1046	" " "			"			"	
TIC-1054	" " "			"			"	
TV-1054	" " "			"			"	
TIC-1055	" " "			"			"	
TV-1055	" " "			"			"	

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PHILA GAS WORKS

MADE: RLP | SH. NO.: 25

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY.	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FE-1115	Raw Water			011			029	12" Pipe
FIT-1115	" "			"			"	DP Cell
PS-1115	" "			"			"	
LT-1117	" "			"			"	
TIS-1121	Cooling Water			"			"	
TIS-1122	" "			"			"	
LT-1127	" "			"			"	
SV-1127	" "			"			"	
AE-1131A	" "			"			030	PH Analyzer
AE-1131B	" "			"			"	" "
AE-1132	" "			"			"	Conductivity Cell
MIC-1125	" "			"			"	
BY-1125	" "			"			"	I to P Conv.
BDV-1125	" "			"			"	

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PHILA GAS WORKS

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

MADE: RLR — SH. NO.: 26

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER				REMARKS
				FLOW	PIPING	MOUNTING	MISC.	
PS-1133	Cooling Water			011			030	
TT-1133	" "			"			"	
PS-1135	" "			"			"	

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PHILA GAS WORKS

MADE RLF CHKD --- | DRAWING NO. | SH. NO. 27 | REV

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
LS-1201A	Wash Water			012			030	
LS-1201B	" "			"			"	
LS-1201C	" "			"			"	
SV-1201A	" "			"			"	
LV-1201A	" "			"			"	
SV-1201B	" "			"			"	
LV-1201B	" "			"			"	
LS-1202A	Glycol Dehydration			015			031	
LT-1202	" "			"			"	
LY-1202A	" "			"			"	I to P Conv.
SV-1202	" "			"			"	
LV-1202	" "			"			"	
TT-1203	" "			"			"	
TT-1204	" "			"			"	
FE-1207	" "			"			"	2" Pipe
FT-1207	" "			"			"	DP Cell
FY-1207	" "			"			"	I to P Conv.
FV-1207	" "			"			"	

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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
PS-1209	Glycol Dehydration			015			031	
LS-1220	" "			"			"	
TT-1225	" "			"			"	
TY-1225	" "			"			"	
TV-1225	" "			"			"	I to P Conv
TT-1240	Product Gas			"			032	
PIT-1240	" "			"			"	
FY-1240	" "			"			"	
PV-1240	" "			"			"	I to P Conv
FE-1240	" "			"			"	
FT-1240	" "			"			"	20" pipe
								DP Cell
FE-1241	" "			"			"	
FT-1241	" "			"			"	10" pipe
								DP Cell
FE-1242	" "			"			"	
FT-1242	" "			"			"	8" pipe
								DP Cell

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PHILA GAS WORKS

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
PIT-1243	Product Gas			015			032	
PY-1243A	" "			"			"	I to P Conv
PV-1243	" "			"			"	
PIT-1244	" "			"			"	

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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FE-1416	PRODUCT GAS			014			019	16" Pipe
FT-1416	" "			"			"	
PT-1416	" "			"			"	
TT-1416	" "			"			"	
							020	
FE-1426	" "			"			"	16" Pipe
FT-1426	" "			"			"	
PT-1426	" "			"			"	
TT-1426	" "			"			"	
FE-1446	" "			"			"	16" Pipe
FT-1446	" "			"			"	
PT-1446	" "			"			"	
TT-1446	" "			"			"	
FV-1416	" "			"			021	
FV-1426	" "			"			"	
FV-1446	" "			"			"	

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PHILA GAS WORKS

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
TT-1451	Product Gas			014				
TT-1452	" "			"			019	
TT-1461	" "			"				
TT-1462	" "			"			"	
TT-1471	" "			"				
TT-1472	" "			"			"	
PT-1498	" "			"			021	
PT-1499	" "			"			"	

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ENGINEERS AND CONSULTANTS
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PHILA GAS WORKS

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TAG NO.	SERVICE		SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
LC-1530	Wash Water				015			035	
LV-1530	"	"			"			"	
LV-1531	"	"			"			"	
LC-1551	"	"			"			"	
LV-1551	"	"			"			"	
LV-1552	"	"			"			"	
LC-1560	"	"			"			"	
LV-1560	"	"			"			"	
LV-1561A	"	"			"			"	
LC-1565	"	"			"			"	
LV-1565	"	"			"			"	
LV-1566	"	"			"			"	
LC-1571	"	"			"			"	
LV-1571	"	"			"			"	
LV-1572	"	"			"			"	
LC-1574	"	"			"			"	
LV-1574	"	"			"			"	
LV-1575	"	"			"			"	

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

SCALE

W.O.

ENGINEER APPROVAL — DEPT. — DATE

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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
LT-1555	Product Gas			015			033	
FE-1580	" "			"			"	48" pipe
FT-1580	" "			"			"	
TT-1580	" "			"			"	
PT-1580	" "			"			"	
LT-1504	Wash Water			"			034	
LY-1504	" "			"			"	I to P Conv
LV-1504	" "			"			"	
LT-1508	" "			"			"	
LY-1508	" "			"			"	I to P Conv
LV-1508	" "			"			"	
LT-1513	" "			"			"	
LY 1513	" "			"			"	I to P Conv
LV-1513	" "			"			"	
LT-1543	" "			"			"	
LY-1543	" "			"			"	I to P Conv
LV-1543	" "			"			"	

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PHILA GAS WORKS

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

SCALE
W.O.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER				REMARKS
				FLOW	PIPING	MOUNTING	MISC.	
LV-1594	Wash Water			015			035	
LV-1594	" "			"			"	
LV-1596A	" "			"			"	

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MADE	CHKD	DRAWING NO.	SH. NO.	REV
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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

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TAG NO.	*SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	PIPING	MOUNTING	MISC.	REMARKS
PT-1601	Low Pressure Steam			016			037	
PY-1601A	" " "			"			"	I to P Conv.
PY-1601B	" " "			"			"	I to P Conv.
PV-1601A	" " "			"			"	
PV-1601B	" " "			"			"	
PS-1601	" " "			"			"	
LS-1602	Feedwater			"			"	
LT-1602	"			"			"	
LY-1602	"			"			"	I to P Conv.
LV-1602	"			"			"	
FE-1605	Low Pressure Steam			"			"	14" Pipe
FIT-1605	" " "			"			"	
TT-1605	" " "			"			"	
HIC-1604	Blowdown Water			"			"	
HY-1604	" "			"			"	I to P Conv.
HV-1604	" "			"			"	

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
PT-1611	Low pressure steam			016			037	
PY-1611	" " "			"			"	I to P conv.
PY-1611	" " "			"			"	I to P conv.
PV-1611	" " "			"			"	
PV-1611	" " "			"			"	
PS-1611	" " "			"			"	
LS-1612	Feedwater			"			"	
LT-1612	"			"			"	
LY-1612	"			"			"	I to P conv.
LV-1612	"			"			"	
FE-1615	Low pressure steam			"			"	14" pipe
FIT-1615	" " "			"			"	
TT-1615	" " "			"			"	
HIC-1614	Blowdown water			"			"	
HY-1614	" "			"			"	I to P conv.
HV-1614	" "			"			"	

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Phila Gas Works

MADE: RLH | CHKD: --- | SH. NO. 37

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER				REMARKS
				FLOW	PIPING	MOUNTING	MISC.	
PT-1621	High Pressure Steam			016			037	
PY-1621	" " "			"			"	I to P conv.
PY-1621	" " "			"			"	I to P conv.
PV-1621	" " "			"			"	
PV-1621	" " "			"			"	
PS-1621	" " "			"			"	
LS-1622	Feedwater			"			"	
LT-1622	"			"			"	
LY-1622	"			"			"	~~I to P conv.~~
LV-1622	"			"			"	
FE-1625	High Pressure Steam			"			"	4" pipe
FIT-1625	" " "			"			"	
TT-1625	" " "			"			"	
HIC-1624	Blowdown water			"			"	
HY-1624	" "			"			"	I to P conv.
HV-1624	" "			"			"	

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

SCALE | W.O. | ENGINEER APPROVAL | DEPT. | DATE

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	DRAWING NUMBER: PIPING	DRAWING NUMBER: MOUNTING	DRAWING NUMBER: MISC.	REMARKS
PT-1631	High Pressure Steam			016			037	
PY-1631	" " "			"			"	I to P conv.
PY-1631	" " "			"			"	I to P conv.
PV-1631	" " "			"			"	
PV-1631	" " "			"			"	
PS-1631	" " "			"			"	
LS-1632	Feedwater			"			"	
LT-1632	"			"			"	
LY-1632	"			"			"	I to P conv.
FE-1635	High Pressure Steam			"			"	4" pipe
FIT-1635	" " "			"			"	
TT-1635	" " "			"			"	
HIC-1634	Blowdown water			"			"	
HY-1634	" "			"			"	I to P conv.
HV-1634	" "			"			"	

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GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
FE-1640	Condensate			016			037	3" pipe
FT-1640	"			"			"	
HY-1640	"			"			"	I to P conv.
CV-1640	"			"			"	
FE-1641	"			"			"	3" pipe
FT-1641	"			"			"	
HY-1641	"			"			"	I to P conv.
HV-1641	"			"			"	
FE-1642	Steam			"			038	3" pipe
FT-1642	"			"			"	
PT-1643	"			"			"	
PY-1643	"			"			"	I to P conv.
N-1643	"			"			"	
TT-1643	"			"			"	
PT-1644	"			"			"	
TT-1645	"			"			"	

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Phila Gas Works

DRAWING NO. | SH NO. 40 | REV

MADE RLP | CHKD | SCALE | W.O.

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
TT-1646	Steam			016			038	
PT-1647	"			"			"	
PY-1647	"			"			"	I to P conv.
PV-1647	"			"			"	
PSH-1647	"			"			"	
PSL-1647	"			"			"	
PT-1648	"			"			"	
PY-1648	"			"			"	I to P conv.
PV-1648	"			"			"	
PSL-1649	"			"			"	
PSL-1649	"			"			"	
PT-1649	"			"			"	
TT-1649	"			"			"	
LC-1651	Condensate			"			"	
LS-1651A	"			"			"	
LS-1651B	"			"			"	
LV-1651A	"			"			"	
LV-1651B	"			"			"	

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Phila Gas Works

MADE: RLP | SH. NO. 41

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
TT-1652	Steam			016			040	
TY-1652	"			"			"	I to P conv.
TV-1652	"			"			"	
FE-1657	"			"			039	4" pipe
FIT-1657	"			"			"	
TT-1658	"			"			040	
TY-1658	"			"			"	I to P conv.
TV-1658	"			"			"	
FE-1659	"			"			"	8" pipe
FIT-1659	"			"			"	
FE-1660	"			"			"	4" pipe
FIT-1660	"			"			"	
PT-1661	"			"			"	I to P conv.
PY-1661A	"			"			"	
PV-1661A	"			"			"	
PY-1661B	"			"			"	I to P conv.
PV-1661B	"			"			"	
FE-1662	"			"			"	6" pipe
FIT-1662	"			"			"	

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Phila Gas Works

MADE: RLP | SH. NO. 42 | GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
TT-1664	Steam			016			040	
TY-1664	"			"			"	I to P conv.
TV-1664	"			"			"	
FE-1665	"			"			"	1½" pipe
FIT-1665	"			"			"	
TT-1669	"			"			041	
TY-1669	"			"			"	I to P conv.
TV-1669	"			"			"	
FE-1671	"			"			"	2" pipe
FIT-1671	"			"			"	
TT-1673	"			"			"	
PT-1674	"			"			"	
HY-1674	"			"			"	I to P conv.
BPV-1674	"			"			"	
FE-1675	"			"			"	14" pipe
FT-1675	"			"			"	

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Phila Gas Works

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GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
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TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	DRAWING NUMBER: PIPING	DRAWING NUMBER: MOUNTING	DRAWING NUMBER: MISC.	REMARKS
FE-1677	Steam			016			041	10" pipe
FIT-1677	"			"			"	
FY-1677A				"			"	I to P conv.
FV-1677				"			"	
FE-1679				"			"	10" pipe
FIT-1679				"			"	
FY-1679A				"			"	I to P conv.
FV-1679				"			"	
LC-1695	Condensate			"			"	Pneumatic
LV-1695	"			"			"	

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	GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.		

MASTER INSTRUMENT INDEX

DATE: 9/3/81

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	DRAWING NUMBER PIPING	DRAWING NUMBER MOUNTING	DRAWING NUMBER MISC.	REMARKS
FE-1681	Steam to Mixers			016			023	4" Pipe
FT-1681	" " "			"			"	DP Cell
FY-1681	" " "			"			"	I to P Conv.
FV-1681	" " "			"			"	
TT-1681	" " "			"			"	
FE-1682	" " "			"			"	4" Pipe
FT-1682	" " "			"			"	DP Cell
FY-1682	" " "			"			"	I to P Conv.
FV-1682	" " "			"			"	
TT-1682	" " "			"			"	

RELEASED FOR BIDDING PURPOSES CONSTRUCTION	ENGR.	DATE

MASTER INSTRUMENT INDEX

DATE: 9/3/81

PHILA GAS WORKS

MADE: RLL — SH. NO. 45

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER: FLOW	DRAWING NUMBER: PIPING	DRAWING NUMBER: MOUNTING	DRAWING NUMBER: MISC.	REMARKS
FE-1683	Steam to Mixers			016			023	4" Pipe
FT-1683	" " "			"			"	DP Cell
FY-1683B	" " "			"			"	I to P Conv.
FV-1683	" " "			"			"	
TT-1683	" " "			"			"	
FE-1684	" " "			"			"	4" Pipe
FT-1684	" " "			"			"	DP Cell
FY-1684B	" " "			"			"	I to P Conv.
FV-1684	" " "			"			"	

RELEASED FOR	BIDDING PURPOSES	CONSTRUCTION
ENGR.		
DATE		

MASTER INSTRUMENT INDEX

DATE: 9/3/81

PHILA GAS WORKS

MADE: RLP | SH. NO. 46

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

RELEASED FOR: BIDDING PURPOSES / CONSTRUCTION — ENGR. — DATE

TAG NO.	SERVICE	SPEC. SHEET NO.	SUPPLIED BY	DRAWING NUMBER FLOW	PIPING	MOUNTING	MISC.	REMARKS
TIS-1701	Main Air Supply			017			035	
TIS-1711	" " "			"			"	
PT-1715	" " "			"			"	
PY-1715A	" " "			"			"	I to P Conv.
PY-1715B	" " "			"			"	" " " "
BV-1711	" " "			"			"	
BV-1701	" " "			"			"	
PSH-1715	" " "			"			"	
PSL-1715	" " "			"			"	
PDS-1731	" " "			"			"	
PDS-1732	" " "			"			036	
PS-1735	" " "			"			"	
PS-1736	" " "			"			"	
PS-1802	" " "			018			"	
PS-1804	" " "			"			"	

APPENDIX I

PGW CONCEPTUAL PLANT DESIGN REVIEW

PRELIMINARY

PGW CONCEPTUAL PLANT DESIGN REVIEW

CONTENTS

PGW CONCEPTUAL PLANT DESIGN REVIEW

1.0 INTRODUCTION

The conceptual design completed during Phase I was based on Koppers-Totzek (now referred as GKT) gasifiers. The design parameters considered were based on the best available literature. The base coal considered was a typical but generic Pittsburgh No. 8 coal.

This report prepared as part of Phase II project discusses the findings obtained from reviewing the Phase I conceptual design. Figure 1.1 gives the overall flow diagram of the gasification plant. In Phase II, the supplier of the gasifier, Krupp-Koppers was contacted and a contract was signed to obtain better data information on their GKT gasification plant. The Battery Limits (BL) for the GKT gasification plant are:

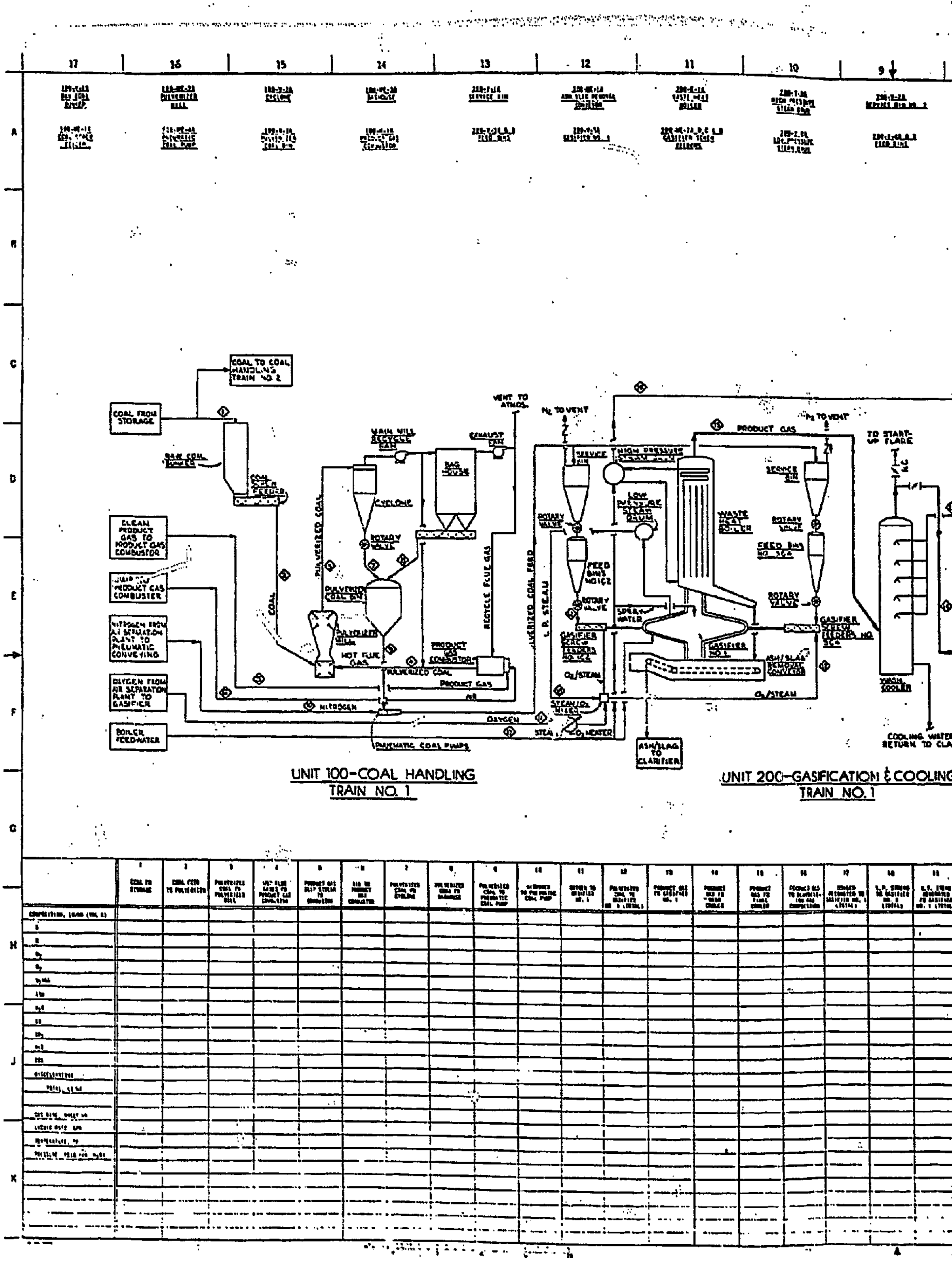
Upstream: Coal dust intake service bunker.

Downstream: Raw gas, free of particulates, after gasholder.

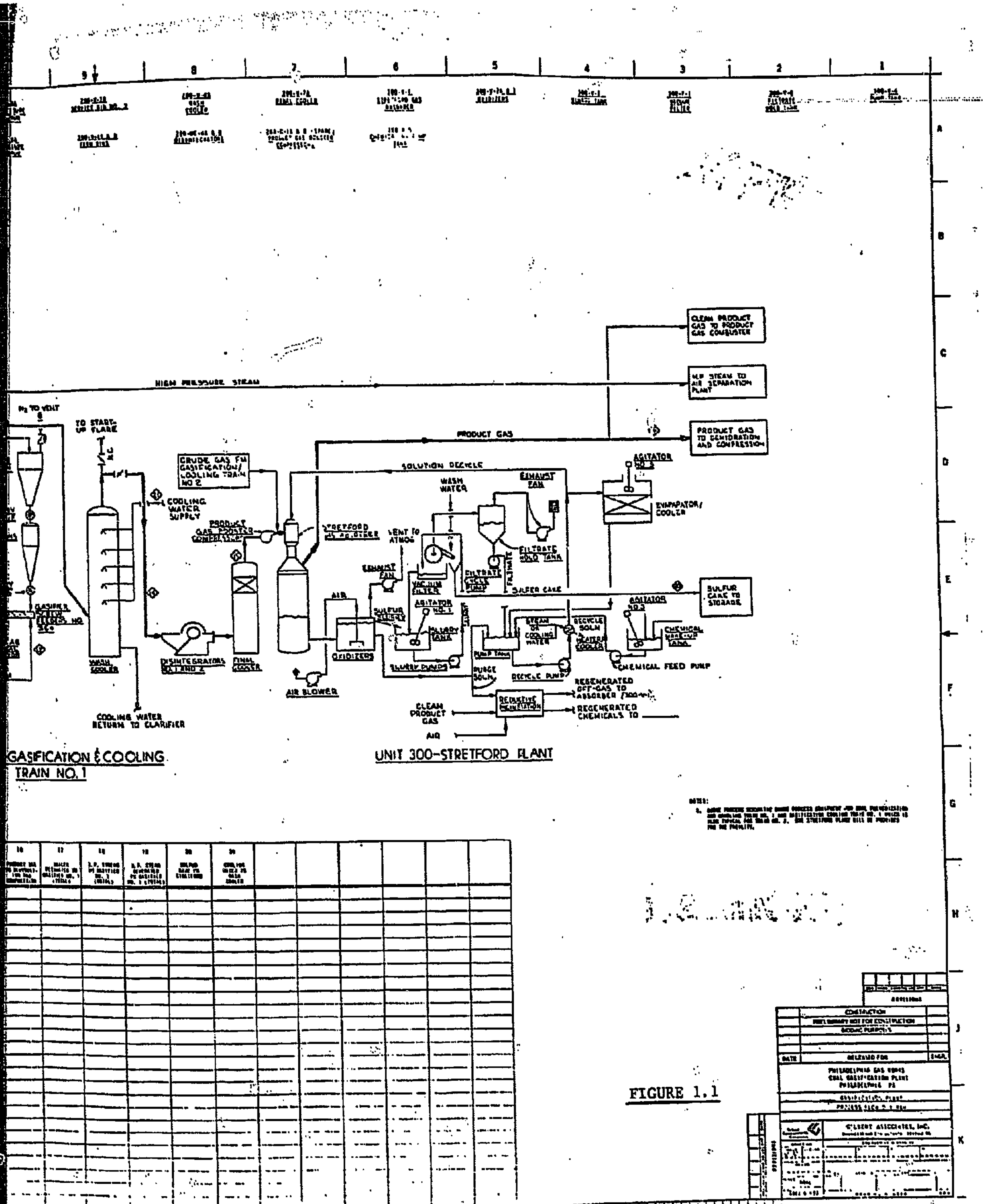
The coal that was used for the design was Pittsburgh No. 8, the analysis of which is given in Table 1.1.

In Phase II, a coal search to obtain a specific design coal for gasification was also performed. The details of the coal search and the final coal selection (C&K coal) are discussed in a separate report. The analysis of the C&K coal is given in Table 1.2.

In reviewing the coal pulverization and drying section, various vendors were contacted to obtain the details of their mills. Factors considered in evaluating the mills are size, reliability, and cost. Coal throughput of about 1000-1200 TPD is considered for



COAL TO COAL HANDLING TRAIN NO. 2
COAL FROM STORAGE
RAW COAL BUNKER
COAL FEEDER
CLEAN PRODUCT GAS TO PRODUCT GAS COMBUSTOR
PRODUCT GAS COMBUSTER
NITROGEN FROM AIR SEPARATION PLANT TO PNEUMATIC CONVEYING
OXYGEN FROM AIR SEPARATION PLANT TO GASIFIER
BOILER FEEDWATER
MAIN MILL RECYCLE FAN
CYCLONE
ROTARY VALVE
BAG HOUSE
EXHAUST FAN
VENT TO ATMOS.
PULVERIZED COAL
PULVERIZED COAL BIN
PULVERIZER MILL
HOT FLUE GAS
PRODUCT GAS COMBUSTOR
RECYCLE FLUE GAS
PRODUCT GAS
AIR
NITROGEN
OXYGEN
STEAM
PNEUMATIC COAL PUMPS
PULVERIZED COAL FEED
L. P. STEAM
N_2 TO VENT
SERVICE BIN
HIGH PRESSURE STEAM DRUM
LOW PRESSURE STEAM DRUM
FEED BINS NO 1 & 2
ROTARY VALVE
SPRAY WATER
GASIFIER SCREW FEEDERS NO 1 & 2
GASIFIER NO 1
WASTE HEAT BOILER
ASH/SLAG REMOVAL CONVEYOR
O_2/STEAM
STEAM/O_2 MIXER
O_2 HEATER
ASH/SLAG TO CLARIFIER
PRODUCT GAS
TO START-UP FLARE
SERVICE BIN
ROTARY VALVE
FEED BINS NO 3 & 4
GASIFIER SCREW FEEDERS NO 3 & 4
WASH COOLER
COOLING WATER RETURN TO CLAR
UNIT 100–COAL HANDLING TRAIN NO. 1
UNIT 200–GASIFICATION & COOLING TRAIN NO. 1



HIGH PRESSURE STEAM
CLEAN PRODUCT GAS TO PRODUCT GAS COMBUSTER
H.P. STEAM TO AIR SEPARATION PLANT
PRODUCT GAS
PRODUCT GAS TO DEHYDRATION AND COMPRESSION
TO START-UP FLARE
CRUDE GAS FM GASIFICATION/ COOLING TRAIN NO 2
SOLUTION RECYCLE
COOLING WATER SUPPLY
PRODUCT GAS BOOSTER COMPRESSOR
STRETFORD ABSORBER
WASH WATER
EXHAUST FAN
AGITATOR NO 2
EVAPORATOR/ COOLER
VENT TO ATMOS
FILTRATE HOLD TANK
FILTRATE PUMP
VACUUM FILTER
SULFUR CAKE
SULFUR CAKE TO STORAGE
AGITATOR NO 3
AGITATOR NO 1
SLURRY TANK
AIR
SULFUR SLURRY
PUMP TANK
STEAM OR COOLING WATER
RECYCLE SOLN HEATER/ COOLER
CHEMICAL MAKE-UP TANK
CHEMICAL FEED PUMP
WASH COOLER
DISINTEGRATORS
FINAL COOLER
OXIDIZERS
SLURRY PUMPS
PURGE SOLN
RECYCLE PUMP
AIR BLOWER
REGENERATED OFF-GAS TO ABSORBER
REGENERATED CHEMICALS TO
REDUCTIVE INCINERATION
CLEAN PRODUCT GAS
AIR
COOLING WATER RETURN TO CLARIFIER
GASIFICATION & COOLING TRAIN NO. 1
UNIT 300-STRETFORD PLANT
PHILADELPHIA GAS WORKS
COAL GASIFICATION PLANT
PHILADELPHIA PA
GILBERT ASSOCIATES, INC.

FIGURE 1.1

TABLE 1.1

COAL DATA SHEET

Mine Operator & Owner:
Type of Mine & Location: Deep Mine, Greene County, Pennsylvania
Seam(s) Mined: Pittsburgh No. 8
Preparation Facilities:
Reserves, Million Tons: Production, TPY:
Loading:
Freight Rate Group:
Coal Size: FSI: 7.5 HGI: 64
Coal Cost, $/Ton: FOB: Est. Freight Rate Philadelphia:

Proximate Analysis, Wt. %/ A.R.

Moisture:	4.58
Ash:	7.83
Volatile Matter:	37.33
Fixed Carbon:	50.26
Btu/Lb.:	13,442
Sulfur:	2.52

Ultimate Analysis, Wt. %

	Dry	A-R
Carbon	77.71	74.15
Hydrogen	5.28	5.04
Nitrogen	1.42	1.36
Chlorine	-	-
Sulfur	2.64	2.52
Ash	8.21	7.83
Oxygen	4.74	4.52
Moisture	-	4.58
Total	100.00	100.00

Ash Mineral Composition, Wt. %(1)

Phos. Pentoxide (P_2O_5)	-
Silica (SiO_2)	47.19
Ferric Oxide (Fe_2O_3)	16.23
Alumina (Al_2O_3)	22.40
Titania (TiO_2)	-
Lime (CaO)	4.11
Magnesia (MgO)	0.76
Sulfur Trioxide (SO_3)	0.87
Potassium Oxide (K_2O)	-
Sodium Oxide (Na_2O)	-
Others	8.44
Total	100.00

Fusion Temperature, °F

	Reducing	Oxidizing
Initial Deformation	2093	2444
Softening	2138	2480
Fluid	2156	2516

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(1) Data is from partial analysis; the compounds not analyzed are included as "Others"

TABLE 1.2

COAL DATA SHEET

Mine Operator & Owner: C & K Coal Company

Type of Mine & Location: Surface Mine- Clarion County, Pa.

Seam(s) Mined: Clarions, Kittannings, & Freeports

Preparation Facilities: Jeffrey Jig Washer

Reserves, Million Tons: 60 Production, TPY: 5 million raw

Loading: Truck or Load-in-motion Train Facilities on Conrail

Freight Rate Group: Clearfield

Coal Size: 2" X 0" FSI: 7 HQI: 55-60

Coal Cost, $/Ton: FOB: 29.00 Est. Freight Rate Philadelphia: 11.00*

Proximate Analysis, Wt. %/ A.R.

Moisture: 5-7

Ash: 8-10

Volatile Matter: 32-36

Fixed Carbon: 45-50

Btu/Lb.: 12,600-12,800

Sulfur: 2.5-3.0

Ultimate Analysis, Wt. %

	Dry	A-R
Carbon	75.0	70.5
Hydrogen	5.5	5.2
Nitrogen	1.5	1.4
Chlorine	.2	.2
Sulfur	3.0	2.8
Ash	9.3	8.7
Oxygen	5.5	5.2
Moisture	---	6.0

Ash Mineral Composition, Wt. %

Phos. Pentoxide	.20
Silica	38.31
Ferric Oxide	30.31
Alumina	22.28
Titania	1.02
Lime	1.43
Magnesia	.56
Sulfur Trioxide	1.73
Potassium Oxide	1.05
Sodium Oxide	.47

Ash Feasibility, °F

	Reducing	Oxidizing
Initial Deformation	2000	2500
Softening	2200	2600
Fluid	2400	2650

* Unit Train Rate (7000 tons)

Gilbert/Commonwealth

this section. The upper limit of moisture content of the as received coal considered is 12 percent. The other details are described in Section 2.

Pulverized coal from the coal pulverization and drying section is conveyed by a pneumatic system to the gasifier service bins. Positive-pressure material-into-air and air-mixing systems are considered. Based on the flow characteristics of the coal (90% through 200 mesh) pipe sizes for conveying 25 TPH and 50 TPH coal are determined. Details of the pneumatic systems are covered in Section 3.

The GKT gasification plant producing 20×10^9 BTU/day (lower heating value) is described in Section 4. This section gives the overall material balance for the B.L. gasification plant (Pittsburgh No. 8 was considered). Coal, oxygen, steam, nitrogen and water requirements are given. The type of steam generated is described. Gas composition at the B.L. gasification plant is given.

Based on the oxygen requirements of the GKT gasification plant, the air separation plant capacity was selected. The description of air separation plant is given in Section 5. This section covers such factors as reliability/sparing philosophy, liquid oxygen storage, utility requirements and economics. Oxygen plant vendors were contacted and their business position and philosophy of designing the plant was reviewed. Cost information is also given in this section.

The gas from the B.L. gasification plant goes to the Stretford plant for sulfur removal. The sulfur could be removed in the form of filter cake or molten sulfur. These two options are evaluated based on the available information. The gas composition considered for the Stretford plant is based on the use of C&K coal. Material balances and economics for different filter cake and/or Stretford purge disposal options are considered. The details of the Stretford plant is given in Section 6.

SECTION 2

COAL PULVERIZATION AND DRYING

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COAL PULVERIZATION AND DRYING

2.1 RING-ROLLER MILLS, BOWL MILLS, BALL-AND-RING MILLS

These mills are the most commonly used type for the dry pulverizing of coal and lignite. They cannot be used in the wet processes. They are extensively used in coal-fired power plants. (Only bituminous coals are considered for PGW plant and mention of lignite in this section is just for providing the capabilities of these mills.)

When the roller rotates in a stationary bowl, they are termed ring-roller mills. If the bowl rotates around stationary rollers, they are bowl mills. Ball-and-ring mills use large steel balls revolving between a rotating bottom ring and a stationary top ring. The size reduction is accomplished by contact between the revolving surfaces and the fixed surface.

These mills can be adjusted to produce either coarse product of about 8 mesh size or fine product down to 325 mesh size. These mills can be provided with a hot inlet gas stream to simultaneously remove moisture from wet material. The overall performance of the mill is improved by the simultaneous drying operation.

The inlet heating gas temperature is limited to 600-700°F maximum. The temperature limitations are imposed by the effect on the lubrication systems which are exposed to the temperature of the outlet gas stream leaving the mill. The higher temperature can be used when a high moisture content coal is fed to the mill. With lower inlet moisture content feeds, the gas inlet temperature must be reduced.

The mills are normally equipped with internal size classifiers for recycle of oversize product to the grinding chamber. The classifiers may either be mechanical rotating type or fixed cyclone type.

The capacities of the present mills in coal service ranges from 1/4 to 100 tons per hour. The power requirements of the mills range from 2 to 1200 horsepower. The energy consumption varies from 8 to 50 HP-HRS per ton of material.

The major problem with these mills is the excessive generation of minus 325 mesh fines. The generation of fines in these mills varies according to the required product particle size distribution. As an example, it will be between 30 and 50 percent fines for a product size of 100 percent passing 100 mesh.

At present large coal pulverizers have a capacity of 60 to 100 tons per hour. About one-half this rate is possible on lignite primarily because of its high initial moisture content. This high moisture content causes a greatly increased duty on the gas circulation system and in the mill to vaporize the water.

Babcock & Wilcox stated their 62 TPH mill is the largest presently operating on coal, primarily because of customer requirements. They are presently using this pulverizer on most of the large utility coal-fired boilers. For future higher capacity boilers and because of deteriorating coal quality, they will be using a large capacity pulverizer with a capacity of 106 TPH. There are much larger pulverizers presently operating, grinding cement raw material, primarily limestone.

The largest of these mills presently operating would have a capacity of roughly 150 TPH of coal. Larger mills are currently being designed and constructed for limestone application which would have a capacity on coal of roughly 250 TPH.

C-E Raymond Combustion Engineering has designed a ring-roller mill system with a capacity of 250 TPH. They have not as yet used it commercially on coal.

The amount of moisture in the feed coal has a marked effect on the performance of the equipment. High moisture content reduces the mill capacity.

The moisture content of bituminous coals must be reduced from an initial 10-15 percent to 1-2 percent in the produce. For lignite, the moisture reduction is from an initial 35-50 percent to a final 2-3 percent. There is a practical limit to the amount of moisture that can be removed from the coal within the mill. Most mills can accept the bituminous coals with an initial moisture content of 10-15 percent. Bowl mills are capable of handling a feed with a moisture content of up to 30 percent and reducing a low moisture content.

Air with reduced oxygen content is commonly used in closed circuit dry systems. This air serves as a conveying medium for transporting coal from the grinding zone to the classifiers. The air also serves as the heating medium for moisture removal from the coal or lignite.

The heated air entering a mill is limited to a maximum temperature of about 700°F because of mechanical considerations. The air leaving the mill must be maintained at 180 to 190°F to prevent condensation. Roughly one pound of air will evaporate 0.1 pound of water from the coal under these conditions - or every 10 percent moisture in the coal will require an additional pound of air per pound of coal. Many air classifiers are designed by the vendors on the basis that for every pound of solids discharged from the mill, one pound of air must be provided for conveying the solids to the calssifier. This value will, of course, depend upon the particle sizes of the coal being conveyed.

For lignite containing high moisture (up to 50 percent), it will be necessary to provide auxiliary drying facilities outside of the mill. This may be done either by predrying the lignite down or 10 to 15 percent before the mill or by providing flash drying equipment in the air stream leaving the mill.

When provided with sufficient heated air to maintain a mill outlet temperature above 150°F, these mills will handle very wet coal but with small reduction in capacity.

The coal should be crushed to a size that can be supplied to the mill by the feeder at a uniform rate. Most mills with a capacity above 20-25 TPH can handle about 3 in. x 0 in. coal. Smaller mills may require the coal crushing to 1-1/4 in. x 0 in.

Mill construction should permit the use of high-temperature incoming air in sufficient volume to maintain a condition of relative humidity below saturation at mill outlet temperature. For direct-fired mills, the range of mill outlet temperature is most frequently between 150°F and 180°F. In a storage system the mill outlet temperatures are maintained at from 110°F to 130°F. It is this mill outlet temperature that imposes the maximum limit on the inlet air temperature. Storage-bin fires, caused by spontaneous combustion will result from improper mill temperature control. These may be inhibited by maintaining an atmosphere of flue gas in the bin.

2.2 PULVERIZATION AND DRYING SYSTEM FOR PGW PLANT

The PGW coal gasification plant producing the equivalent of 20×10^9 Btu/day medium-Btu gas will require about 1000 to 1200 TPD of as received bituminous feed coal. This raw coal will be received at the plant site in 2 x 0 inch size. The moisture content of the coal will be less than 10 percent. The HGI will be 55-65. The raw coal must be pulverized and dried to meet the K-T gasifier feed conditions of 90 percent through 200 mesh and 1-2 percent moisture content.

The flow diagram of the coal pulverization and drying system is shown in Figure 2.1. The gasification plant consists of two gasifier trains and hence two separate coal pulverization and drying systems will be required. A third train may be required for obtaining a high reliability and on-stream factor for the whole plant. Part of the product gas from the gasification plant will be combusted in the heater to provide hot gases.

Based on the above information, the following companies were contacted to obtain the technical and cost information of their mill systems:

1. Williams Patent Crusher and Pulverizer Co.
2. C-E Raymond Combustion Engineering, Inc.
3. Babcock and Wilcox Co.
4. Fuller Co.

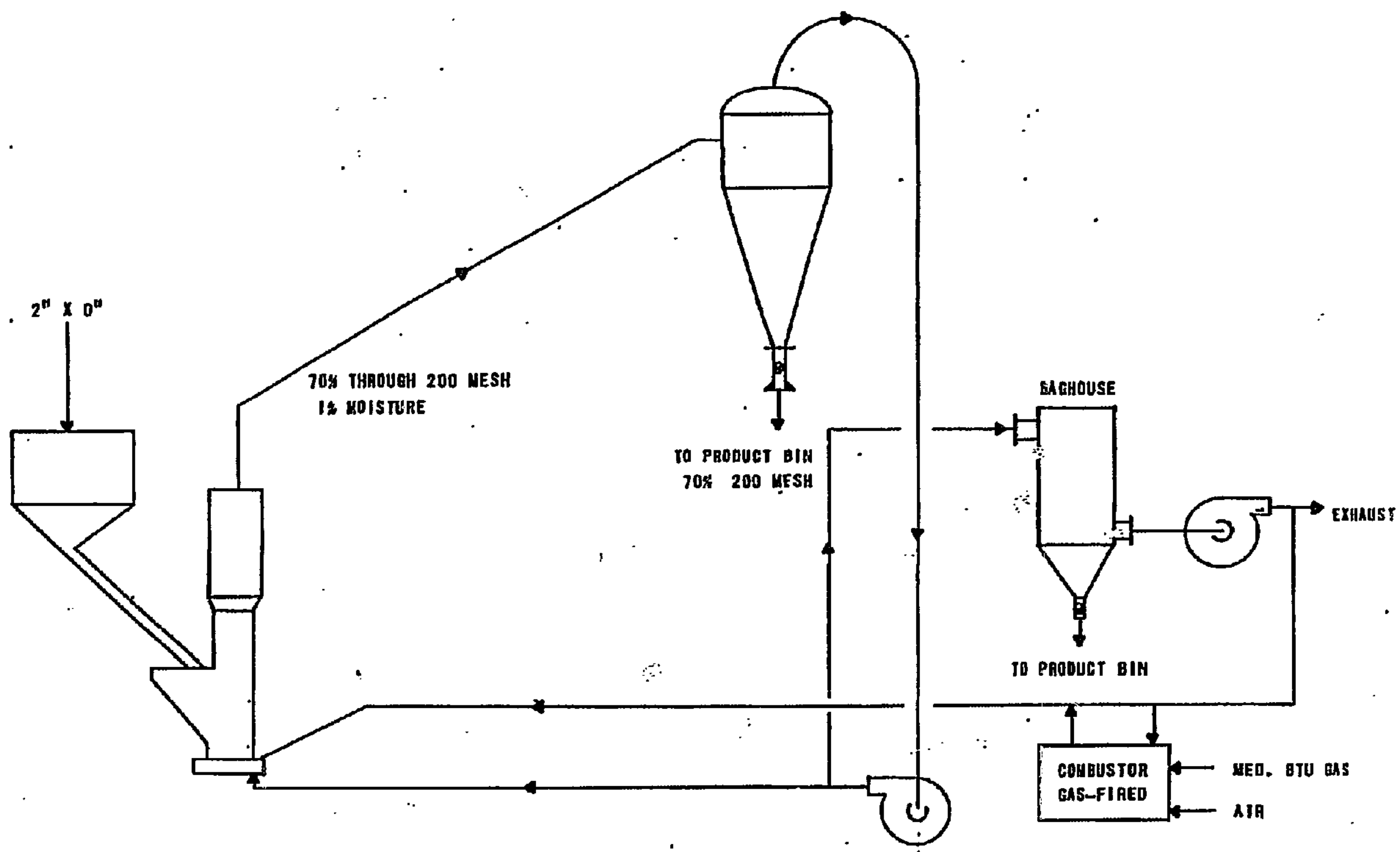

FIGURE 2.1
COAL PULVERIZER. SYSTEM

SECTION 3

PNEUMATIC CONVEYING

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PNEUMATIC CONVEYING

3.1 INTRODUCTION

Coal from the pulverization and drying section will be collected in product bins. This coal has to be conveyed to the gasifier service bins of the gasification plant. The pipeline and the equipment required to introduce air (or nitrogen) and material into it, and to receive and separate air and material at its terminus, comprise a pneumatic system.

Two types of systems are considered: (1) systems in which material enters a stream of air under positive pressure (material-into-air-stream pressure-system). (2) systems in which air and material are intermixed simultaneously at the entrance of the conveying line (air-mixing systems). These systems resemble the first type, in which material enters an air stream, except that air and material are intimately intermixed in a special type of feeder at the entrance to the conveying line, resulting in a denser stream of material than is otherwise possible to obtain.

3.2 POSITIVE-PRESSURE SYSTEM (MATERIAL-INTO-AIR SYSTEM)

The pressure range of this system is limited by the available pressure ranges for the high-volume, positive-displacement blowers required for this type of coveying. Blower pressures are limited to a maximum of about 15 psig.

In this system a high velocity air stream is established in the conveying line by the air discharged from a positive-displacement or centrifugal blower through an injector fitting (Figure 3.1). Material is withdrawn from a storage vessel by gravity or mechanical conveyors and is delivered to a rotary airlock feeder. The feeder then discharges the material into the air stream, which transports it through a pipeline to a vented receiver. Discharge

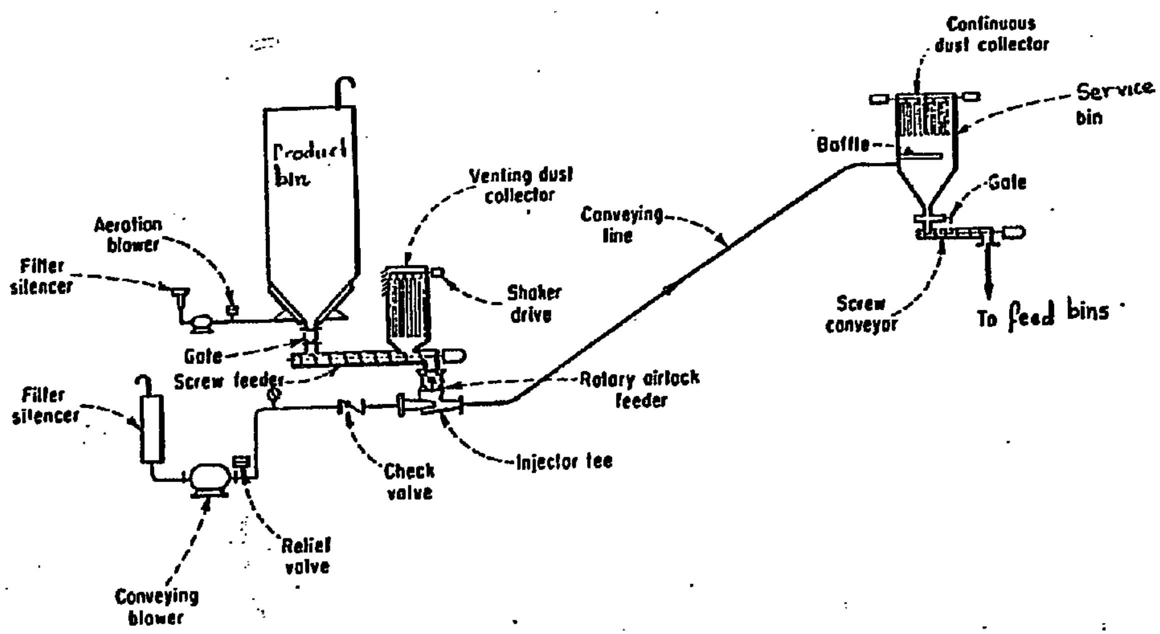

FIGURE 3.1 POSITIVE-PRESSURE, MATERIAL-INTO-AIR SYSTEM

into several receivers is done, one at a time, by operating a diverter valve located at each receiver to shunt the flow from a main piping header into a selected receiver.

The receivers on pressure systems are generally bins with vent connections to atmosphere or to ordinary single or multicompartment dust filters, depending on material characteristics. In some installations, the dust filters may be mounted on the receiving bin, forming its top, so that the filter dust may be discharged directly back into the bin.

In some systems, the injector fitting is eliminated and the air stream can receive material from any one of several storage bins, each of which is fitted with a rotary airlock feeder.

Dust filters are required at two points on a pressure conveying system: First, at or near the airlock feeder that discharges the material into the conveying air stream. This relieves pressure buildup at that point by venting the air leaking back into the material-feeding system from the air-conveying line. And second, at the receivers, so as to prevent buildup of pressure and possible discharge of dust into the surrounding process area, by venting the conveying air directly to atmosphere. Venting may not be required on airlock feeders installed directly below bins on installations where the bins are kept under dry air pressure to prevent internal condensation.

The positive-pressure system is generally applied when material must be delivered to a number of widely separated receivers located at a considerable distance from the source of supply. Where a series of storage bins are supplied with material and the bins must be kept under positive pressure at all times, the vent piping may be manifolded and connected to a single dust filter from which air is exhausted continuously. A blower manifolded into the filling lines at a hose selector station maintains pressure on the bins continuously. Dust collected by the dust filter is discharged into the filling line through an airlock feeder when the line is in operation.

The positive-pressure system has the inherent defect, common to all material-into-air-stream systems, of absorbing a considerable amount of power for moving air. In fact, the power required to supply air to the system far exceeds the power required to move the material to its destination mechanically. In mamy cases, the air lost by leakage of air through the airlock feeders may amount to 20 percent of the air supplied, if maintenance of the feeder is neglected.

3.3 AIR-MIXING SYSTEM

Systems in which air and material are intermixed in a special feeder are, in effect, positive-pressure systems. They operate at relatively high pressure and low air-to-material ratios. From the discharge point of the feeder onward, they resemble the positive-pressure systems described above, except that pipelines are smaller and dust-filter size requirements are reduced.

Two types of special feeders are in common use. One employs a special rotary feeder that receives material directly from a shallow surge hopper fed by a mechanical or air-activated conveying system (Figures 3.2 and 3.3). Air is supplied to the end covers of the feeder from a high-pressure blower and enters each side of a rotary feeder pocket just after the filled pocket passes beyond the material inlet from the supply hopper. At the entrance to the conveying line, the dense, high-pressure mixture is blown out and through the conveying system. Residual air in the feeder pocket is vented off into the surge hopper by a pre-vent connection on the feeder so that the empty pocket is ready to receive another charge of material. This type of feeder is very sensitive to the head of material in the surge hopper. Too high a head of material prevents effective venting; consequently, conveying may cease completely.

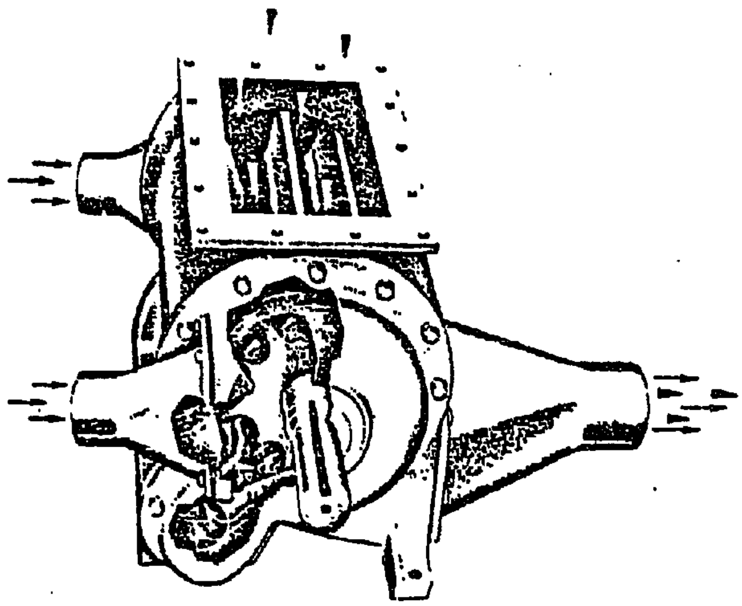

FIGURE 3.2 INTERIOR VIEW OF AIR-SWEPT DOUBLE ENTRY FEEDER VALVE (CEA-CARTER-DAY COMPANY)

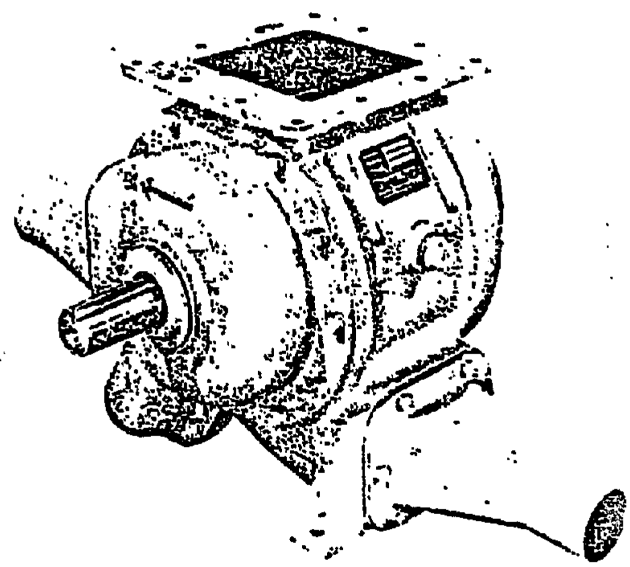

FIGURE 3.3 EXTERNAL VIEW OF AIR-SWEPT DOUBLE ENTRY FEEDER VALVE (CEA-CARTER-DAY COMPANY)

The other type of special feeder (Figures 3.4 and 3.5) uses an impeller screw with gradually decreasing pitch which receives material from a hopper supplied by gravity, or by a mechanical or air-activated conveying system. This "choke" screw compacts the material as it is forced through a barrel housing and check valve into a mixing chamber. The mixing chamber is fitted with several nozzles that are supplied with high-pressure air from a sliding-vane or centrifugal compressor, and directed toward the entrance to the conveying pipeline. The entering material drops directly into the stream of air and is conveyed through the line. This impeller screw is supported in an overhung position by a pair of external bearings; it therefore requires a balancing chamber and weights at its discharge end in order to reduce vibration caused by wear.

A more recent design of impeller screw is supported by bearings at both ends which virtually eliminates vibration and, hence, screw dmamage when operating under no load or light load. The discharge of the screw is at right angles to the shaft axis and compression is effected by reverse pitch flights opposing the impeller flights. The discharged material enters the same type of mixing chamber as in the overhung shaft design. See Figure 3.6.

Air-mixing systems are limited to conveying pulverized and powdered materials, due to the high material-to-air ratios used and their dependence upon the fluidity of aerated material for successful conveying. These systems are used for conveying semi-abrasive material relatively long distances both with a minimum of air and in a dense mixture that tends to reduce pipeline wear. The low air-to-material ratio used makes this type of system useful for handling material that must be kept sanitary and free from airborne spores.

In the impeller-screw type of feeder, pulverized materials are required in order to develop a compression seal at the discharge end. This prevents blow-back from the pressure zone.

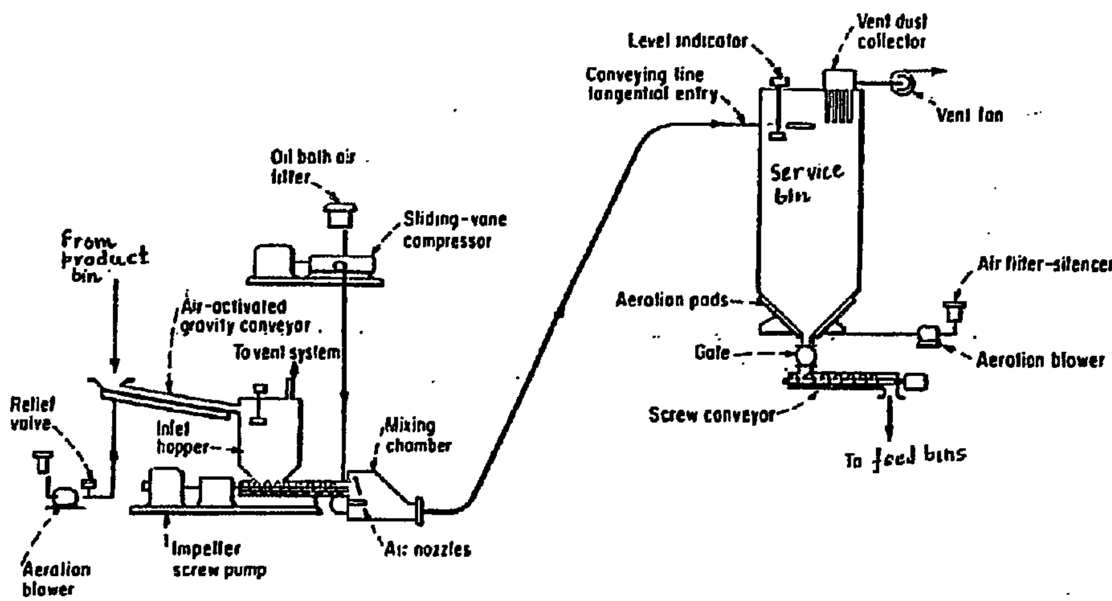

FIGURE 3.4 AIR-MIXING SYSTEM

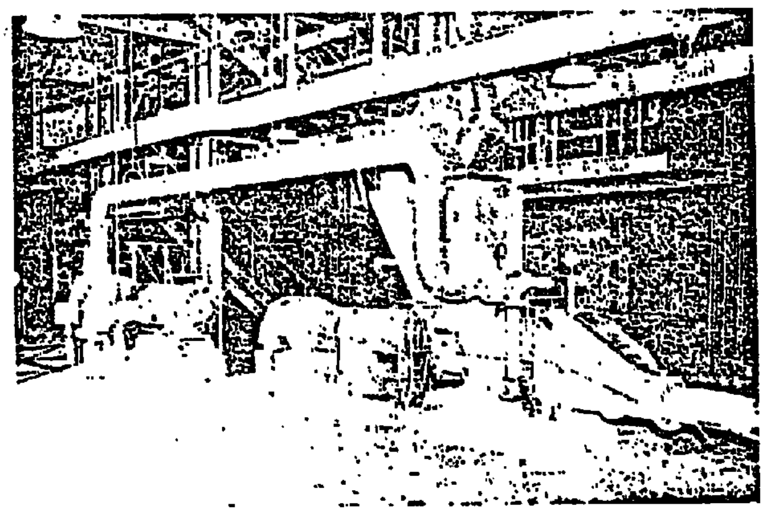

FIGURE 3.5 FULLER-KINYON AIRMIXING SYSTEM.
(FULLER COMPANY/GATX)

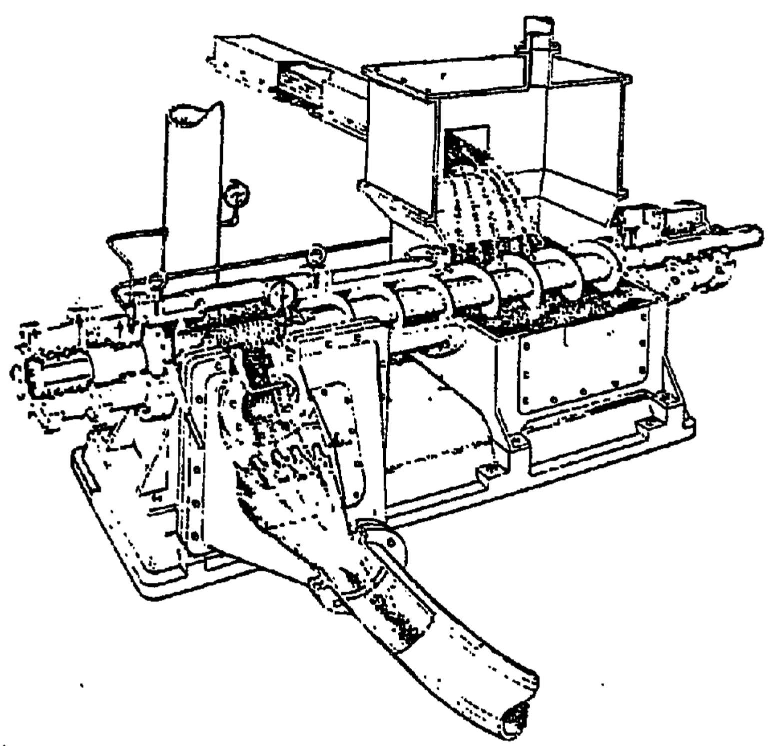

FIGURE 3.6 MODERN TYPE "M" DESIGN OF AIRMIXING SYSTEM. (FULLER COMPANY/GATX)

The maximum operating pressure on air-mxiing systems using the special rotary airlock feeder is 15 psig. This limit is determined by the pressure ranges of available low-volume positive-displacement blowers when they are compounded, that is, used in series to boost the pressure. Systems using the impeller screw feeder may operate at pressures up to 40 psig. Compressor pressure during operation is normally 4 to 6 psig above line pressure. This difference is the pressure drop across the air injection nozzles located in the mixing chamber at the discharge end of the impeller.

The air-mixing systems are essentially pressure systems and can deliver material to any one of several discharge points through diverter gates. However, since material and air are mixed at only one point, the feeder's versatility is limited. All material must be supplied to the pump hopper by gravity, or, from a remote area, by an auxiliary system of mechanical or air-activated gravity conveyors.

The rotary airlock feeder type of system loses a considerable amount of air through the feeder due to the high pressures used for conveying. However, the high conveying rates obtainable more than compensates for this power loss.

The impeller screw type of system absorbs a variable amount of power in the air compressor depending upon the conveying line loading. The line loading, in turn, affects the conveying line pressure. The impeller screw absorbs power due to the compression of material as it is forced through the seal against the conveying line pressure. When no material enters the screw, the power is low. When highly aerated material enters the screw, it can seriously reduce the efficiency of the impeller screw pickup. Power is also reduced and the material may not even enter the conveying line.

3.4 FLOW CHARACTERISTICS OF COAL

The properties and characteristics of materials play an important role in designing a pneumatic conveying system. The properties of pulverized coal is shown below:

- o Bulk Density, lb/ft^3:

Loose	29
Settled	39
Work	31

The settled bulk density is useful for determining power and air requirements and loose density for estimating bin and hopper volumes and feeder capacities.

- o Particle Size: 90 percent through 200 mesh

  Particle size is used to determine dust collection requirements, feeder clearances, and minimum conveying velocity. A complete sieve analysis will be required for detail design.

- o Moisture Content: 1 percent

  The reliable and continuous operation of the pneumatic conveying system depends on keeping the coal as dry as possible during conveying. Nitrogen used for conveying should be free of moisture to prevent any absorption by coal and thereby plugging the line.

- o Aeration and Deaeration characteristics: Highly fluidizable

  These characteristics are useful in selecting type of level indicator in bins and designing the service and feed bins of the gasifier.

3.5 PROCESS DESIGN

The design of the conveying system is based on conveying 50 TPH coal. The coal can be conveyed in two lines each having a 25 TPH capacity, or in one large line having the full capacity of 50 TPH. The conveying distance from the product bin to the gasifier service bin is about 185 ft (125 ft horizontal and 60 ft vertical). Conveying velocity depends on the bulk density and particle size of the coal. The velocity assumed for estimation purposes is 5520 fpm (92 fps).

The conveying system is designed basically to determine the energy requirements based on the pressure drop across the system.

Summation of the following five factors, in consistent units, gives the pressure drop across the system:

1. Acceleration energy needed to overcome inertia of the solids, and get them into motion.

2. Energy required to elevate the solids.

3. Energy required to sustain solid materials in the fluid stream, and overcome the material's friction in the conveying duct.

4. Energy losses associated with changes of direction at bends and elbows.

5. Fluid losses in the duct, and at the terminals of the system. These are made up of pressure loss at the system's entrance, friction loss of the pure air stream in the duct work, pressure drop across the collector or separator at the end of system, and losses from any auxiliary units which may be incorporated into the system. Fluid head and kinetic energy terms are generally neglected, unless the system is characterized by unusually large vertical lifts or fluid velocities.

Table 3.1 shows the analysis of 25 TPH and 50 TPH conveying systems.

TABLE 3.1

COAL CONVEYING SYSTEM DESIGN PARAMETERS

System Capacity, TPH	Material/Air Ratio (wt)	Air Required SCF/HR	Pipe Size, & Inches	Line Pressure PSI
25	5	130,000	8.5	6.3
	10	65,000	4.25	12.0
50	5	260,000	17.0	6.3
	10	130,000	8.5	12.0

A positive-displacement blower will be required for each system. This blower could be included in the air-separation plant which provides the nitrogen for pneumatic conveying.

3.6 RECOMMENDATIONS

- Obtain actual property values of the selected pulverized coal.
- Determine the exact conveying distance from the equipment layout.
- Obtain vendor recommendations on reliability, flexibility and economics of two conveying systems (each 25 TPH) versus one system (50 TPH).