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FUEL ELEMENTS AND FUEL ELEMENT MATERIALS

EXPERIMENTAL FACILITIES FOR FISSION PRODUCTS LIFT-OFF TESTS

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One of the hypothetical accidents on the HTGR primary cooling circuits is the failure of an outbuilding circuit resulting in a depressurization in the primary loops of the reactor. In this case, there is a risk of release of the part of deposited activity during the running of the reactor. The study of the lift-off of these products (Cs^{137}, I^{131}, Sr^{90}...) in relation to size of the failure i.e. to the shear ratio is very important for the safety of HTGR power reactors.

The Metallurgy Department and the Reactor Department of CEN/GRENOBLE have developed experimental facilities for HTGR tests.

- an in pile Helium loop COMEDIE
- an out of pile Helium loop

In pile Helium loop.

The in pile loop is made of :

. a section for irradiation of the fuel element
. a section for the deposit of solid fission products

The operating parameters of the loop are :

Pressure 30 to 100 bars, Temperature : 400 to 1 100°C
Helium flow : 60 g/s, Available diameter in the irradiation zone : 70 mm
Available height : 400 mm.

The gas passes through a filter which gives access, if necessary, to knowledge of the fission products source.

Further specific functions are, as follows :

- reirradiation of a spent fuel element
- power and temperature cycling
- analysis of the fission products released (gases released and solids deposited).

Deposit section :

The deposit section which is the economizer of the loop consists of three clusters of tubes. The tube materials in each cluster can be different.

There are the possibilities of the deposit section :

- Length : 2 830 mm
- Outside diameter : 10 mm wall thickness 1 mm
- Wall temperature : 600 to 850°C entrance
  350 to 550°C exit
- Thermocouples to measure the temperature are fixed at several levels.

Analysis of the deposits can be made during stops in the irradiation by on line gamma scanning.

All possibilities for purification and analysis of the gas are given in this loop :

- Purification : BTS catalyst, Molecular sieve, Active charcoal
- Water ingress and water analysis by PANAMETRIC cells
- On line analysis of radioactive gases at three points.

Out of pile Helium loop.

The loop is essentially made of : a blower, a heater, a test section and apparatus to measure flow rate, temperature and pressure.

The normal operating conditions are : $P_{max.}$ = 60 bars $T_{max.}$ = 500°C

The tubes with deposited fission product: are put in the test section.

Then pressurized helium can be blowned through the tubes, with possible adjustment of the parameters : duration, temperature and speed of the blow down test.

Applications of the in pile loop to lift-off studies.

To study this type of accident, it is necessary, in the first place, to have deposits of fission products in very well known conditions. To get good results on deposits, the irradiation must be done with a percentage of uncovered particles.

Two kinds of deposits will be used at the start for the first tests planned in the program.

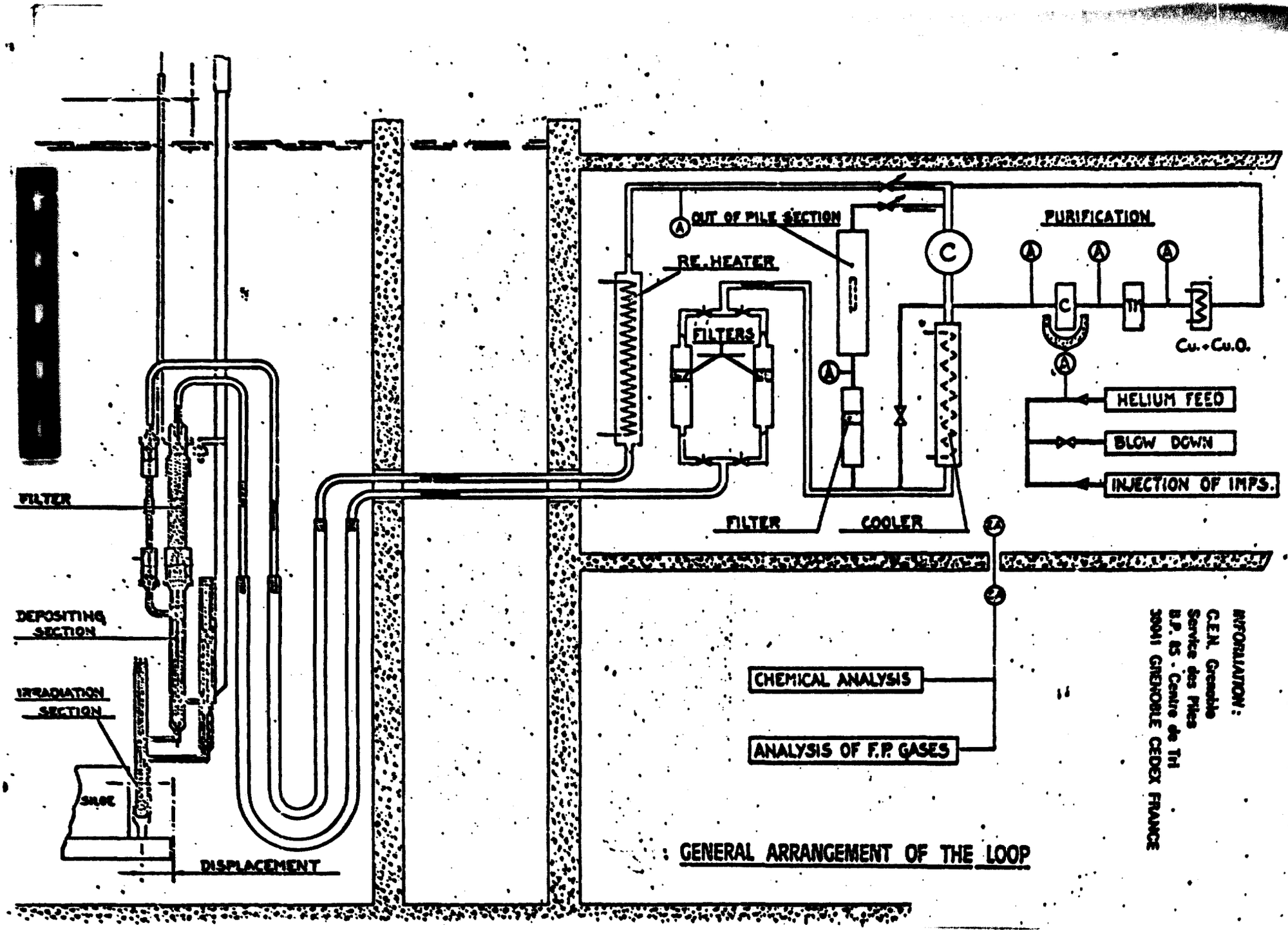
- the first in nominal conditions with oxydizer amount ≤ 10 vpm
- the second in more severe conditions with graphite oxydation and carbon deposits.

From the tubes of the deposit section of the loop (economizer) it is then possible to study the blow down accident, as follows :

- in the first proposition, we can dismantle the deposit section of the loop, recover it and make laboratory tests on the materials in the out of pile loop (shear ratio of about 15 at room temperature or at 500°C).
- in the second proposition we can study the accident in situ.

In this case, it is necessary to add to the loop an expansion vessel which can be used in two ways

- once the expansion vessel is at the same pressure as the loop, induce a fast depressurization of the loop through a filter to recover carried fission products.
- once the expansion vessel is at a higher pressure than the loop, the blow down is made at constant pressure, speed and temperature during 1 to 2 minutes.
- in the "depressurization test", the shear ratio will be variable with time.
- in the "blow down test", the shear ratio will be constant and in our conditions, it is possible to get values from 2 to 3.



GENERAL ARRANGEMENT OF THE LOOP

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