Complete Refurbishment Of An Existing Hazardous Waste Incinerator In Eastern Germany On a Turn-Key Contract Basis

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INTRODUCTION

The area around Leipzig and Halle in eastern Germany attracted the chemical industry already in the 1920's. The abundance of lignite that could be easily mined in open pits served as an ideal source of inexpensive energy and raw materials supply.

Before the second world war the area hosted some of the largest chemical production facilities in the world. In 1990, shortly after the reunification of Germany, most of that pre-war structure was still in operation and largely unchanged.

During privatization, a large complex was formed to become the Buna-SOW-Leuna-Olefin Verbund (BSL) which is being taken over by Dow Chemical. Part of the BSL-structure is the Saxonian olefin production facility in Böhlen near Leipzig. The site originally covered 5.8 square kilometers including a 4 x 200 MW lignite fired power plant. Due to the fact that each chemical production facility generates various environmentally harmful residues, a combustion plant was built in 1974 and commissioned in 1977. The Rückstandsverbrennungsanlage RVA Böhlen (= residue combustion plant Böhlen) was nestled in the center of the chemical complex. Today after major restructuring of the complex, it is located directly adjacent to the new 2 x 930 MW_{el} lignite fired power plant Lippendorf, which is currently under construction.

The RVA Böhlen, as commissioned in 1977, was finally shut down at the end of March 1997. Figure 1 shows the old facility. It consisted of various storage tanks for aqueous and halogenic liquid wastes, an open pit bunker for solid hazardous wastes, a counter current fired rotary kiln, a horizontal secondary combustion chamber (SCC), a low pressure steam waste heat boiler, a multi cyclone fly ash separator, an I.D. fan, and a 90 m brick stack.

Due to insufficient throughput capacity, totally outdated technology and wear and tear of 20 years of operation, it was decided that everything except the bunker and the stack has to be replaced. The new plant, as shown in Figure 2, consists of the existing but refurbished open pit bunker, a refurbished crane for solid hazardous waste, the new feed system, a new cocurrent fired rotary kiln, a new vertical SCC, a new waste heat boiler, a new 7-stage APC-train, a new tank storage facility and various other new balance of plant (BOP) equipment such as weighing station, container storage, and I + C system etc.

In 1992, when the RVA Böhlen was privatized, the grace period given by the Reunification Contract was 4 years and ended on December 1st, 1996. On that day, the old facility was destined to be shut down unless it would fulfill the requirements of the German 17th BImSchV[1] in all respects. A complex planning and bidding process for a total overhaul of the plant was started. Various concepts were developed and scraped again.

Finally in April 1995, way too late to meet the December 1996 deadline, the turn-key contract for the complete refurbishment of the existing hazardous waste incinerator was awarded to the L. & C. Steinmüller GmbH (LCS), Gummersbach. In the meantime some minor but badly needed improvements were made.

The new storage tank B7 for high calorific liquid hazardous waste was installed, the office building was refurbished completely and some infrastructure repairs were carried out. The permitting procedure for the new facility had also been started. After contract award in April 1995, the first priority was to obtain a permit for the construction of the new facility as quickly as possible. These efforts came to an abrupt halt when the owner decided to abandon all plans and sell the plant. In October 1995 the plant was purchased by its current owner, the Broerius Abfallwirtschaft Sachsen GmbH (BAS).

SCHEDULING

In October 1995, after takeover of the plant by its new owner, time was the biggest problem in three ways:

1. The plant had been shut down by the local permitting agency, the RP Leipzig, because it was evident that the plant could not be brought into compliance with the requirements of the 17. BImSchV by the imposed deadline of December 1st, 1996.

2. The downtime of the plant was the most critical economical factor for the new owner due to the fact that each day out of operation generated cost but no revenue.

3. With the market for hazardous waste to be incinerated being highly competitive, each day away from the market due to downtime of the plant meant that customers would find alternative ways of disposing of their hazardous waste.

Fortunately intense political interest in keeping the only hazardous waste incinerator in the state of Saxony in operation led to a deal between the new owner and the permitting agency, which accommodated the interests of both parties to the most possible extent.

The terms[2] agreed upon in late 1995 can be summarized as:

1. The plant can go back on line immediately after it is upgraded with an ESP, thus reducing the emissions of particulate matter to below 30 mg/Nm^3.

2. The plant will be operated only with a restricted input menu (no halogenated waste, no heavy metals in the waste)

3. The plant will be ultimately shut down by March 31st, 1997

4. The plant will be upgraded with state-of-the-art equipment by September 30th, 1997, leading to emission limits fixed in the permit[3] in the range of 5 to 10 times below the values required in the 17th BImSchV for acid gases and heavy metals. Table 1 summarizes the emission limits imposed through the permit.

4. The owner will demonstrate the seriousness of the plan to complete refurbishment of the plant by submitting the permitting documents by December 31st, 1995 and by starting construction on site by mid 1996.

Based on that, a new contract was negotiated between BAS and LCS. The milestones of that contract in terms of keeping the tight schedule imposed by the permitting agency were:

December 4, 1995:	-	submittal of the permitting documents for the ESP-retrofit
December 9, 1995:	-	start of construction for the ESP-retrofit (based on a special interim permit)
December 31, 1995:	-	submittal of the main permitting documents for the complete refurbishment of the plant
March 15, 1996:	-	start-up and commissioning of the old plant with the new ESP
	-	submittal of the remaining documents to accompany the permitting process
March 31, 1996:	-	start of commercial operation of the old plant upgraded with the new ESP
June 1, 1996:	-	start of construction of the new APC-plant
August 1, 1996:	-	start of erection of the new APC-plant
October 15, 1996:	-	start of construction of the new SCC, waste heat boiler, and tank storage facility
December 15, 1996:	-	start of erection of the new SCC, waste heat boiler, and tank storage facility
March 31, 1997:	-	decommissioning and clean up of the old plant
April 14, 1997:	-	start of demolition of the old plant and start of construction of the new rotary kiln and remaining BOP-equipment (new feed system, feed water storage tank, etc.)
May 13, 1997:	-	start of erection of the new rotary kiln and remaining BOP-equipment
July 1, 1997:	-	start-up and commissioning of the new APC-plant
July 14, 1997:	-	start-up and commissioning of the new rotary kiln, SCC, waste heat boiler, tank storage facility, and remaining BOP-equipment

October 1, 1997: - burning of the first hazardous waste

November 11, 1997: - start of the trial run

December 19, 1997: - preliminary acceptance and take over the plant by BAS

This extremely tight schedule, allowing only 3 months between the end of operations of the old plant and start-up of the new plant, required thorough planning of each individual step in order to identify the critical path.

GENERAL AND INFRASTRUCTURAL CONSIDERATIONS

Whereas the APC-plant and the tank storage facility could be erected adjacent to the old plant on an open site, the major part of the BOP-equipment, the SCC, the waste heat boiler and especially critical, the rotary kiln had to be placed into the existing plant.

The new plant, as can be seen in Figure 3, has a layout similar to the old one. This was mandatory due to the fact that the open pit bunker with the crane feeding solid hazardous waste could not be relocated. Another fix point besides that building was the existing steel structure to support the pipe connections to the existing infrastructure of the adjacent industrial /power generating complex. This pipe support structure Q2 is the umbilical cord of the entire hazardous waste incinerator. Since the plant itself does not generate electricity, but exports steam, the pipe support structure is crucial to the plant's concept. The following media are supplied to and exported from the hazardous waste incinerator via Q2:

- Low pressure steam (4.8 bar, 250°C) is exported into the low pressure steam district heating system of the BSL (after 2001 the low pressure steam will be used in the newly erected lignite fired power plant for the primary air heaters).
- Boiler feed water is imported from the BSL net (later from the power plant)
- Pressurized air is imported from the BSL net
- Nitrogen gas is imported from the BSL net
- Water is supplied through the BSL net
- Sewage is discharged into the BSL sewage treatment plant

The technological and economical concept of the plant is based on utilizing the existing infrastructure of the surrounding industry. Thus the plant can not be viewed as an independent operation.

The most important connection is the feed water import / steam export loop. The new steam generator is designed to supply approximately 15 t/h of steam @ 25 bar, 270°C (363 psi, 518°F). Since the plant does not generate any electricity, the entire electrical consumption must be purchased through the public grid at a cost of about 0.23 DM/Kwh (15 cents/Kwh). Therefore it is mandatory to reduce electric power consumption to the absolute minimum. In the new plant, the I.D. fan as one of the main consumers will not be driven by an electric motor, but by a steam turbine.

The turbine will be fed with high pressure steam directly from the boiler (25 bar, 270˚C) and will discharge low pressure steam (4.8 bar, 250˚C) into the BSL net. Various other consumers of high and low pressure steam within the plant are also connected as shown in Figure 4.

PHASE I - THE NEW ESP

In October 1995, the most important task was to bring the old plant back online as soon as possible. Under the settlement with the permitting agency, operation could be resumed only after the retrofit of an ESP.

However, the ESP had to be erected in such a way that:

- It must be easily incorporated into the layout of the entire refurbishment
- It must not interfere with erection of the new APC-plant or the new SCC and waste heat boiler
- it must directly connect to the new waste heat boiler on one side and to the APC plant on the other side without extensive duct work.

In order to balance these criteria, the general arrangement of the new plant had to be laid out. Figure 5 shows how the new ESP was fitted to the old plant. Several changes had to be made to accommodate the new ESP without violating the criteria outlined above. First the flue gas inlet at the old brick stack had to be rotated 90˚ clockwise to the south. This was necessary for two reasons. First, the original flue gas duct and inlet at the stack was in the way of the new waste heat boiler. Second, the final flue gas duct had to be installed in order to accommodate the continuous emission monitoring system (CEMS) required during operation. Therefore, the new ESP was located bridging the roadway between the existing old plant and the location for the new APC-plant. The new waste heat boiler had to be tailored into the remaining space between the stack, the new ESP, and the existing old I.D. fan. To allow for maximum possible space the old I.D. fan was rotated 180˚ and the interims duct work from the old boiler / multi-cyclone outlet was detoured in a wide angle to the inlet of the new ESP. As can be seen on Figure 5 the inlet duct to as well as the outlet from the new ESP, and the inlet to the new flue gas duct to the stack past the CEMS were kept clear for the connection of the new waste heat boiler and the new APC plant respectively. On the side connecting to the new APC plant this was realized by utilizing what was meant to become the bypass duct of the APC plant after the complete refurbishment.

The extremely short period of time between beginning of construction on December 9th, 1995 and beginning of start-up and commissioning on March 15th, 1996 could only be realized taking into account the fact that the chosen ESP size and design was already in operation elsewhere, so that the engineering time could be reduced to an absolute minimum.

PHASE II - THE NEW APC-PLANT

The design of the APC-plant was governed mainly by the extremely low emission limits imposed on the plant by the permitting agency combined with the legal requirements of a waste water free zero discharge plant and the necessity to recycle the maximum possible amount of residues. Considering these factors a state-of-the art 7-stage APC-train was planned.

It consists of the ESP followed by Steinmüller's patented Sodium Tetrasulfide injection system for the removal of mercury, especially elemental mercury. As detailed in Figure 6, the next stage is a spray dryer and a baghouse to collect the dried neutral salts from the first scrubber. After the baghouse, a two stage wet scrubber for the removal of HCl and HF is installed. The effluent from this first scrubber is neutralized externally with slaked quick lime followed by a flocculation and precipitation process to complex the heavy metals. The generated liquor consists mostly of Calcium Chloride ($CaCl_2$), Calcium Fluoride (CaF) and complexed heavy metals. The dissolved salts and the complexed heavy metals are dried in the spray dryer and removed from the flue gas stream in the baghouse. The residual mixture is combined with the fly ash from the ESP and disposed of in an underground landfill. These underground landfills commonly represent former salt mines, where the formed caverns need to be refilled for structural support. This way of disposal is currently considered recycling in some cases, such as this one.

The next stage is a second wet scrubber for the removal of SO_2. Slaked quick lime is used as a scrubbing liquor in order to form marketable gypsum. The flue gas polishing is done by the Steinmüller patented activated carbon reactor (ACR) followed by a low temperature SCR-DeNO$_x$-reactor (LTSCR).

In order to enter the ACR, the flue gas leaving the scrubber must be reheated from its saturation temperature of approximately 65˚C (150˚F) to about 130˚C (265˚F). This is achieved in the first stage by a steam reheater for the primary drying of the flue gas followed by a cross-flow heat exchanger.

After the ACR, NH_3 is injected into the flue gas for the LTSCR-process[4]. The temperature of the LTSCR is set at 170˚C (340˚F). Heating the flue gas from the ACR-temperature of 130˚C (265˚F) to 170˚C (340˚F) is done in a first step by the I.D. fan. It supplies about 10 - 13 K to the flue gas due to the pressure drop of approximately 130 mbar (1.88 psi) across the entire flue gas path. The second step is overcome by another steam reheater for the final adjustment of the flue gas to the LTSCR temperature.

The flue gas leaving the LTSCR is discharged through the cross-flow heat exchanger prior to the ACR and then past the CEMS into the stack. As shown in Figure 7, the APC-plant is set up in a very compact open steel structure. Only the spray dryer, the baghouse and the ACR have a penthouse for the weather protection of their critical components.

Adjacent to the APC-train is the pump building, housing all the pumps and vessels handling the two different scrubbing liquors. The main circulation pumps for the wet scrubbers as well as most of the vessels are located on the ground floor. The first floor is occupied by the lime slakers, the gypsum centrifuges, and the neutralization, flocculation and precipitation system for the effluent of the HCl-scrubber. The second floor accommodates the entire low voltage switch gear and electrical equipment for the APC-plant. The storage facility is located on the west side of the APC-plant. Due to the green field advantage, construction and erection of the APC-plant is not further detailed.

PHASE III - THE NEW INCINERATOR

November 15th, 1996 marked the start of Phase III of the project. This must be considered the beginning of the critical path and, therefore, the most important phase within the entire project.

Comparing Figure 5 and Figure 8 gives a rough idea about what it means to start construction and erection of major pieces of equipment such as the SCC or the steam generator literally inside the operating hazardous waste incinerator.

In Phase III, the renewal of the following pieces of equipment are summarized:

1. The bunker crane for feeding solid hazardous waste
2. The feeding system for solid hazardous waste including the feed hopper, the belt conveyor, the drum feeder etc.
3. The primary and secondary air system, including fans etc.
4. The rotary kiln, including burners, cooling systems etc.
5. The SCC, including burners, ash extractors etc.
6. The waste heat boiler including the feed water system, the ash extractors, the steam system etc.
7. Parts of the electrical power supply for the entire plant.

Technologically, none of those components deviate from the well known, well proven, state-of-the-art hazardous waste incineration technology based on the rotary kiln technique. Therefore, the equipment is not further detailed from a technological point view.

The first problem was to clear the space for the steam generator and the SCC. Unfortunately the main power supply lines, as well as some controls, the natural gas lines to the burner of the existing rotary kiln and various other critical media supply pipes had to be cleared before construction could begin. The only time available for that was a scheduled 8 day maintenance outage of the old plant in October 1996. After that hurdle was successfully overcome construction of the large foundation for the boiler and the SCC resumed.

The most critical difficulty for this foundation was first, the slight overlap of it onto the existing foundation of the stack, and second the interference with the existing foundation of the front end of the old rotary kiln. The first difficulty posed a problem because it was absolutely mandatory to avoid inducing any weight onto the foundation of the existing stack in order not to interfere with its statics. The second one forced a gap in the new foundation for the SCC and the boiler, which had to be filled after the existing plant was demolished. After months of detailed planning, endless calculations and numerous different ideas and suggestions on how to solve the two problems, the foundation was finally poured into place touching the existing foundation on all four sides. In early December 1996, the new foundation was in place and by about December 10th the erection of the steel structure supporting the SCC and the waste heat boiler was started and completed before Christmas.

Due to the large weight of the SCC after being refractory lined, its supporting frame had to be adjusted about 10 - 12 cm (4 -5 inches) above the support frame of the boiler. Here the much higher compression of the steel structure had to be compensated for, so that after completion, the inlet of the steam generator and the outlet of the SCC would be leveled.

Just before Christmas the steam generator could have been erected. Due to the Christmas holiday season and a very harsh winter, it was chosen to preassemble the pressure part of the waste heat boiler to a maximum possible extent in our shop in Gummersbach and deliver it in 3 preassembled sections to the site by the end of January 1997. The size of the preassembled sections was determined by the maximum permissible dimensions for the road transport. The pressure part of the boiler was erected in about 5 days on site with a minimum of welding. It was completed with the drum and the connecting pressure pipes by the end of February 1997. The pressure test was delayed until the end of March due to weather conditions and the fact that the supports for the insulation had to be mounted first to avoid any possible leakage by improper mounting.

In early January 1997 the old plant had another scheduled maintenance outage of 10 days. This outage was used to refurbish the existing bunker crane. After a week of 16 hour work days, operation of the old plant was resumed with a refurbished crane.

The next critical milestone was the erection of the SCC, weighing about 42 tons. Due to its size, it was shipped in eight sections from the Steinmüller workshop in Poland and preassembled to three pieces on site. One piece represented the quarter spherical head piece connecting the cylindrical part of the SCC to the waste heat boiler. The second piece was the above mentioned cylindrical part with the third piece being the bottom of the SCC with the inlet housing for the end of the rotary kiln. Since the steel frame supporting the SCC was above the front end of the operating old rotary kiln, this third piece would only be lifted to the inside of the steel structure and rested on the concrete bottom underneath. The remaining two pieces were erected on February 4th, 1997.

Great care had to be taken since the steel structure of the SCC touched the platform on the front end of the operating rotary kiln at various points, and the distance between the new SCC and the burner of the operating rotary kiln underneath is merely 3 feet.

After the erection of the SCC and completion of the steam generator, the time in February and March was mostly spent completing these components, building the new road ways on site and preparing for the decommissioning and the demolition of the old plant. During that time most of the APC-plant was completed, construction of the tank storage facility was finished and the new I + C system was partly installed. On March 17th, 1997 the first life line of the old plant was cut. Due to the facts that the throughput of the refurbished plant is about 60 % higher than of the old plant and there wasn't any kind of APC-equipment before, the electrical consumption of the new plant exceeds by far the capacity of the transformers of the existing plant.

One of the two redundant 6 KV-transformers, each with a capacity of 1.200 Kwh/h was replaced by the first one of the new used 1.600 Kwh/h transformers. This left the plant and the construction site running on only one transformer for about 6 weeks.

In the same week, the new foundations for the new rotary kiln were poured elsewhere on site. These prefabricated concrete blocks were lifted into place about a month later. Pouring the concrete foundations externally at a different location than they ultimately rest saved about 4 weeks in time. The tight schedule after shut down of the plant did not allow for conventional construction by excavating the foundation pit, casting the mold, introducing the steel reinforcement pouring the concrete and letting it harden and dry. In early May, after the old rotary kiln was demolished and the new foundation pits excavated, the precasted new foundation blocks were lifted in place without interrupting the erection process for the new plant.

The old plant was decommissioned and handed over for demolition starting April 14th. Only two days were available to completely dismantle the front end platform of the rotary kiln, remove the burner and the rest of the combustion equipment and take off the front end plate of the rotary kiln. At the same time the refractory lining of the old rotary kiln and the old SCC was broken out. Immediately after that the rotary kiln was disassembled into three sections.

These were lifted out by a large crane. By early May the demolition process of the old plant was almost completed and the new foundations for the new rotary kiln were in place. What had been in operation for 20 years vanished in less than 3 weeks!

The steel structure of the old SCC and the old waste heat boiler was saved to be reused in the new plant. The new 80 m^3 boiler feed water storage tank was rested on the steel frame of the old boiler. The old SCC steel structure serves well in supporting numerous pipelines, the primary air duct, cables, platforms and the new feed belt conveyor.

Parallel to dismantling the old rotary kiln the inlet duct to the ESP had to be removed quickly. It blocked the critical path from the ESP via the existing boiler feed water degasifier to the main building. Since the main building not only contains the control room but also holds the low voltage switch gear and electrical equipment room for the entire plant (except the APC plant) it was very time critical to clear that path as quickly as possible.

Two weeks were available for demolition of the old equipment and erection of pipe and cable support ways between the ESP and the main building. At the beginning of May, the start for laying cables and pipes was made. By early June the plant was fully hooked up electrically and the first function checks were performed.

At the other end of the busy site, the beginning of June marked a very critical time. At the second of June the new rotary kiln was delivered on site and lifted in place by a large caterpillar crane. At this point in time the 250 tons of refractory lining in the new SCC were completely installed. One week later, the new rotary kiln was assembled to the point for the refractory lining to be started. Lining the kiln would take about four weeks until almost the middle of July 1997.

With the rotary kiln, as the last major component in place, the most critical part of the erection of the new plant was completed.

BOP-EQUIPMENT AND COMMISSIONING

Besides the major components mentioned above, numerous other things had to be installed. Fortunately none of them were conflicting with the time critical path.

Among the numerous BOP-equipment was:

- A new entrance gate
- A new weighing station
- New I & C equipment and a new digital control system (DCS)
- A new container storage building
- A refrigerated storage container for medical waste
- A new drum feeder
- A new tank storage facility including 3 unloading stations for tank trucks
- New roadways including lighting and run off collection
- A new control room
- A complete new fire protection system for the entire plant
- A safety platform for securing leaking tank trucks etc.
- Landscaping of sites where old equipment was removed
- Other details and odds and ends which are needed to make the refurbished hazardous waste incinerator fully operational.

In the first half of July 1997, the refurbished plant will be started up and commissioned. Loop checks, function tests and cold test runs will occupy most of July and August. During September 1997, the hot commissioning will start by firing the burners on natural gas, thus drying out the refractory lining, cooking the boiler, and for the first time, producing flue gas.

The first hazardous waste feed is scheduled for early October. After balancing the plant and adjusting all controls to ensure normal operation, a trial run period of six weeks is anticipated from November 7th, 1997 to December 19th, 1997. On that day, the preliminary acceptance and hand over of the new plant to the owner is planned.

CONCLUSION

From starting the project in late October 1995 to hand over in late December 1997, a time of only 26 months will have expired. A 20-year old hazardous waste incinerator will have been completely demolished and rebuilt with a downtime of only 3 months between decommissioning the old plant and commissioning the new plant. Only 6 months from stopping to resuming the incineration of hazardous waste mark a true accomplishment, especially due to the fact that this retrofit is a very complicated one. Constructing and erecting an almost entirely new plant around an existing old one during full operation as in Phase I and II is already a task in itself. But constructing and erecting a new steam generator, SCC, rotary kiln, feed system etc. within an existing hazardous waste incineration plant not only requires exact planning, scheduling and precise execution of the job, but also a lot of enthusiasm, personal motivation and engagement of the engineers in the offices and the erection crew on site. The greatest quest for project management, in order to accomplish that task, is to keep the spirit alive and ensure that the team stays on track. And most important of all, only if the vendor and the customer pursue the same goal together as a team can the goal be reached successfully.

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Table 1. Emission limits imposed by the permit in comparison to the German 17th BImSchV.

Emissions Controlled by a Continuous Emissions Monitorius System (CEMS)

Pollutant	24 Hour Mean		30 min. Mean		Unit
	RVA Böhlen	17. BImSchV	RVA Böhlen	17. BImSchV	
PM	5	10	10	30	mg/m^3
NO_x	70	200	200	400	mg/m^3
HCl	2	10	10	60	mg/m^3
SO_x	5	50	20	200	mg/m^3
HF	0.25	1	1	4	mg/m^3
C_{org}	5	10	10	20	mg/m^3
CO	50	50	100[1]	100[1]	mg/m^3

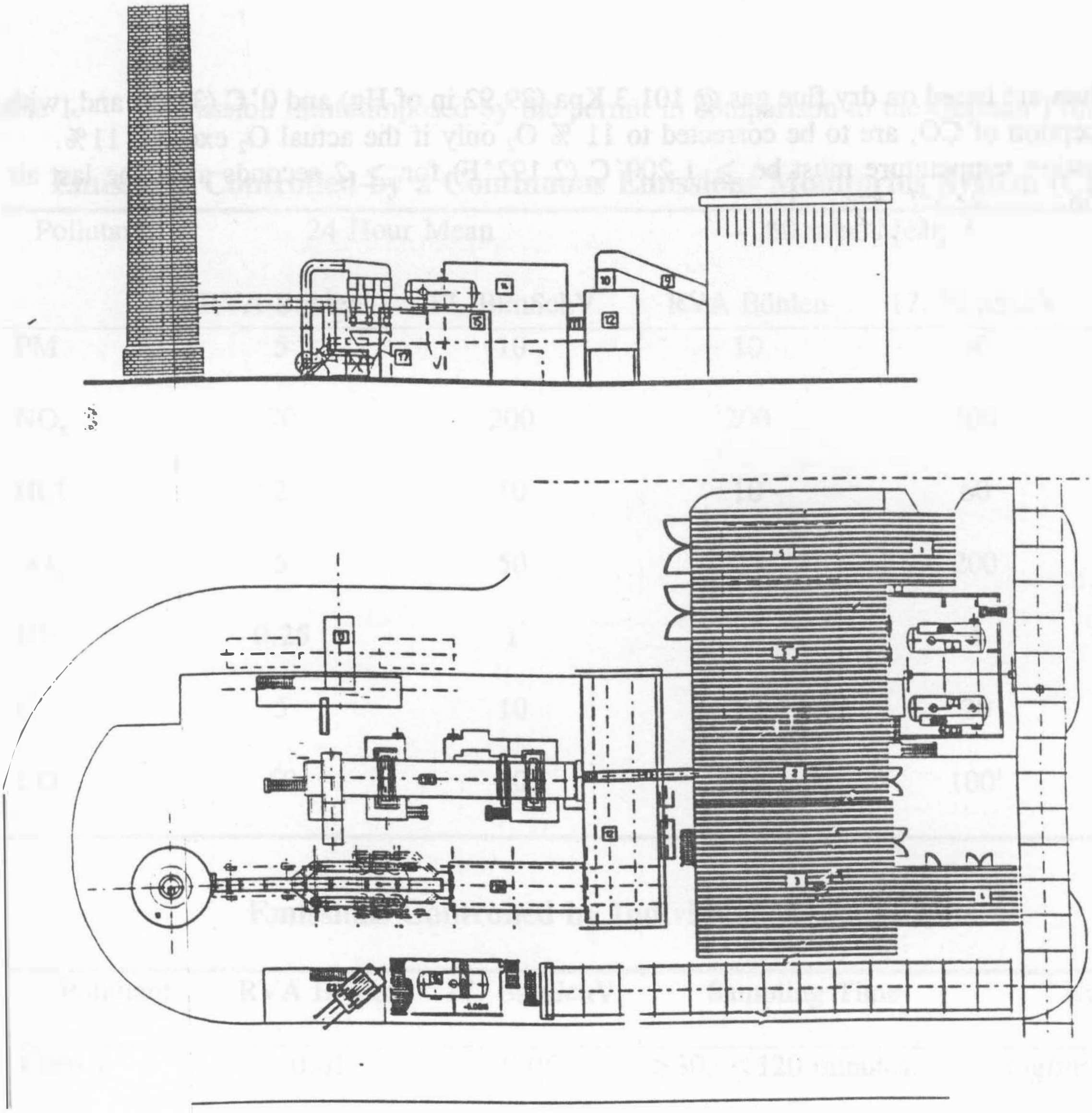
Emissions Controlled by Individual Measurements

Pollutant	RVA Böhlen	17. BImSchV	Sampling Time	Unit
Class I	0.01	0.05	>30, <120 minutes	mg/m^3
Class II	0.01	0.05	>30, <120 minutes	mg/m^3
Class III	0.1	0.5	>30, <120 minutes	mg/m^3
PCDD/F	0.05	0.10	>500, < 960 minutes	ng I-TEQ/m^3
NH_3	5	---	120 minutes	mg/m^3

Class I heavy metals = (Cd + Tl)
Class II heavy metals = total Hg
Class III heavy metals = (Sb + As + Co + Cr + Cu + Mn + Ni + Pb + Sn + V)

[1] = 1 hour mean

- All values are based on dry flue gas @ 101.3 Kpa (29.92 in of Hg) and 0˚C (32˚F) and, with the exception of CO, are to be corrected to 11 % O_2 only if the actual O_2 exceeds 11%.
- Combustion temperature must be $\geq$ 1.200˚C (2.192˚F) for $\geq$ 2 seconds after the last air injection.



1 = primary air fan
2 = waste feed system
3 = control building
4 = maintenance building
5 = waste storage pit
6 = liquid waste storage tank
7 = liquid waste storage tank
9 = waste feed conveyor
10 = waste chute
11 = rotary kiln
12 = secondary combustion chamber
13 = ash handling system
14 = waste heat boiler
15 = feed water degasifier
17 = multi cyclone

Fig. 1. Site Plan of the Old RVA Böhlen

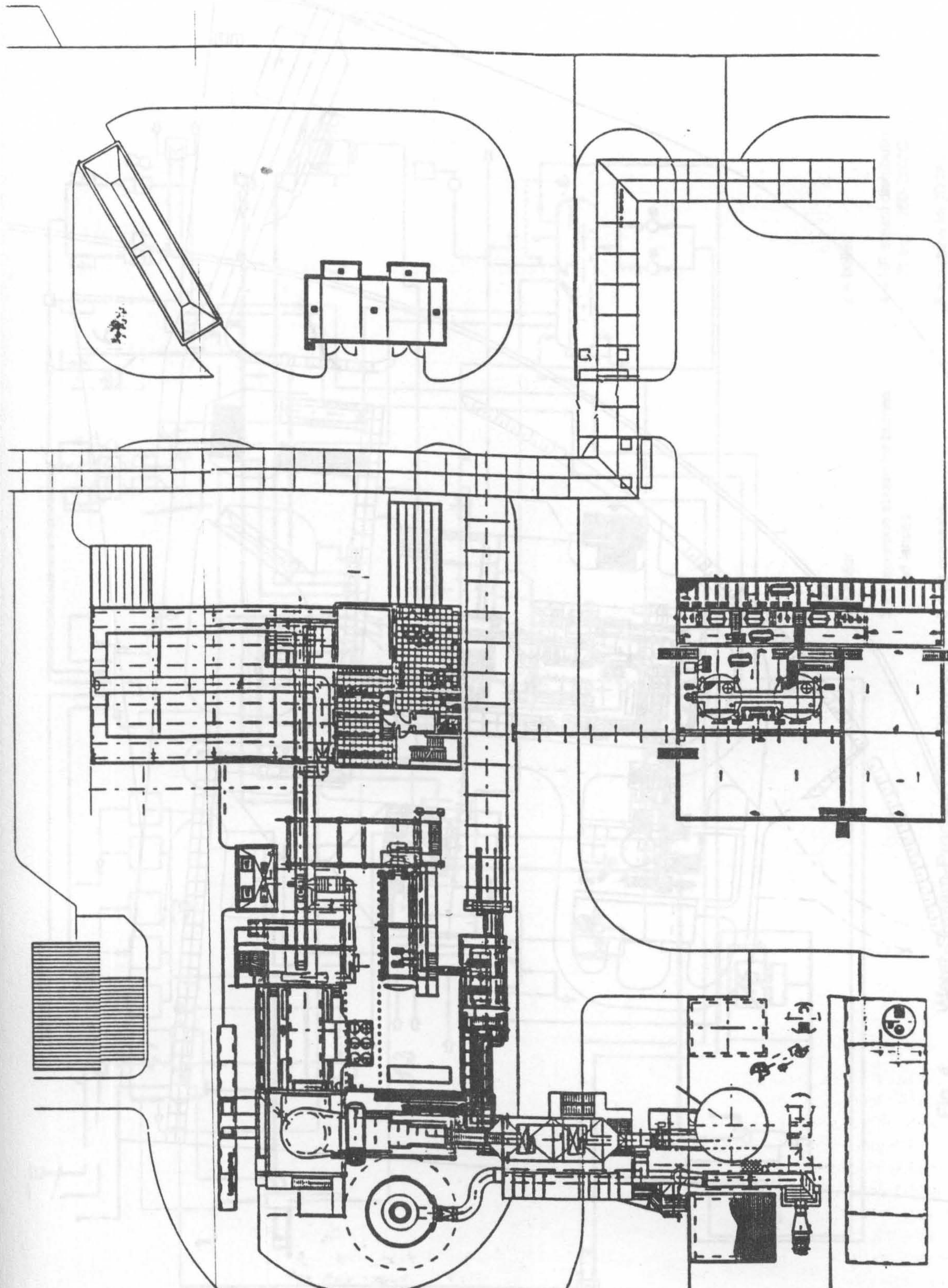


Fig. 2. General Arrangement of the New Hazardous Waste Incineration Plant

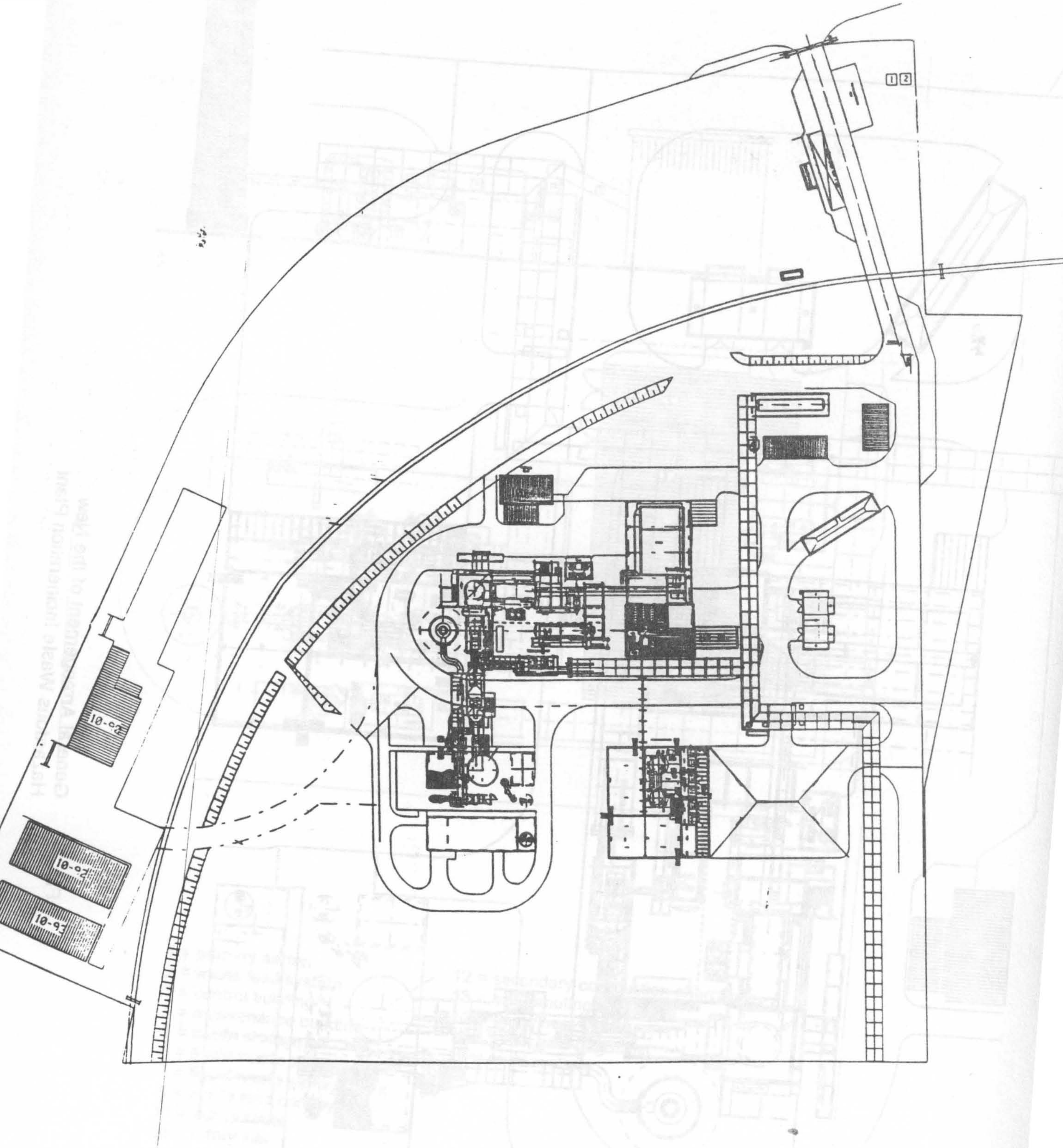


Fig. 3. Site Plan of the New RVA Böhlen

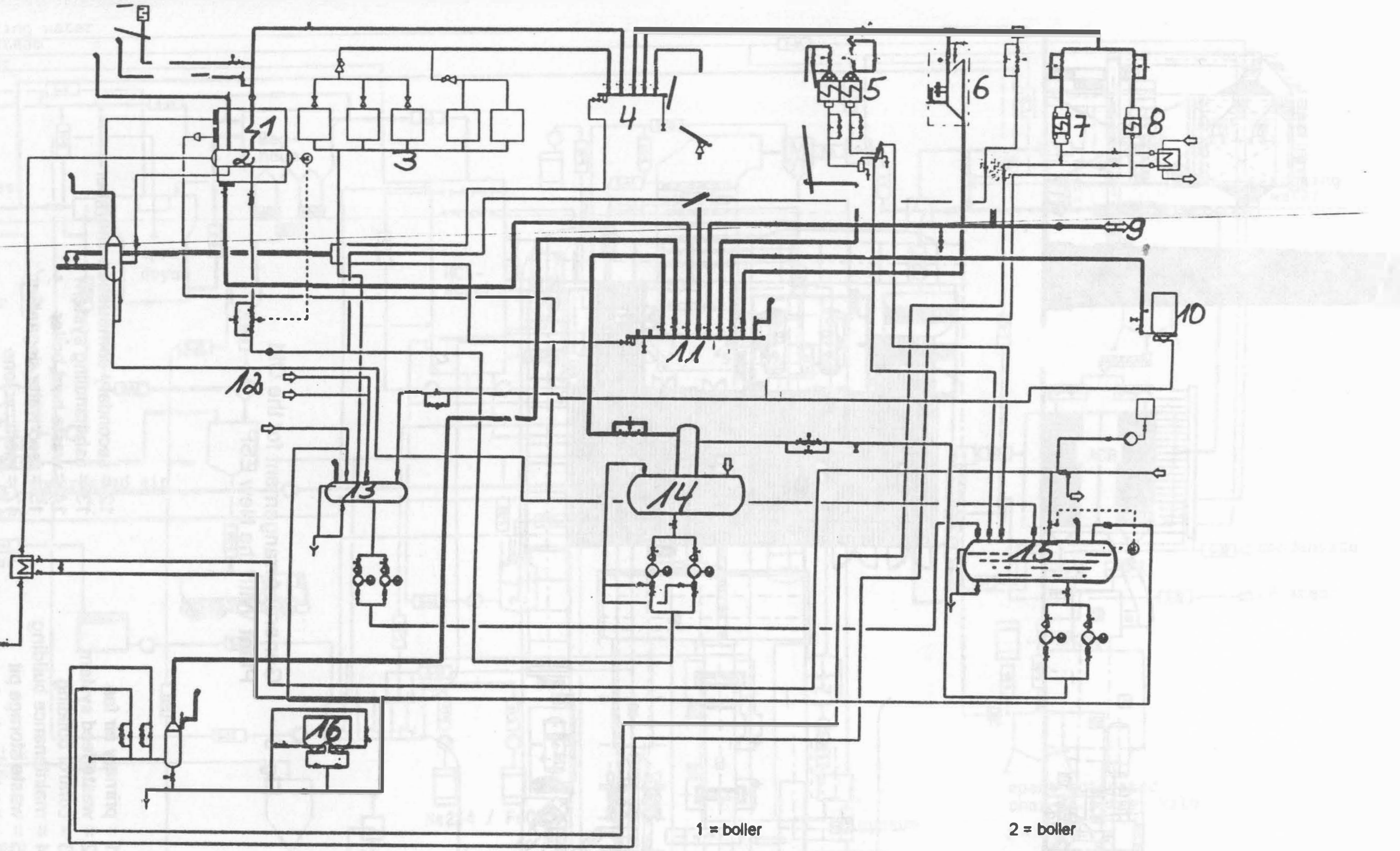


Fig. 4. Water-Steeam-Process Flow Diagram

1 = boller

2 = boller

3 = dispersion steam for burnes and lances

4 = HP steam distribution 21 bar / 260-280°C

5 = air preheater

6 = turbine for ID fan

7 = flue gas reheater 1

8 = flue gas reheater 2

9 = LP-steam

10 = spray dryer

11 = LP-steam distributor 4 8 bar / 230-260°C

12 = from tank storage

13 = condensate storage tank

14 = feed degasifier

15 = feed waler storaqe lank

16 = ACR

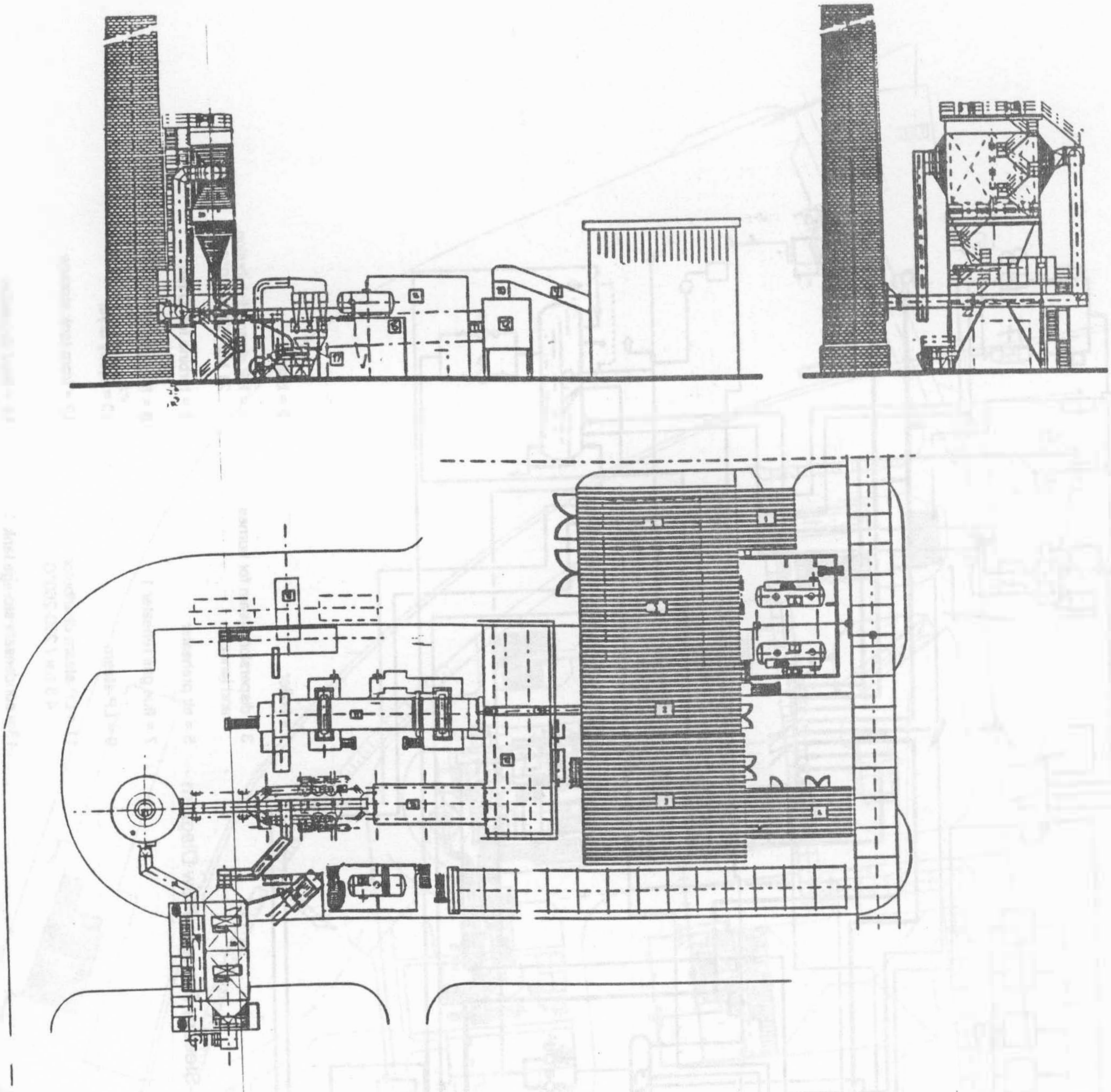


Fig. 5. General Arrangement for the Old Plant With the New ESP

1 = primary air fan
2 = waste feed system
3 = control building
4 = maintenance building
5 = waste storage pit
6 = liquid waste storage tank
7 = liquid waste storage tank
9 = waste feed conveyor
10 = waste chute
11 = rotary kiln
12 = secondary combustion chamber
13 = ash handling system
14 = waste heat boiler
15 = feed water degasifier
17 = multi cyclone
20 = ESP
21 = flue gas duct to stack
22 = interims flue gas duct

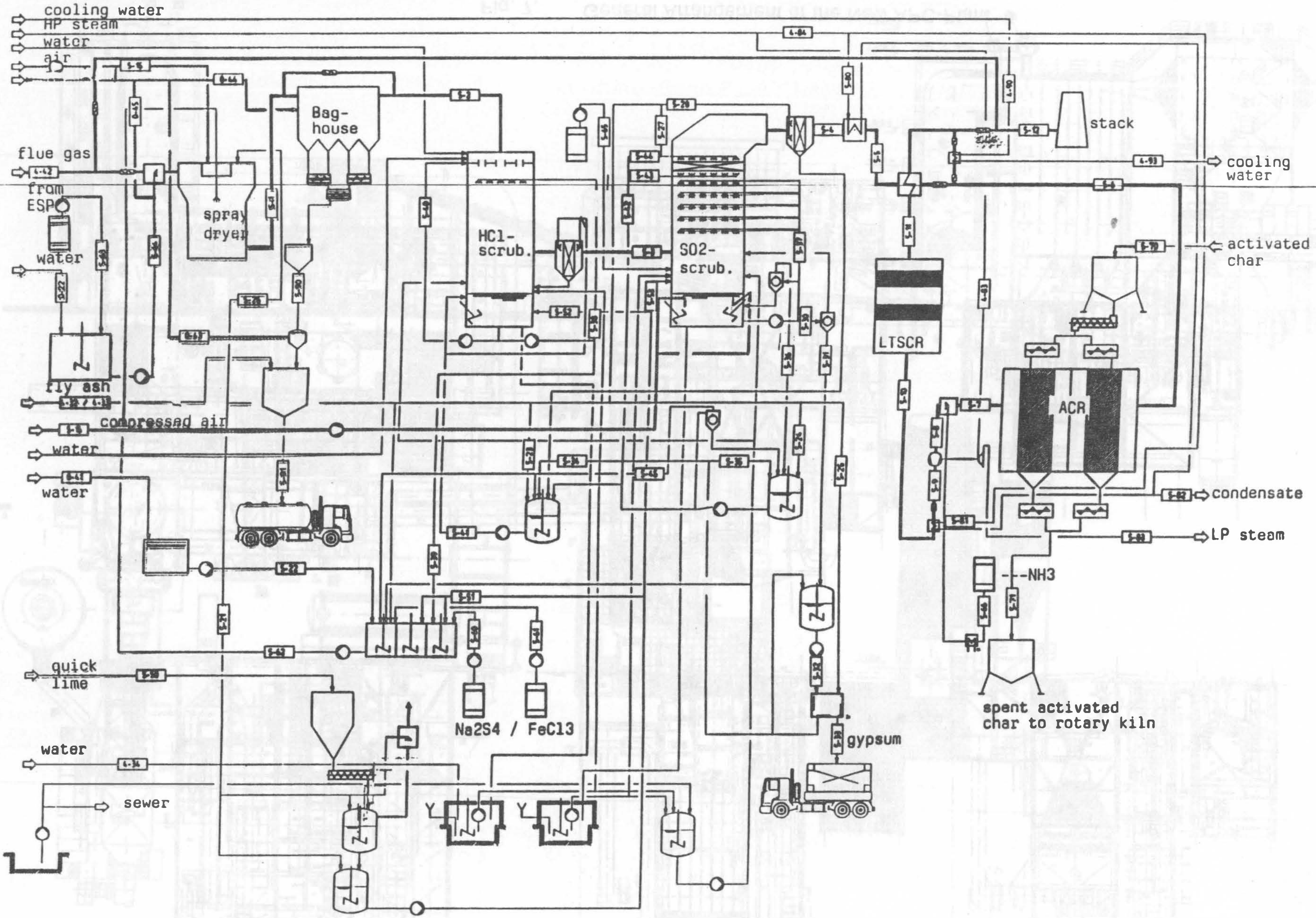


Fig. 6. **Process Flow Diagram of the New APC-Plant**

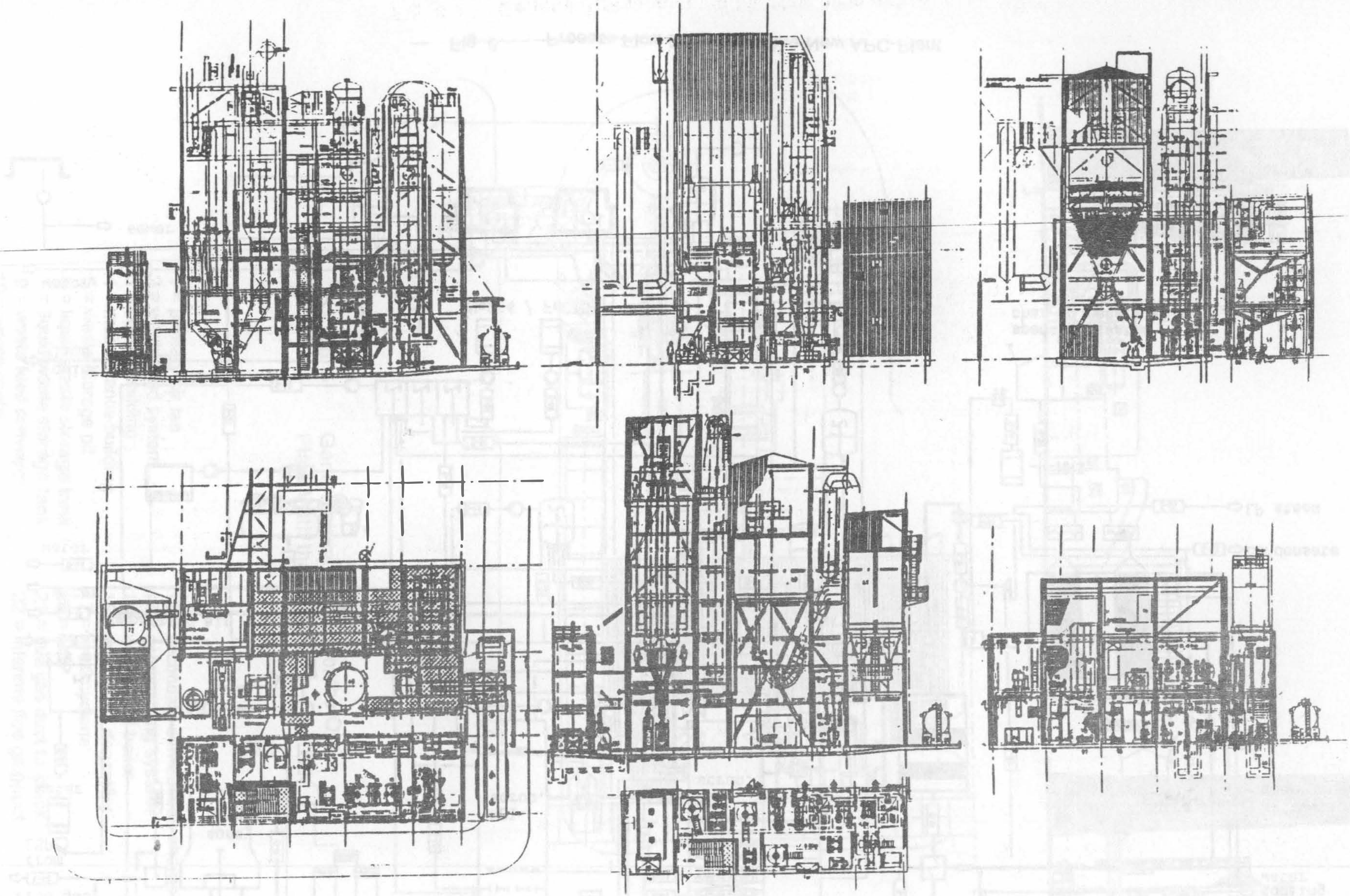


Fig. 7. General Arrangement of the New APC-Plant

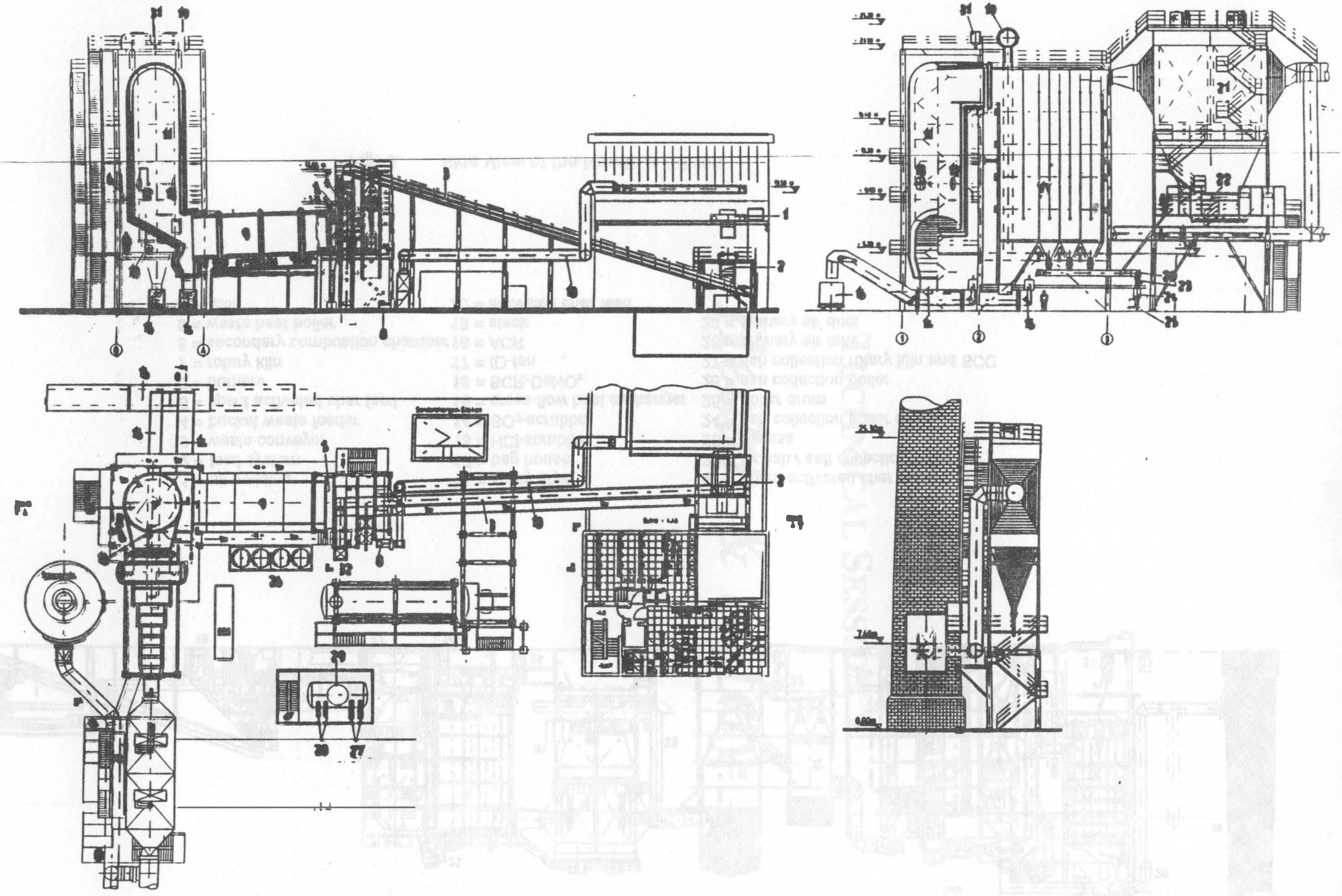
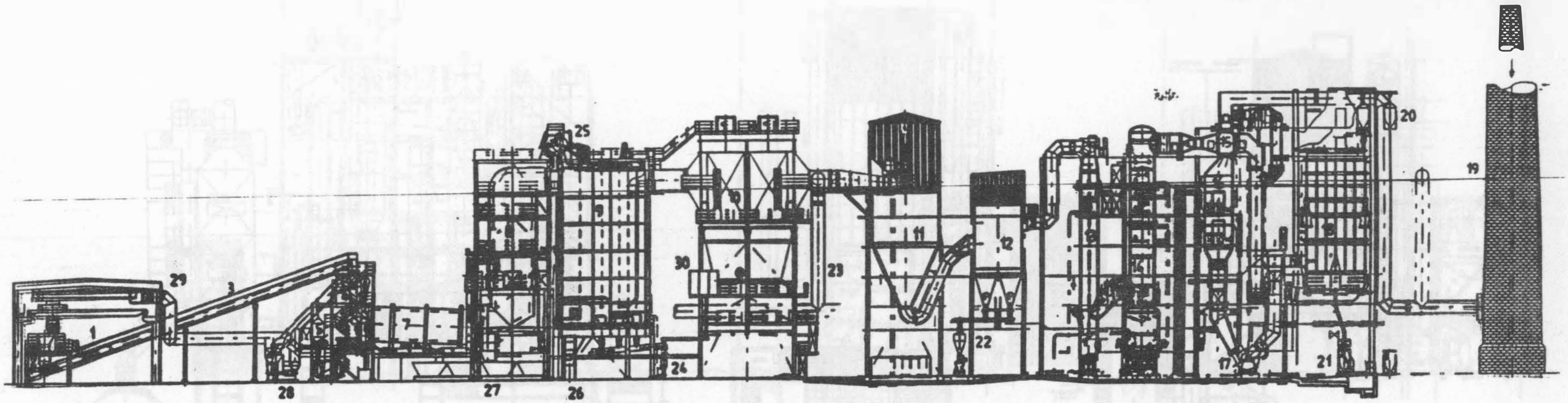


Fig. 8. General Arrangement of the New Incineralion



1 = pit building
2 = feed system
3 = waste conveyor
4 = bucket waste feeder
5 = spent activated char feed
6 = burners
7 = rotary kiln
8 = secondary combustion chamber
9 = waste heat boiler
10 = ESP

11 = spray dryer
12 = bag house
13 = HCl-scrubber
14 = SO_2-scrubber
15 = cross-flow heat exchanger
16 = SCR-$DeNO_x$
17 = ID-fan
18 = ACR
19 = stack
20 = activated char feed

21 = spent activated char collection
22 = fly ash / salt collection system
23 = bypass
24 = ash collection boiler and ESP
25 = boiler drum
26 = ash collection boiler
27 = ash collection rotary kiln and SCC
28 = primary air fans
29 = primary air duct

Fig. 9. Side View of the New RVA Böhlen