AVR GmbH
Arbeitsgemeinschaft Versuchsreaktor AVR GmbH
AVR = Joint Working Group Experimental Reactor

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AVR

Short Notice

AVR Operational Experience, Overview

Edgar Wahlen, AVR
Peter Pohl, AVR

Executive Statements Summary

1 History

1956 Engagement of AVR in HTGR from the very beginning

1961 Begin plant construction

1964 First core ordered (UCC)

1966 First core delivered, First criticality

2 Overall achievements

2.1 The plant has been operated for 21 years (1967 – 1988). Given the experimental and first-of-its-kind character of the plant, the achieved time availability with a record value of 92 % in 1976 is quite remarkable (Fig. 1).

2.2 Starting in 1974, operation at 950 °C had a share of nearly 30 %.

2.3 The personnel dose uptake records show significant improvements in the course of the years due to better components and procedures (lessons learned, Fig. 2).

2.4 Radioactivity release to the atmosphere remained well below licenced levels (Fig. 3).

3 Fuel

3.1 AVR was the indispensable mass test facility for all development steps of pebble fuel (Table 1).

3.2 Pebbles with oxide fuel, and no matter if HEU or LEU, BISO or TRISO coatings, showed at max. fuel temperatures of > 1300 °C and burnups of partly > 20 % fima excellent fission product retention (Table 2).

3.3 In the modern UO_2, TRISO pebble the fission product release is practically exclusively determined by the little as-manufactured free uranium outside of the coatings.

4 Pebble cycling

During plant operation, 2.4 million pebbles were cycled. The cycling system as a first of its kind needed frequent maintenance but worked well after various improvements, and accounted for only 3 % of the generator non-availability (Fig. 4).

5 Water ingress

A water ingress in 1978 due to a steam generator leak did in the end not affect continued plant operation, and there was no need to replace fuel.

6 Safety demonstrations

6.1 Experiments simultaneously simulating the loss of forced cooling and stuck rods resulted in a simple shut-down and, with the rods kept withdrawn, in a recriticality with the reactor stabilizing at a very low core power (Fig. 5).

6.2 A complete loss-of-coolant accident was realistically simulated with the AVR at depressurized conditions (Fig. 6). A maximum temp. of 1090 °C occurred in the core center in less than 10 hrs after accident initiation.

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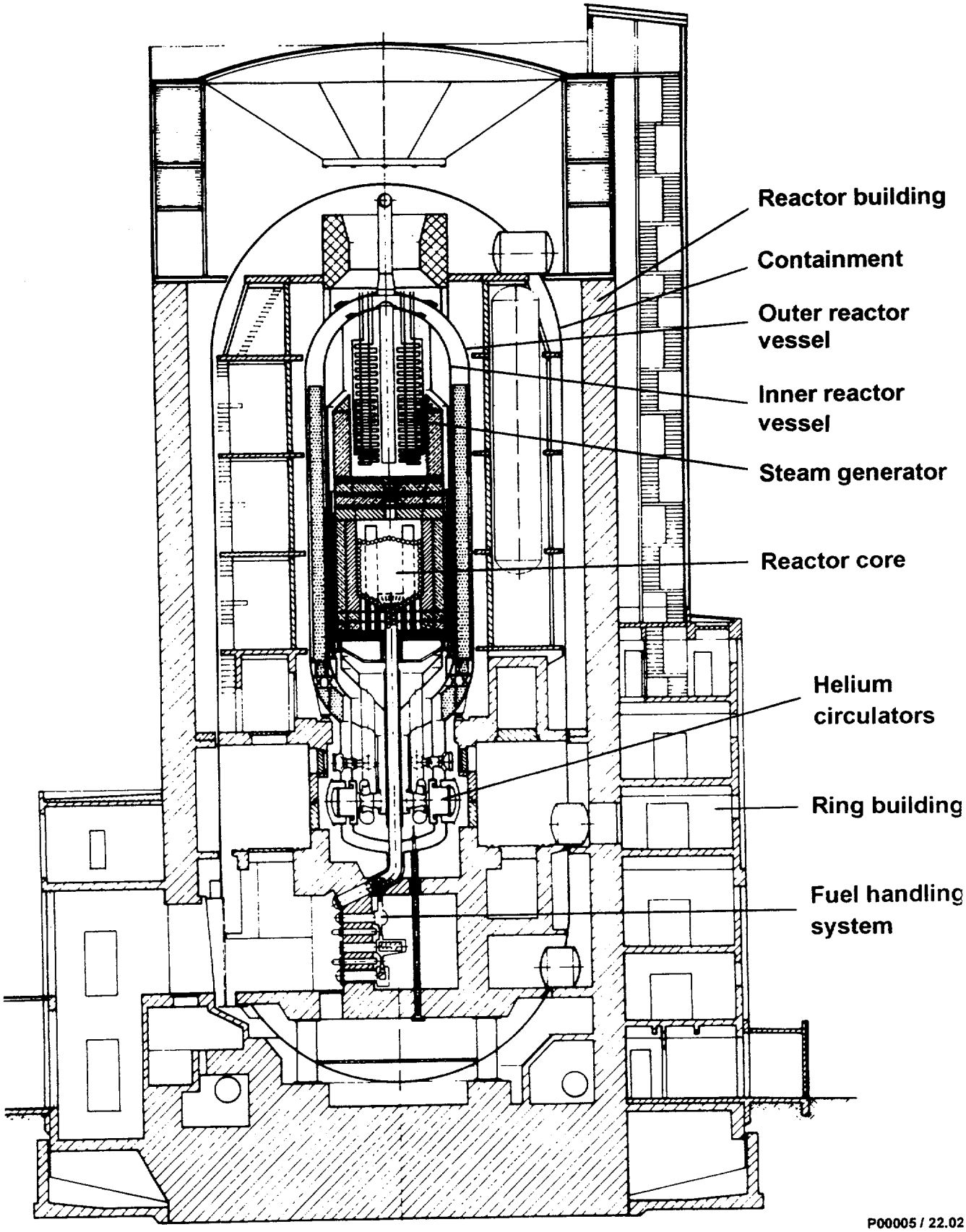
Reactor building



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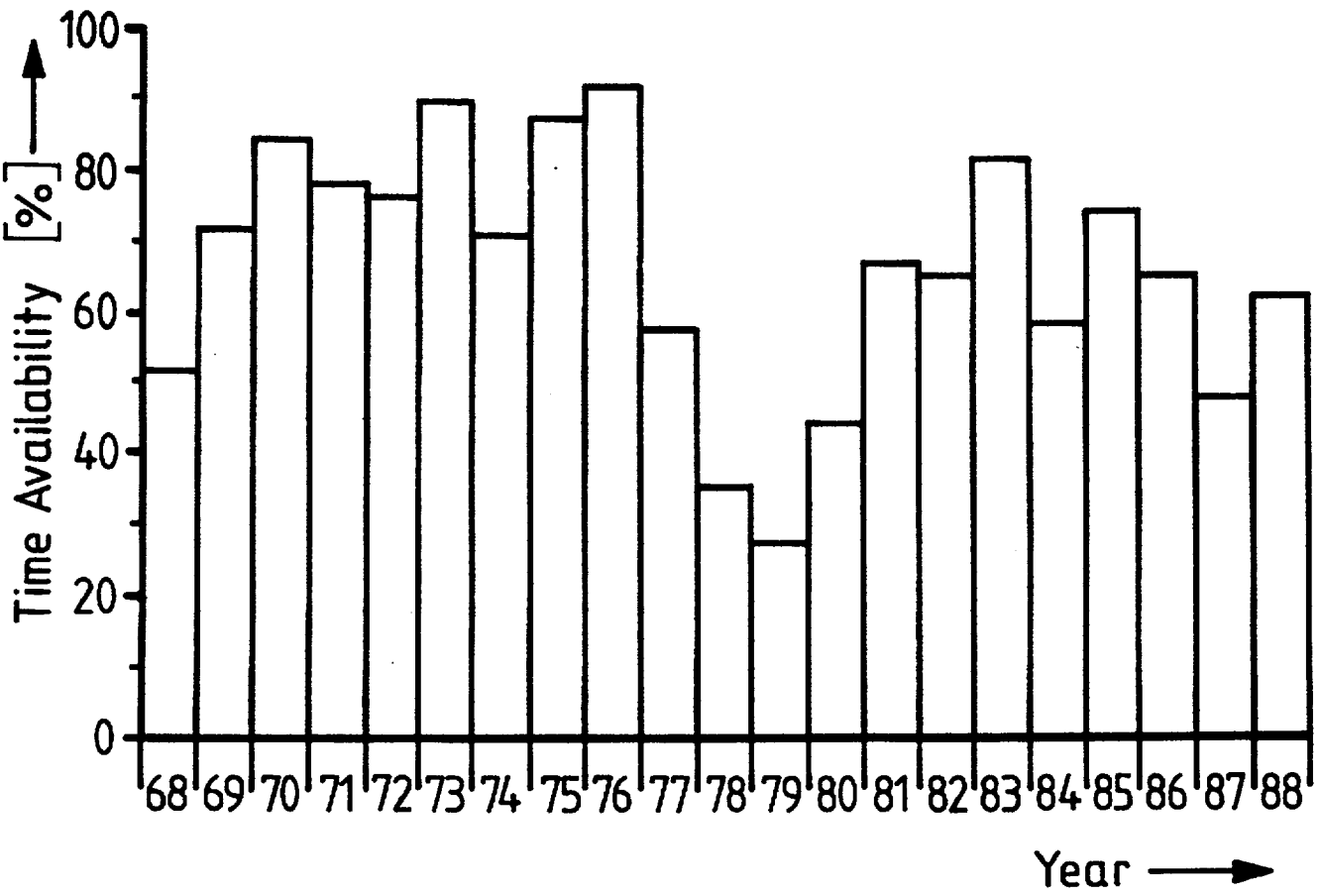
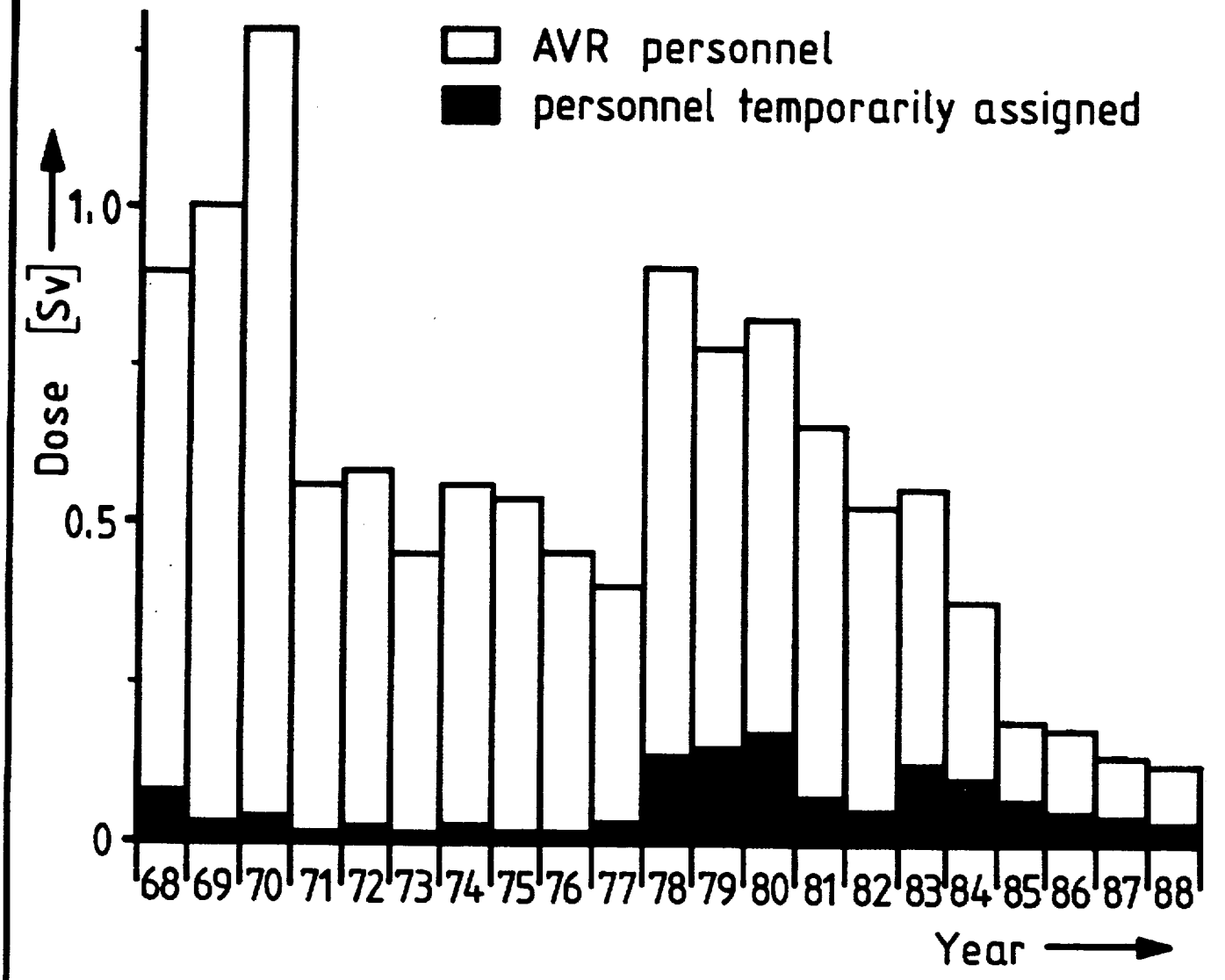


AVR	Time Availabilities of AVR	Fig. 1



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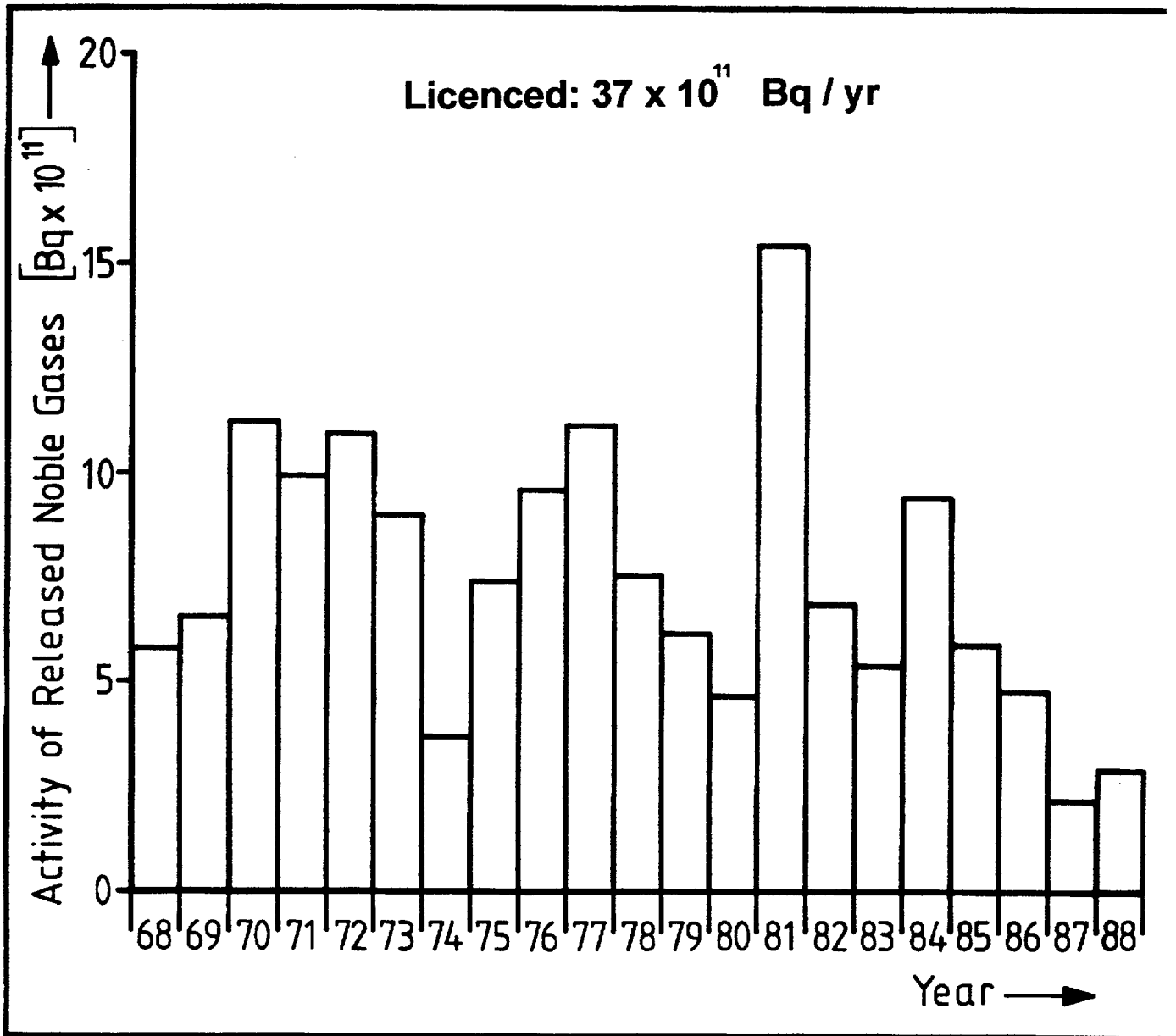
Personnel Radiation Exposure Data for AVR Annual Collective Doses

Fig. 2



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Release of Radioactive Noble Gases to Environment over the Years 1968-'88

Fig. 3

AVR as mass test bed

Pebble structure

- Shell type 37,700
- Pressed type 253,000

Fuel design

HEU

- (U / Th) C_2 with 5 g Th 87,600
- (U / Th) O_2 with 5 or 10 g Th 129,400
- Feed / Breed, UO_2, UC_2, UCO, ThO_2 20,300

LEU

- UO_2, different enrichments 53,400

Coating design

- BISO type 202,900
- TRISO type 74,300
- Feed / Breed (TRISO / BISO mixed) 13,500

Stationary operation at 950 °C

Activity concentrations in Bq / m^3 and descending order

- **Total fission gases** **4.6 E 08**
- **Tritium** **3.7 E 07**
- **C 14** **1.9 E 07**
- **J 131** **5.2 E 02**
- **Cs 137** **3.0 E 02**
- **Sr 90** **2.0 E 02**
- **Ag 110m** **4.9 E 01**
- **Co 60** **1.0 E 01**

FUEL HANDLING SYSTEM

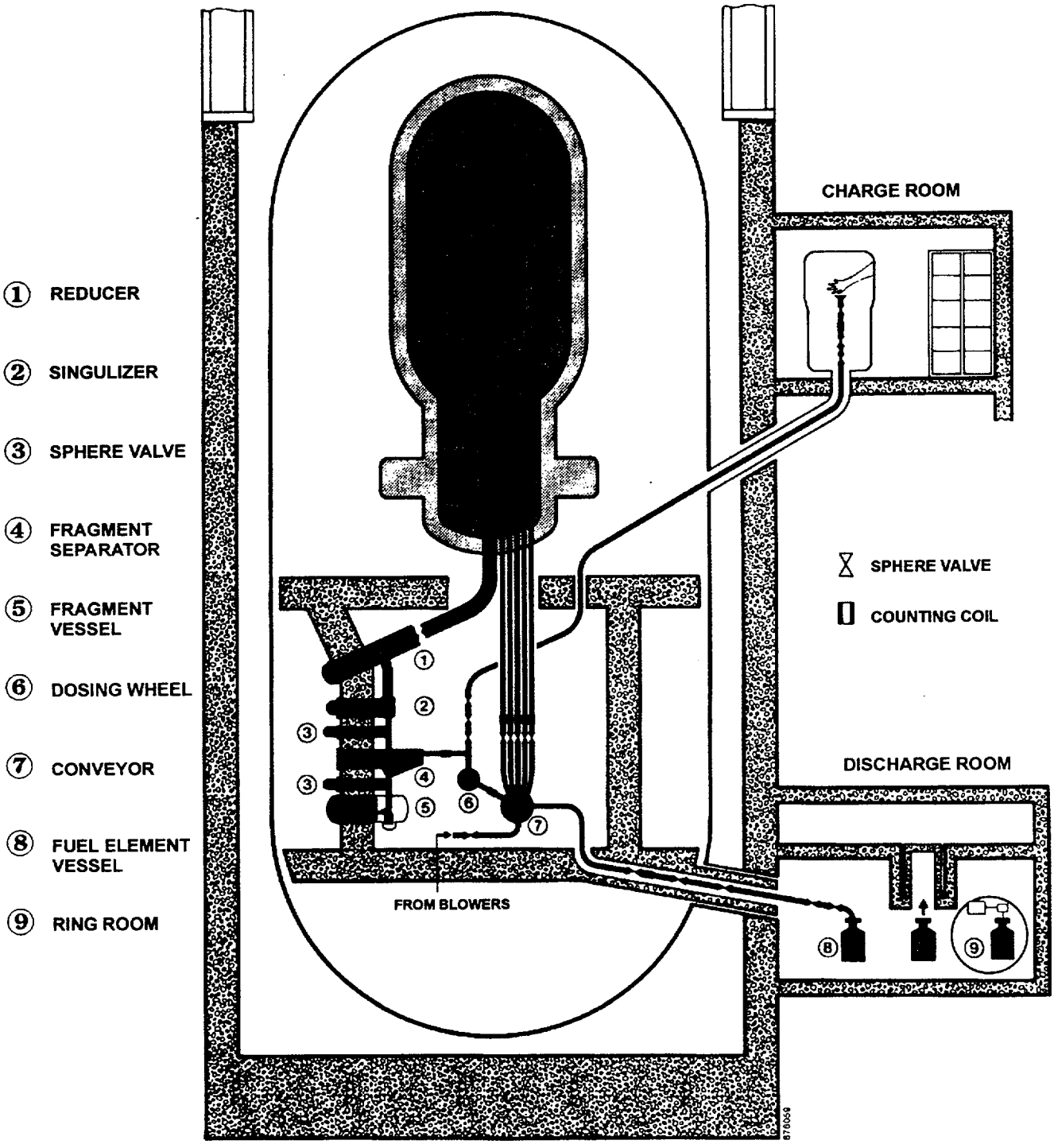
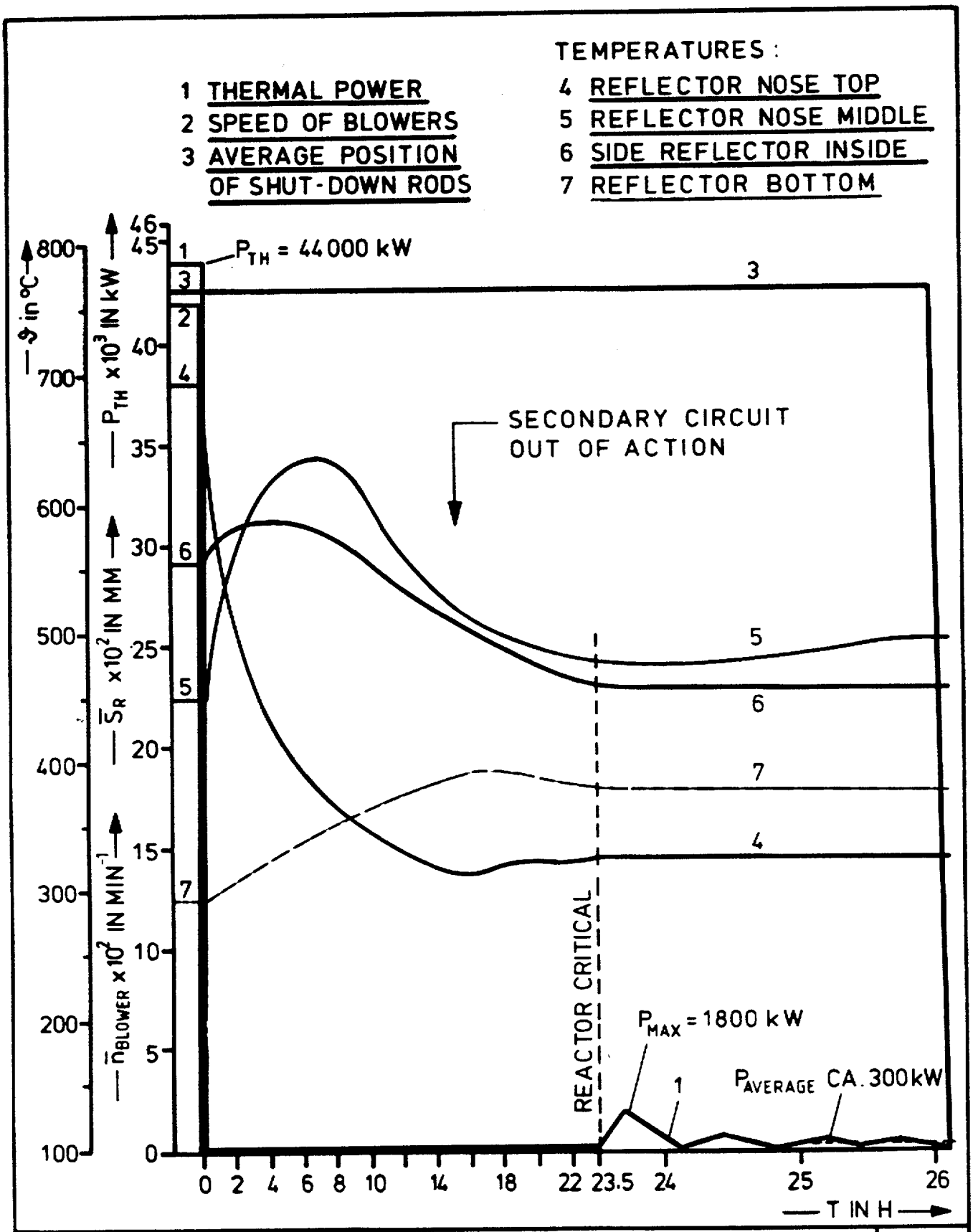


Fig. 4



AVR	SIMULATED FAILURE OF SHUT DOWN EQUIPMENT AND INTERRUPTED DECAY HEAT REMOVAL FOR THAT TIME	Fig.5

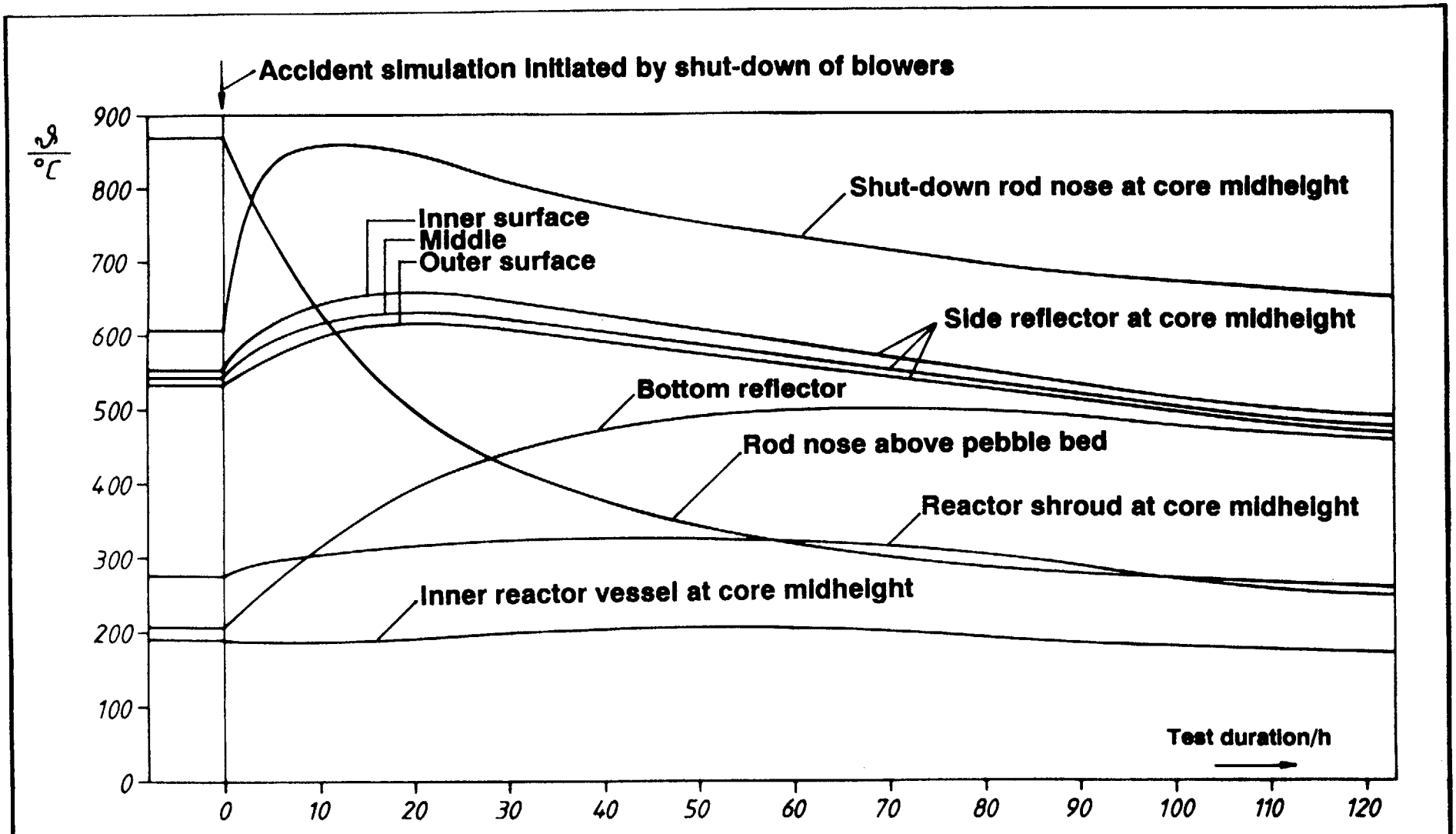


Fig. 6 Measured Temperature Curves during LOCA Simulation of October 14, 1988

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AVR Plant history

- 1956 Engagement of AVR in HTGR, from the very beginning
- 1961 Begin plant construction
- 1964 First core ordered from Union Carbide
- 1966 First criticality
- 1967 to 1988 In operation as Experimental and Pebble Test Reactor

- Electricity production 1,670 GWh with about 300,000 pebbles.
  That means an average production of 6 MWh from each pebble.