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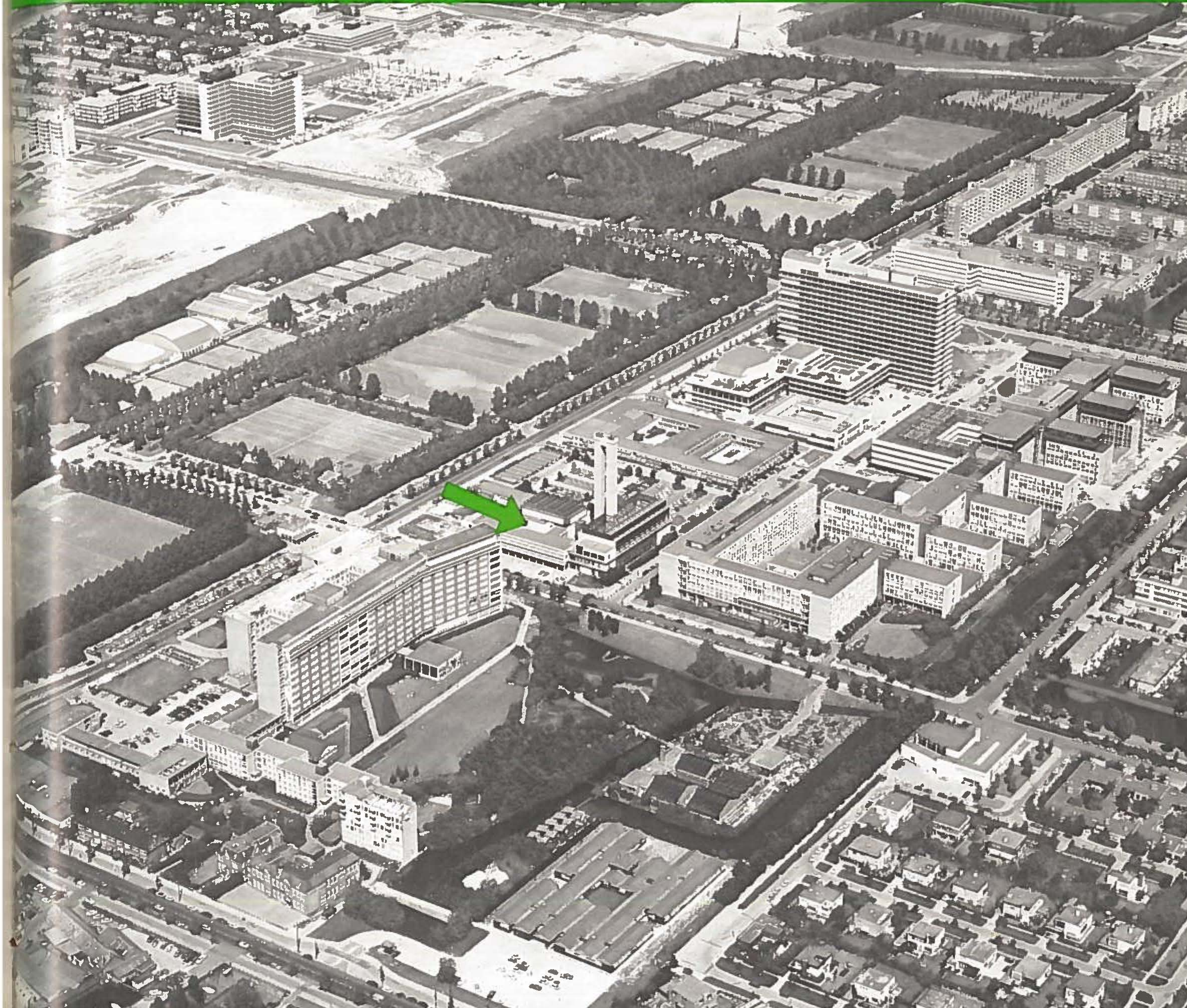

Aerial view of the campus at the Free University in Amsterdam, The Netherlands. Arrow indicates the Energy Center. Page 10.

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Central Power Plant of the Free University in Amsterdam, The Netherlands

by Ir. L. van der Meer

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About the University

The "Free University" is one of two universities located in Amsterdam. It was originally founded as a private institution in 1880, by a nation-wide organization for the promotion of "higher education based on Christian reformed principles." This organization established the "Free University" in the belief that:

—Science can only be pursued in an atmosphere of freedom, without interference of Church or State, and

—Scientific Research should also take place with the humble realization of dependence on the creator.

These principles are now guaranteed by a law for higher education. At present the University is, as are all other universities in Holland, a Government institution.

Since 1960 the "Free University" has occupied the present, approximately 50-acre campus in the southern part of Amsterdam.

There are seven faculties: Theology, Law, Literature, Economics, Mathematics and Physics, Medical Sciences and The Humanities. About 12,000 students are engaged in undergraduate and graduate studies. The Student Residence Center and the School of Nursing are located approximately one mile south of the campus. Three-thousand three-hundred students of both Amsterdam Universities live in the student center. The power plant is located in the center of the campus, as indicated in the aerial photograph on the cover.

Central Power Plant (General)

The Energy Center, as it is called on campus, consists of two buildings: the boiler room, with the incinerator room annex; and the engine hall. These buildings are grouped around a double chimney, aesthetically designed not to look like a power plant smokestack. Its height was governed by regulations of civil aviation of the nearby Schiphol Airport. The unique design of the chimney has given the campus its own focal point. As shown on the campus layout (Fig. 1) three tunnels radiate from the boiler room to every building on campus. A photograph of one of the tunnels shows their generous design (Fig. 2).

The utility distribution lines are installed on the walls of the tunnels. This arrangement leaves ample room in the middle of the tunnel for the wagon traffic between the incinerators and the buildings on campus. On the plan of the campus, the location of the tunnels is shown in broken lines (Fig. 1).

The Power-Heat Schematic Diagram (Fig. 3) shows the energy flow between the units in the energy center. It further details the electric power distribution, and the hot and cold water flow characteristics emanating from the center. Water is used for the transfer of the heating and chilling capacities. The capacities listed are projected for the year 1980, when it is estimated that the university campus will have reached its optimum size. The energy center (Fig. 4) also generates part of the electric power requirements on campus. The motor-driven generators operate in synchronization with the municipal supply.

Heating System

Five hot water boilers can supply hot water to a loop in the energy center. Boiler capacities are:

2 units of 5 Gkal/U or 20 x 10^6 Btu/h each
1 unit of 10 Gkal/U or 40 x 10^6 Btu/h
2 units of 20 Gkal/U or 80 x 10^6 Btu/h
for a total of 240 x 10^6 Btu/h

To this heating capacity can be added, the heat recovered from the exhaust of the natural gas or oil fueled motors driving the generators, a maximum of 2.7 Gkal/U or 5 x 10^6 Btu/h. The main fuel is natural

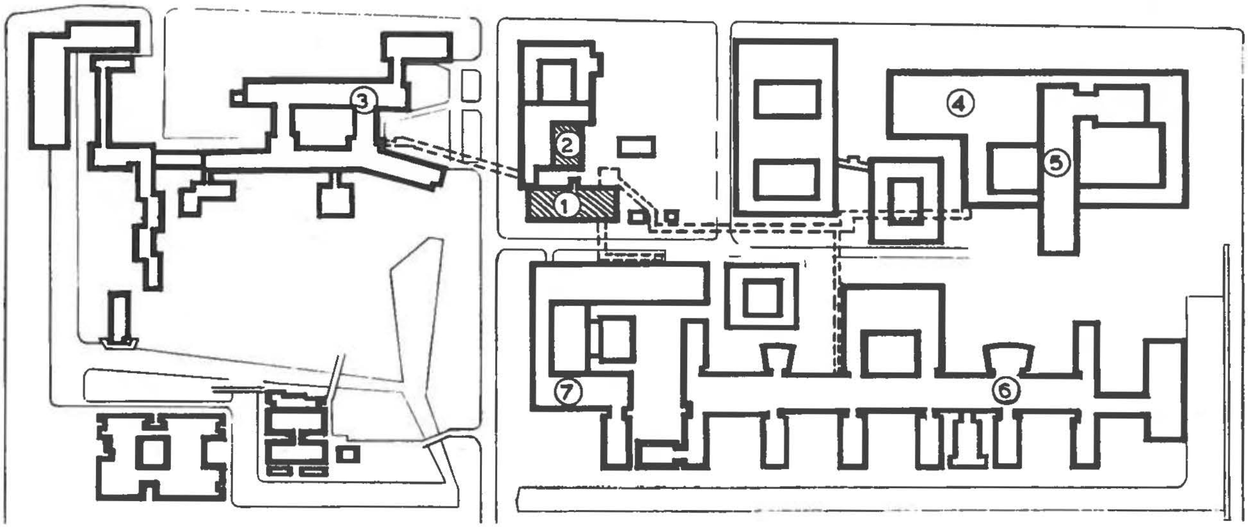

Fig. 1—Campus layout of the Free University of Amsterdam: 1. boiler house, 2. engine hall, 3. hospital, 4. main building, 5. library, 6. mathematics and physics, 7. medical sciences.

gas; however, two of the boiler units can also be fired with light fuel oil.

Hot water supply and return mains connect the buildings on campus with the energy center's boiler room. Each building has a mechanical room with "water-to-water" and "water-to steam" heat exchangers.

Temperature control in the secondary water distribution is accomplished by regulating the supply of hot water to the heat exchanger with a throttling valve. Hot water is distributed at the rather high temperature of 180 C (356 F) because the hospital requires steam of 5 ATA (73.5 psi abs); the water returns at 120 C (248 F). Presently under consideration is the distribution of hot water at a lower temperature and generation of steam with electric boilers locally, where required.

Cooling System

Chilled water for process cooling and air conditioning is distributed through supply and return mains, installed in the tunnels. Control is by variable volume through throttling valves in the supply lines to the buildings. We endeavor to maintain an as large as possible ΔT, approximately 10 C (18 F). Chilled water supply is at 5 C (41 F); return at 12 to 16 C (54 to 61 F). The main building has non-opening windows and is completely air conditioned.

The chiller plant operates without cooling water. It is called a dry chiller plant. Instead of cooling towers, air cooled condensers are installed on the roofs of the boiler room and engine hall, where the chillers are located. By means of fans, air is pushed through the condenser finn tube bundles. Due to the generally mild climate in Holland, the heated air does not cause fog problems; it rises fast and dissipates into the atmosphere. Special acoustical protection has been designed to dampen the fan noise.

In the design of the energy center, much thought was given to prevent noise and vibration from being transmitted to other buildings and the surrounding area. This design has been so successful that the noise level outside the engine hall is lower than the traffic noise from the surroundings.

Located in the engine hall are three chillers with York compressors, capacity 1.4 Gfrig/U (465 tons) each. In the boiler room are two chillers, with a capacity of approximately 8 Gfrig/U (2650 tons) each, for a total refrigeration capacity of 6700 tons. The two 2650-ton chillers each have two parallel operating Borsig compressors on the evaporator.

Electricity

Electric power is supplied by the Municipal Electric Company (G.E.B.) in the order of 10 MW (max. 12 MW) at 10,000 volts.

The University also generates part of its electricity consumption. Installed in the engine hall are six 1500 pk (horsepower) motor generators with a total generating capacity of 6 MW. The motors, made by Ruston, are six cylinder, dual fuel capability, 600 rpm, coupled to Smit Generators 1000 KW, 10,000 V, 50 cy. The Power Heat Schematic (Fig. 3) of the energy center shows this arrangement.

The electric distribution to the buildings is divided into essential and non-essential supply. It is normal operating practice to generate somewhat more electricity than required on the essential service. In case of a power

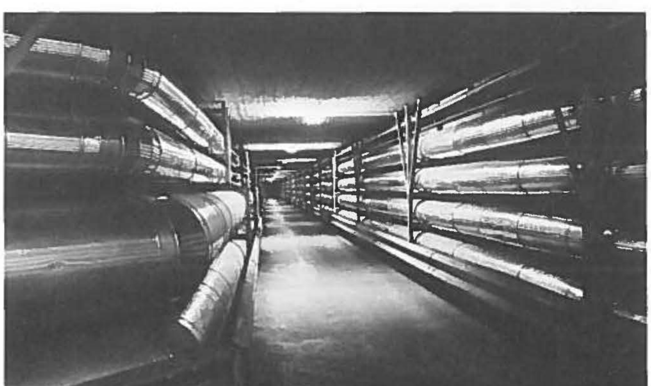

Fig. 2—View of one of the generously designed tunnels.

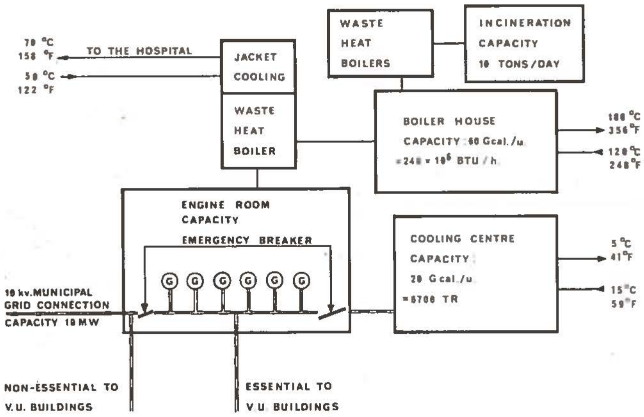

Fig. 3—Power-heat schematic diagram.

failure, the emergency breakers disconnect and the essential net is supplied with the motor generators.

Our own generation of electricity allows us to practice some peak shaving at times of high demand. Some fears were expressed that a pulsating torque induced by the motors driving the generators, could cause irregularities in the electrical distribution. A suitable damping coil was incorporated in the generator, to counteract any self-induced frequency.

The University does not experience any difficulty in synchronizing and running parallel with the municipal supply. Each motor generator set has a waste heat boiler in the exhaust. The thus recovered waste heat in the form of heated water is fed into the hot water distribution.

The recovered heat energy in the cylinder cooling water is used to heat the bath water for the hospital. This brings the thermal efficiency of the motor generators to a respectable 75%.

Incineration

Two incinerators with a capacity of approximately 250 kg/h (550 lb/h) serve the campus continually. One incinerator has a rotating cylindrical grate, the other a stationary grate.

The flue gases first pass through a waste heat boiler and are then cleaned in a multi-cyclone. The furnace temperature is kept above 600 C (1112 F), if necessary with the aid of auxiliary burners.

The after-burner brings the flue gas temperature to

Fig. 4—Energy center.

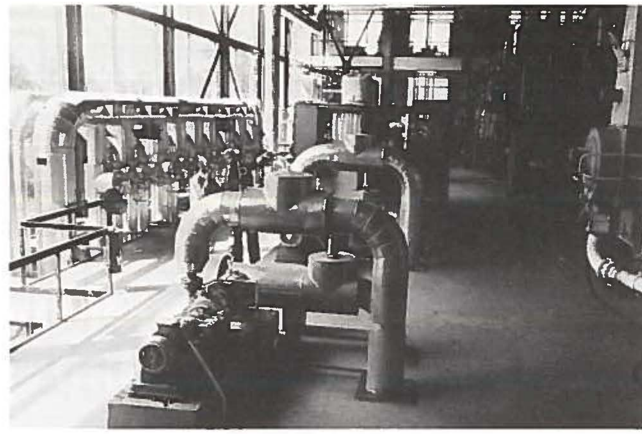

Fig. 5—Boiler room.

1000 C (1832 F). The wear and tear on the grates and the waste heat boilers is enormous.

Recent Yearly Production And Consumption Figures

Produced per year:

18,000 MWH	- Electricity
75,000 Gcal	- Heat (300 x 10^9 Btu)
11,000 Gcal	- Cooling (44 x 10^9 Btu)
30,000 m^3	- Demineralized water (8 x 10^6 U.S. gal)
27,500,000 kg	- Incinerated (60 x 10^6 lb)

Consumed per year:

16,000 MWH	- Electricity
800,000 m^3	- City water (200 x 10^6 U.S. gal)
16,000,000 m^3	- Natural gas (565,000 MCF)

Control and Staffing

The staff required for manning the energy center and buildings consists of a shift superintendent, a shift control room attendant, five shift maintenance technicians and a fireman for the incinerators. The control room, located in the energy center, is manned around the clock by a control room attendant.

All malfunctions on campus are displayed on an annunciator panel, located in the control room. By means of a television camera and monitor, the control room attendant can scan each individual building's instrument panel for malfunctions. By radio he can communicate with the building's maintenance technician as well as the shift superintendent.

In addition, some areas such as the rare book section in the library, are protected by fire and smoke detectors. In case of fire, all available manpower in the above staff operates as an auxiliary fire brigade, until the municipal fire fighting force arrives. ✱

NECROLOGY

Charles N. Bauer, Superintendent, Central Distribution Department, Baltimore Gas and Electric Company, Baltimore, Maryland, on February 21, 1977.