THE CHERNOBYL DISASTER

Introduction

- On April 26 1986,one of the reactor exploded on the fourth unit of the Chernobyl nuclear power plant in Ukraine,
- This accident is the worst that has ever occurred on a civilian nuclear facility.
- This disaster caused considerable consternation worldwide, in particular in what were then Soviet Socialist Republics and in Western Europe.

The RBMK Reactor

- The RBMK reactor has a flawed design.
- The disadvantages of such a reactor were the complexity of the coolant distribution

system and, more importantly, the difficultly and complexity of managing power level

and distribution, which was the main cause of the accident.

The Accident

- The accident occurred during a test to check the possibility of powering the main

reactor coolant pumps from one of the turbo-generators for a few seconds

The sequence of events that led to the disaster can be summarised as follows:

reactor power reduction was started on April 25 at 1:00 am; power was gradually

reduced from an initial 3200 MWth to approximately 1600 MWth by around

1:00 pm;

at the request of the Grid Control Centre in Kiev, the reactor was maintained

at half power for around 10 hours to supply the grid.

The Accident

- This unplanned period at

half power led to reactor poisoning by xenon. The control rods were therefore gradually removed from the core to maintain the power level;

power reduction was resumed around 11:00 pm

at 0:28 am on April 26, the power level was down to 850 MWth; the operators then switched over to the medium-power control system. This switchover, which

was poorly controlled, led to an excessive power drop to 30 MWth and further

ncreased core poisoning by xenon. The operators sought to perform the test at

all costs and withdrew a large number of controlrods from the core;

The Accident

- the operators started up the two recirculation pumps at 1:03 am and 1:07 am respectively; the increase in fluid flowrate in the core led to a reduction in steamformation and a consequent reduction in reactivity. The operators decided towithdraw more control rods;
- at 1:15 am, the operators disabled the reactor trip signals to that they could per-form the test;
- between 1:15 am and 1:22 am, cold water was injected into the core, which fur-ther decreased the reactivity. The automatic control rods reached their high position at 1:19 am. The operators then decided to further withdraw manual controlrods, dangerously reducing the shutdown margin in the core;

The Accident

- four seconds after 1:23 am, the test was started; the slowing of the generator leading to slowing of the reactor coolant pumps, caused a decrease in water flow-
- rate and increased vaporisation in the core, which led to a reactivity insertion and an increase in power, which further accelerated vaporisation. The situation became divergent;
- forty seconds after 1:23 am, the head operator hit manual reactor trip; however,
- given the design of the control rods (with graphite tips), their entry into the corecaused a reactivity insertion, which was probably the final trigger of the reactivity accident;
- forty-four seconds after 1:23 am, the reactivity insertion caused a sudden power surge followed by an explosion. According to some witnesses, a second explosion occurred two seconds later.

Consequences

- From a health perspective, 28 people (notably fire-fighters) died quickly due to the
- very high radiation doses they received (three other people had been killed during the
- explosion). Many health problems have been observed among the 600,000 “liquidators”
- (soldiers and civilians who built the rudimentary concrete sarcophagus to contain the
- damaged reactor and who cleared the most contaminated soils over a radius of 30 km
- In the most contaminated areas of Belarus, Ukraine and Russia, an undeniable health
- effect of the radiation is the very marked increase in thyroid cancer among children
- under 15 at the time of the accident. The incidence rate is between 10 and 100 times the
- “natural” rate [17].