

Transportation Authority Electric Transformer Substation in Sakae, Nagoya city, Aichi prefecture



1. Characteristics of the fire

The fire emerged in an electric transformer substation located inside the premises of Sakae Station of the Toyama subway line in Nagoya. Black smoke generated by the fire quickly spread into the underground passage connected to the station and emerged through the underground vents. Soon after the fire emerged, electricity for the entire Toyama line was stopped, which caused some of the trains to stop inside tunnels. Around 800 passengers evacuated themselves to Fushimi Station on foot through the tunnels. In addition, as the municipal transportation authority disapproved of extinguishing the fire with water, the transformer substation burned for over 3 hours. Furthermore, 5 firefighters who were involved in the extinguishment of the fire sustained severe injuries due to heat radiated by the smoke, and 2 of them subsequently died from their injuries.

2. Overview of fire outbreak

- (1) Time and date of emergence
Around 14:40 on August 16, 1983 (Tuesday)
- (2) Time and date of detection (detection method)
14:52 on August 16, 1983 (Tuesday) (119 call placed)
- (3) Time and date of extinguishment
18:03 on August 16, 1983 (Tuesday)

3. Overview of fire origin

- (1) Location
3-5-12 Sakae, Chuo ward, Nagoya city, Aichi prefecture
- (2) Name of building where the fire emerged
Sakae transportation authority electric transformer substation, Nagoya city

(3) Structure and configuration of building where the fire emerged

① Date of construction

December 7, 1957

② Status of structural extension and alteration

Structural extension for connections completed on March 31, 1979

③ Target use of the building

Subway station (electric transformer substation)

④ Structure

Three-story underground steel-reinforced concrete structure

⑤ Area

Total floor area 19,930 m² (of which 568 m² was the subway electric transformer room)

⑥ Number of accommodated people

Employees working at the subway station 93

Employees present when the fire emerged 16

⑦ Tenants

The Sakae underground passage, which connects through to Sakae Station, has a floor area of 80,599 m² and accommodates 311 shops.

⑧ Use of the building per floor

1st floor underground (B1): Subway ticket gates, staircases to the entrances, electric transformer substation (232 m²)

2nd floor: Platforms, tracks, transformer substation (245 m²), storage room

(4) Status of installed fire extinguishment and prevention facilities

① Fire extinguishment facilities

Sprinklers, internal fire hydrants, 3 CO₂-based extinguishers, 95 powder-based (ABC) extinguishers (including 2 large extinguishers).

② Alarm systems

Automatic fire alarm system, smoke detectors, differential detectors, emergency announcement system

③ Evacuation facilities

Guiding lights

※ The above facilities were installed inside Sakae station. The fire extinguishment facilities installed in the transformer room underground consisted only of powder-based extinguishers (3 small and 3 large) and an automatic fire alarm system. As an exception, since the transformer was of the dry type, the fixed extinguishment facilities were replaced with large extinguishers.

(5) Status of fire prevention management

① Fire prevention manager

Notification of selection from May 1, 1980

② Fire prevention plan

Notification from 3 March 1980

③ Evacuation drills

November 17, 1981

May 11, 1982

November 5, 1982

May 24, 1983

4. Weather conditions

- (1) Weather
Rainy
- (2) Wind direction, speed
Easterly, speed 3.8 m/s
- (3) Temperature, humidity
Temperature: 26.1°C, humidity: 96%
- (4) Weather warnings, bulletins, etc.
Warnings were being issued with regard to large ocean waves and floods caused by strong wind and rain

5. Causes of fire

- (1) Ignition source
The source of the fire was a deteriorated over-voltage protection condenser in the transformer room on the 2nd underground floor.
- (2) Route
A ground fault event induced ground-fault current in the primary side of the rectifier, and as a result a spark was produced between it and the steel angle block of the power distribution duct on the ceiling, which caused the fire.
- (3) Ignited substances
The coating of electric wires and the FRP duct cover.

6. Fire damage

- (1) People
 - ① Two fatalities
 - ③ Three injured

} All 5 persons were firefighters involved in extinguishing the fire
- (2) Property
 - ① Building where the fire emerged
 - (a) Degree of burning: Partial
 - (b) Burned structures: Rectifiers and power distribution lines installed in the transformer rooms on the 1st and the 2nd underground floors
 - (c) Cost of damage 9,124,000 yen
 - ② Structures to which the fire spread
None

7. Fire route (progression)

(1) Overview of outbreak location

A passer-by walking along Nishiki Street noticed smoke emerging from the ventilation openings of the transformer room, which were located on the road divider, and subsequently informed the transportation authorities. At approximately the same time, upon hearing the automatic fire alarm system, a station attendant went to the transformer room and confirmed that smoke was emerging from it.

(2) Notification of fire department

Upon confirming that smoke was emerging from the transformer room, the station attendant informed other attendants, who returned to the station master's office and called 119.

(3) Initial firefighting attempts

One station attendant opened the door to the transformer room on the 1st floor with the intention of evaluating the situation inside. However, he closed the door immediately due to excessive amounts of smoke, and therefore there were no initial attempts to extinguish the fire.

(4) Fatalities

Members of the fire department took turns in entering the transformer room and attempting to extinguish the fire with powder-based extinguishers; however, they could not confirm the location of the fire due to the severe smoke produced by it. The two firefighters who died worked in a pair and repeatedly entered and exited the transformer room searching for the location of the fire. In one of those attempts, they could not exit the room and were discovered 1 hour and 45 minutes later.

(5) Evacuation

① People in the subway

The station attendants provided evacuation guidance for people near the ticket gates. The nearly 700 passengers from two cars which were stranded inside the tunnels evacuated themselves by walking about 200 m in complete darkness.

② People in the underground passage

Members from the Subway Promotion Association and security guards played a central role, by closing the shutters of shops located in the vicinity of the fire and providing evacuation guidance for shoppers. At the time of the fire, there were approximately 5000 people in the area.

8. Firefighting activities undertaken by the fire department

(1) Dispatched units

① Dispatched vehicles

Ordinary pump trucks	44
Portable foam tank trucks	3
Rescue trucks	6
Light generator truck	1
Supervision trucks	5
Smoke exhaustion foam tank trucks	3
Command trucks	2
Total	64

② Dispatched personnel

Firefighters	154
(No members of firefighting groups)	

(2) Firefighting and rescue activities

① Firefighting activities

14:52 Ordered a special firefighting operation immediately after receiving word that a fire had emerged in the transformer room of Sakae Station at 3-5-12 Sakae, Chuo ward

14:57 The units which arrived first confirmed the emergence of black smoke in the vicinity of Meiji Seimei Building
15:01 Firefighting units gathered in front of the 5th entrance

15:02 Firefighters proceeded to enter the building after deciding that the extinguishment operation should be conducted by combining the efforts of all small units using powder-based fire extinguishers

15:13 The smoke exhaustion foam tank trucks began expelling the smoke

15:33 The door of the transformer room was opened with the intention of confirming the location of the fire. However, the dense smoke obstructed firefighters from identifying the location and the firefighters began discharging the powder-based fire extinguishers.

15:51 Electricity for the Meijo subway line was interrupted, and smoke was expelled with the aid of water dispensed through sprinklers

16:18 Sashes of the above-ground exhaust vents were broken with an engine cutter, and water was poured in through the openings

17:08 Some units proceeded to the transformer room on the 2nd underground floor and dispensed water

17:19 All units entered the site and dispensed water simultaneously

17:45 Two firefighters who had gone inside the transformer room were discovered on the stairs leading to the 2nd underground floor

9. Problems, lessons learned

- (1) Although the fire which burned the rectifier and the cable inside the transformer room was small, as a result of severe smoke, a total of 5 firefighters were killed or injured, the subway was stopped, and the underground passage was closed.
- (2) As the fire emerged underground, determining the location of the fire took time, and the smoke could not be efficiently expelled.
- (3) The rectifier was manufactured 21 years before the accident, and it is assumed the fire resulted from its deterioration caused by aging. It can be assumed that many similar incidents can be expected to occur in the future.
- (4) Smoke from the underground transformer room freely entered the underground passage, and therefore a revision of fire prevention partitioning is required.

Fig. 1 Layout of the underground passage in Sakae

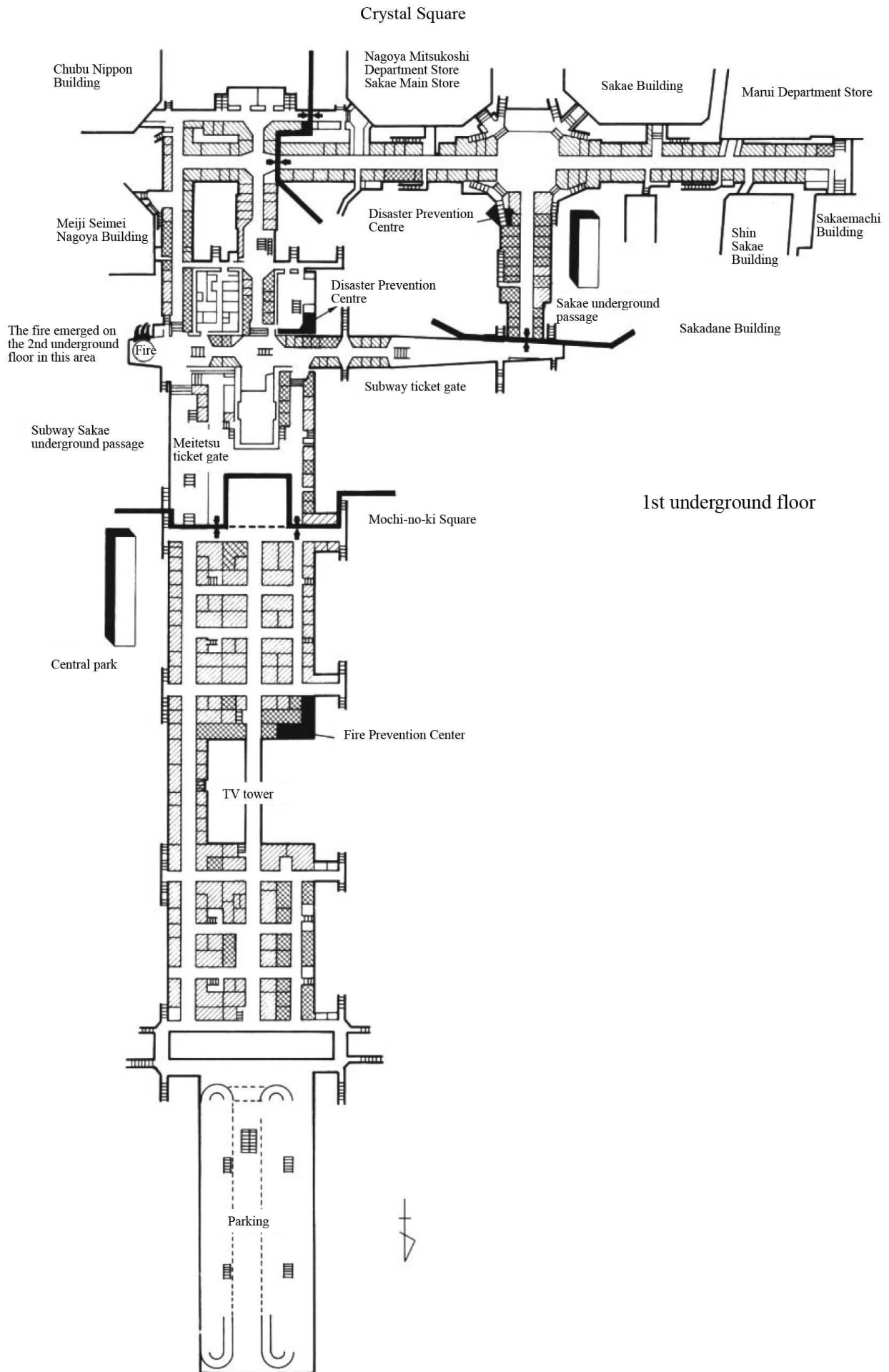


Fig. 2 Layout of the 2nd underground floor

- ✕ : Sparks produced
- : Fire emerged
- : Burned area
- : Burned grounding line
- ▨ : Completely burned area
- Tr : Transformer
- SR : Rectifier
- 5 2 : AC interrupter

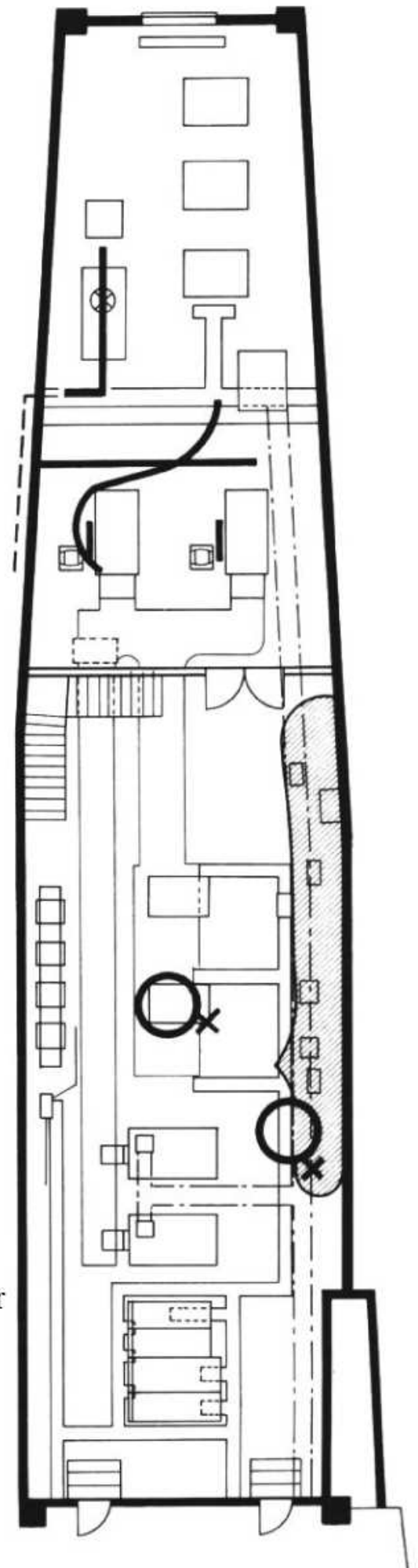


Fig. 3 Layout of the 1st underground floor

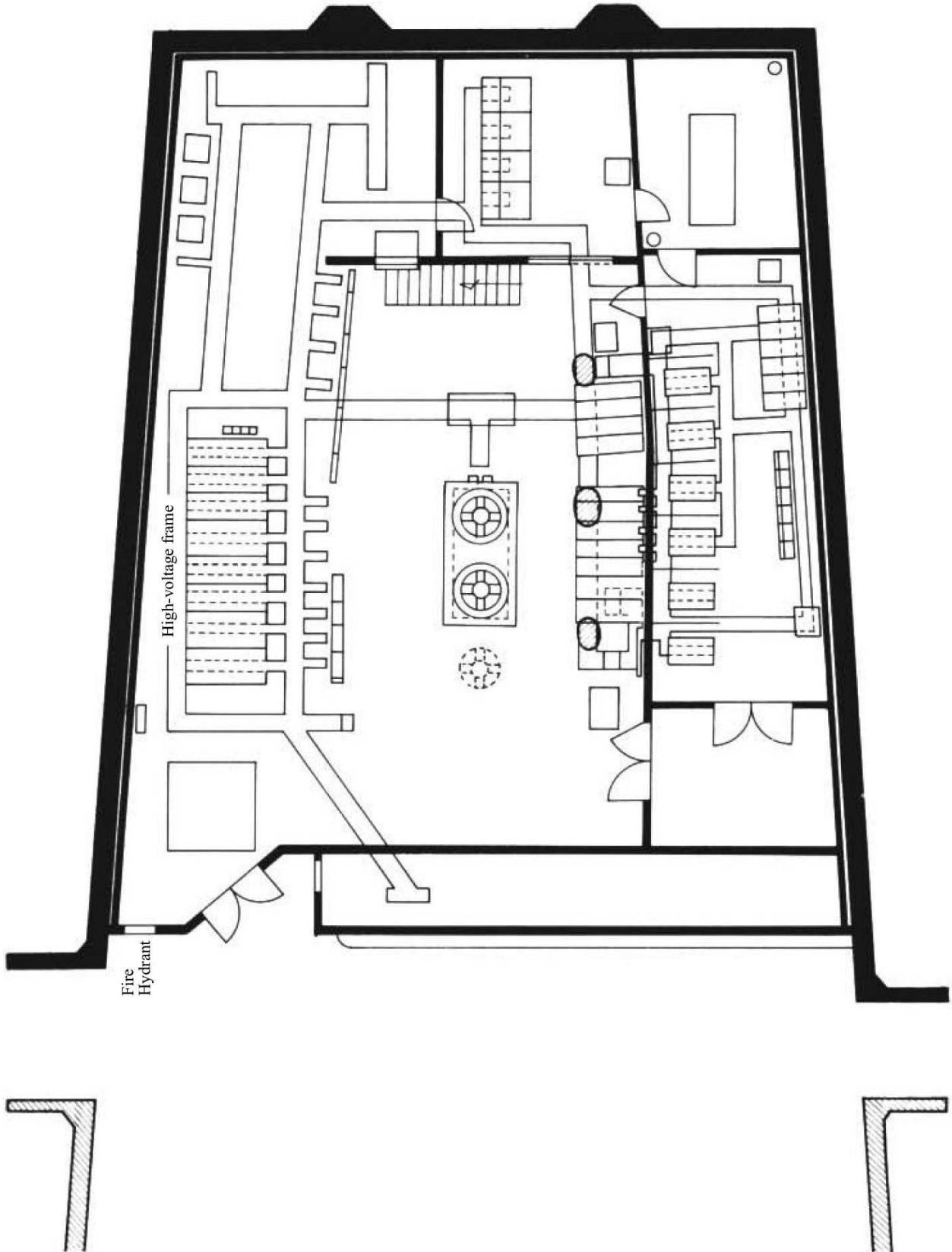


Fig. 4 Cross-section of the site

