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DEPARTAMENTO DE INGENIERIA DE PROTECCION

RADIOACTIVE WASTE MANAGEMENT AT AN ARGENTINE NUCLEAR POWER PLANT

(A T U C H A)

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R E S U M E N

La OIEA organizó en su sede en Viena una reunión de trabajo a fin de redactar un Código de Prácticas sobre gestión de residuos radiactivos en centrales nucleares para actualizar y/o complementar la Publicación Safety Series N° 28, titulada "Management of Radioactive Wastes at Nuclear Power Plants".

El presente trabajo fué redactado a pedido de la OIEA y como un aporte del autor a la mencionada reunión, que se llevó a cabo entre el 10 y 17 de Noviembre de 1975.

En la primera parte se exponen principios generales de protección radiológica y de gestión de residuos radiactivos adoptados por la CNEA. En la segunda parte se expone el resultado de casi dos años de operación de la Central en lo que respecta a producción, tratamiento y eliminación de residuos radiactivos. Se describen los distintos sistemas de tratamiento con que cuenta la central, facilidades de almacenamiento, producción de residuos, límites de eliminación autorizados, actividad descargada al ambiente, etc.

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BUENOS AIRES - ARGENTINA.

PART I

INTRODUCTION AND GENERAL DISCUSSION.

This report contains two parts: Part I, which is a general introduction, and Part II, which consists of a report written in cooperation with the Health Physics Staff of the Atucha Power Plant. Part II was arranged in accordance with the scheme suggested by the IAEA. The numbering, where applicable, accords with this scheme.

Atucha is a 320 MW(e) nuclear power station which became critical on 13.6.74 and has been delivering power to the grid since June 1974, so it has been acting as a source of experience for approximately one year.

The power reactor is of the heavy water, natural uranium type. The fuel is cooled by heavy water, which passes through inner tubes, with heat transfer to light water for steam generation in order to drive the turbine.

The spent fuel, which is removed from the reactor on power at an approximate rate of 1 FE/day, is stored under water and has not been reprocessed up to date.

As the spent fuel pool will fill its capacity in approximately two years time, a new storage facility with capacity for 3000 spent fuel elements is now in design and will be built and in operation before 1978.

A second nuclear power plant (a 600 MW(e) Candu Type) is under construction at Córdoba. This new plant will be finished in approx. five years time.

PRINCIPLES OF WASTE MANAGEMENT.

1. General.

Human and environmental protection considerations govern the basic decisions involved in any program for the management of radioactive wastes: to discharge the wastes into the environment or to apply containment. Calculations related to the environment into which disposal would be effected, make it possible to carry out a technical and economic evaluation as a basis for such a decision.

It is usually considered axiomatic that, if man as an individual is protected, then his environment will also be protected. The protection limits laid down for man appear to be adequate for the protection of the environment as they ensure very low stochastic risks of effects on individuals and even lower effects on whole species.

Since the protection of man is the main consideration, the basic principles of radiological protection apply: the "dose commitment" due to one year's disposal should not exceed the "dose limits" recommended by ICRP for members of the public. (Argentine has adopted similar rules). These limits must be applied to the critical population group.

On the other hand, the dose received by the public, as a result of disposal, must be "as low as readily achievable, taking into account social and economic considerations". The discharge to the environment must be limited to a value, a further reduction of which would entail a social cost which would be greater than the benefit associated with the corresponding reduction of the risk (cost-risk reduction differential analysis).

2. Limiting radiological capacity.

The first step in the resolution of this problem is the evaluation of the "radiological capacity" of each particular environment. This means the activity (in the form of materials having a given isotopic composition) which could be discharged into that environment, in the course of a year, and result in a dose commitment through critical pathways equal to the dose limits recommended by ICRP.

In order to assess radiological capacity, it is necessary to determine the relationship between the activity discharged into the environment and the resulting dose commitment in man. This relationship depends on a large complex of parameters which vary according to the kind of environment which is used for disposal, and the pathway through which the activity reaches man.

Each place was studied as a special case, and a realistic assessment was made of the radiological capacity of the environment. In these studies, carried out by the Environmental Study Group of the Health Physics and Safety Area, parameters such as location and relevant habits of the population, population distribution, nature of the wastes likely to arise, and so on, were taken into account.

This value is usually known as the "limiting radiological capacity" because in its determination only scientific and technical aspects have been considered, without any safety factor being applied and without any social, economical or political considerations being borne in mind.

3. Stipulated radiological capacity.

The limiting radiological capacity is informed to the Licensing Authority who fixes a final value for that particular region, called the "stipulated radiological capacity", with certain safety factors, taking into consideration that:

a) In calculations of the limiting radiological capacity there is a reasonable margin of uncertainity due to a general lack of knowledge regarding man's use of the environment.

b) Regarding socio-economic considerations, irradiation of the public should be "as low as readily achievable".

This safety factor is not necessarily a fixed quantity: its value may be high when little is known about the local environmental conditions, whereas a low safety factor is usual when the local environmental conditions have been studied thoroughly. Further, the safety factor can vary with time, declining when the results of monitoring show that the environmental calculations were correct and increasing when the opposite is true.

Another question is the possible existence of many facilities located in the same region and discharging to the same environment, so it is the Licensing Authority who fixes the final discharge limits for each facility.

From the point of view of the plant design, the problem is simple: the discharge must be always below the limits fixed by the Authority and as low as practicable.

Both Argentine reactors are sited next to large bodies of water-Paraná River and Lake Río Tercero. The permitted release rate of radionuclides is, or will be, in accordance with the results of environmental studies carried out in each of these sites.

The experience gained during the first year of operation at the Atucha Power Plant shows that the release of activity is well below the fixed limits.

4. Brief description of Atucha's waste systems.

The waste management systems in Atucha are simple. The system for liquids consists of receiving and dispersing tanks, arranged in such a way as to make possible the sampling, analysis and release -or treatment if required- of the liquid effluents.

Two different treatments are available: filtering and evaporation. After a second analysis, the treated liquid is released. The bottom sludge of the evaporator, as well as the filter bed materials are included into a thermoplastic resin and become a solid waste. The active gaseous effluents are mainly originated from degassing operations and are contained in order to allow the decay of short radionuclides prior to their release through the ventilation system. All gases are discharged through the stack after passing through a battery of absolute filters. In certain ventilation circuits, an additional battery of activated charcoal filters is ready for the case of an accident with iodine release.

Some ventilation circuits, where the presence of iodine and tritium, is normally expected, are always passed through activated charcoal and silicagel filters.

The bulk solid wastes (papers, cloths, gloves, etc.) are pressed and transported off-site.

The high active solid wastes (rare) are stored in a vault at the Plant, and mechanical, active filters (sometimes with high activity) are disposed in steel linned holes in a small disposal area in the vicinity of the Plant.

Spent resins are stored underground in special storage tanks.

Up to date, only two defective fuel elements were found in Atucha, one of them due to mechanical damage. As the defect was found prior to the entry of this fuel element to the reactor, it was not irradiated and caused no operating or waste problems. The second defect, due to the failure of the cladding, occurred in operation, but it caused no problems and the fuel element was irradiated as planned originally.

Our experience during this year has been that the amount of radioactive wastes produced by a nuclear power plant was so small that no problems appeared.

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PART II

REPORT FROM ATUCHA STATION

Written with the cooperation of Ing. Eduardo Díaz and Ing. Julio Recalde, Health Physic and Safety Staff of Atucha Power Plant.

I. GENERAL.

1. Power rating: 1100 MW(th)/320MW(e).
2. Average fuel burn-up achieved: 7000 MWD/TON.
3. Fuel cladding material: Zircaloy-4.
4. Fuel composition: UO_2 Natural uranium.
5. Average assemblies with defective cladding: Only two up to date and found, one of them, before irradiation. The other caused no operating problems. Design value for waste and other auxiliary systems: 1%.

II. DISCHARGE FACILITY.

1. By stack (gaseous wastes).

   a) N° of stacks in use: only one (1).
   b) Stack height above ground level: 40 meters.
   c) Exhaust rate: 70-50 m^3/s (2.10^3 Ci/y).

2. By pipeline (liquid wastes).

   a) Discharge rate, both tritiated and not tritiated liquids: 7.10^3 m^3/y.

   Activity discharged: Tritium 90 Ci/y.
   Other radionuclides: 1 Ci/y.

   Average concentration: Tritium: $\sim 10^{-5}$ Ci/l.
   Others: $\sim 10^{-7}$ Ci/l.

III. ON-SITE STORAGE FACILITIES.

1. Short-term

a) Solid wastes.

Atucha has a vault for disposal of high active solid wastes (rare) with a capacity of about 40m^3. It is an underground concrete vault at the Plant, of 2m x 2m and 10m deep.

There is a storage room large enough to store drums of pressed and solidified wastes with a capacity for 100-150 drums (1 year of normal operation).

b) Liquid wastes.

Atucha has three receiving tanks and two dispersion tanks, each has a capacity of 32m^3.

It has two additional receiving/dispersal tanks for tritiated liquids with a capacity of 10m^3 each.

A brief description of the system operation is given in paragraph VI.

c) Spent resins.

Atucha has a tank for spent resins with a capacity of 12m^3 (5 years of normal operation) and space for another similar tank.

After this time (5 or 10 years) it will be necessary to transport the spent resins to a final disposal site.

d) Gaseous wastes.

Atucha has four collection tanks of 16m^3 each, only for waste gases originated in the degassing of the primary system. Each tank, able to hold a pressure of 10 at, has enough capacity for one or two months of normal operation.

A brief description of the system operation is given in paragraph V.

2. Long-term (shallow burial).

There is only a small area for the disposal of high active mechanical filters from the primary system. In this area there are four steel linned holes 27m deep and 40cm in diameter for the disposal of these filters. There is enough place for additional holes.

Other solid wastes are transported off-site.

a) Area: 200 m^2

b) Volume: 130m^3

IV. TRANSPORTATION OF WASTES (OFF-SITE).

1. Main types of wastes transported: low active solid wastes and solidified concentrates of liquid waste system.

2. Volume of waste transported annually: 20m^3 (both types).

3. Estimated activity transported: no values available. The exposition surface levels were above 200 mr/h and 1 R/h for solidified wastes drums.

4. Brief description of containers used: standard steel drums of 200 l capacity.

5. Distance of transportation: approximately 150km.

6. Type of transport: trucks.

V. GASEOUS WASTES.

1. Main source of gaseous wastes: degassing of the primary system.
   Other: Pressure vessel and plant ventilation.

2. Available treatment facilities:

(See diagram)

Degassing wastes are compressed into 16m^3 tanks at 10 at. Each tank holds a volume equivalent to one month of normal operation.

When one of these is filled, a second one is connected and the first is kept full for a one month decay. Then, a third is connected, the second is kept full for decay and the gases held in the first are released to the atmosphere during the month.

A fourth tank remains for emergency or abnormal situations.

All gaseous wastes and the ventilation exhaust air are released through stack after passing through a battery of absolute filters (HEPA filters).

In certain ventilation circuits and additional battery of activated charcoal filters is ready for emergency situations in which iodine release could occur.

The exhaust air from some particular rooms where the presence of iodine and tritium is normally expected are always passed through silicagel and activated charcoal filters.

Analysis of tank gases are made prior to their release and the stack gases released are continuously monitored.

As the stack monitoring system originally provided monitors all gamma emmiters (Geiger or proportional type) it was not possible to fix differential release values for different radionuclides. Therefore it was necessary to work with the lowest value corresponding to Ar^{41}.

A differential monitor is under construction in order to allow the release control of each radionuclide separately. With such a system it will be possible to have a better control of stack release and to know the real percentage of the annual release limits.

Point 5.a. shows that the release for the first year was 100% of the release limits. This value is not real because it considers all gaseous wastes as Ar^{41}.

3. Type of filter used for main discharge route:

HEPA filters and activated charcoal filters, mentioned above.

4. Permissible annual release.

a) Activated and noble gases:

Kr^{85}	$1.1. \times 10^{4}$	Ci/y.
Xe^{133}	1.3×10^{4}	Ci/y.
Ar^{41}	1.5×10^{3}	Ci/y.

b) I^{131} : 0,96 Ci/y.

Airbone particulate: 0,1 Ci/y.

c) Tritium: 6.500 Ci/y.

5. Annual release (% of annual limit).

a) Activation and noble gases: 100% (Real value was actually less).

b) I^{131} : 1%

c) Tritium: 3.5%.

d) Airborne particulate: 0,06%.

6. Permissible level for short period release: 10 times the average release value for very short periods of time (days) or 2 times for monthly releases.

VI. LIQUID WASTES.

1. Source of liquid wastes: leakage of different systems, decontamination works, control laboratory, laundry, etc.

(For liquid wastes system interpretation, see diagram)

2. Treatment used:

Liquid wastes are driven to one of three receiving tanks of $32m^{3}$ capacity each. When the tank is full, another is connected and the contents of the first are analysed. When the result of the analysis is known, there are two possibilities: to pass the contents with no treatment to one of the two dispersal tanks (each having $32 m^3$ capacity) and subsequent discharge, or to treat them.

Depending of the chemical composition, two different treatments are available: evaporation or filtering. The treated liquids are stored in one of the dispersal tanks, and, after a new analysis, they may be discharged or retreated.

There is one evaporator and one filter of the removable-bed tipe. The spent bed material and the bottom sludge of the evaporator are sent to an intermediate storage tank prior to their inclusion in a plastic matrix, which takes place in a special facility.

The included wastes are poured into standard steel drums, 200 l capacity, and become a solid waste which is transported off-site.

Tritiated liquids are driven to one of two receiving tanks of $10 m^3$ capacity each and normally no treatment is necessary; but it is possible to treat them by filtration or evaporation before their discharge.

3. Coolant clean-up method: Mechanical filter and ion-exchange resins.

4. Limitation placed on specific nuclides in coolant: none.

5. Treatment of tritiated liquids: normally none.

6. Percent of treated coolant returned to reactor use:

   The coolant is cleaned as it passes through ion-exchange resins at a rate of 20 m^3/h (primary system circulation rate: 20.000 m^3/h; moderator circulation rate: 700 m^3/h; total primary system capacity: 300 tons) therefore it passes through resins once every 15 hours. From this kind of treatment, all coolant treated is returned to reactor use.

   An enrichment facility allows the purification of heavy water from a reactor use value (99,7%) to a 99,8% value.

   All liquids routed to waste system do not return to use.

7. Volume of wastes arising: 7.000 m^3/y.

8. Volume of wastes collected: approx. the same value.

9. Volume of wastes treated: no values available.

10. Permissible annual release:

    a) Tritium : 10^5 Ci/y.

    b) Other: 5 Ci/y.

    c) Permissible concentration levels in discharge pool (mCi/l):

Sr^{90}	1.1	10^{-7}
Rn^{106}	1.2	10^{-5}
Cs^{137}	1.5	10^{-5}
Zr^{95}	6.3	10^{-5}
I^{131}	2	10^{-6}
Co^{60}	4.6	10^{-5}
Cr^{51}	1.4	10^{-3}
Mn^{54}	9.2	10^{-5}
Ni^{65}	9.1	10^{-5}
Fe^{59}	1.6	10^{-5}
Ce^{144}	1.2	10^{-3}

11. Annual release (% of annual limit):

    a) Tritium: 0.1%.

    b) Other gamma emmiters : 20%

12. Discharge facility:

    All liquids are discharged in the same pool, where the cooling water from the turbine condenser also discharges prior to its fall to the river through the power recovery turbine.

VII. SOLID WASTES.

1. Source of solid wastes:

(See diagram)

The main solid wastes are of low activity and include wood, used airfilters, gloves, used clothes, papers, glass, small radioactive metal pieces, etc.

These solid wastes are pressed into 200 l steel drums and transported off-site. The sludges of the evaporator and filter are included in a thermoplastic resin into 200 l steel drums and transported off-site.

Mechanical filters of the primary system are disposed in a small appropriate facility.

A shielded transfer machine takes the filter from its original operation place and transfers it to a transportation casket, which is transported to the disposal area. Once there, another similar transfer machine takes it from the casket, carries it to a selected hole and allows it to fall into it. Then, it is possible to pour a concrete sludge in order to ensure very low possibilities of leakage. Holes are steel linned and have a 10cm concrete outside layer. Each filter has a length of approximately 1m.

There is also a small facility in order to disassemble less active filters to allow the recuperation of the stainless steel structure. The spent active filter candles are put in a steel container, transported and disposed-of in a similar fashion as high active filters.

Spent resins are driven to a storage tank and stored in plant. No treatment is available for spent resins. The storage capacity is enough for five years of normal operation. There is enough space to build a second tank for another 5 years, but after this it will be necessary to transport the resins off-site.

Only Boron clean-up resins are regenerated.

2. Average annual volume and activity.

a) Resins: approx. $3m^3$ for the first 3 years and $3m^3$ for the next 2 years.

Dates of activity values are not available.

b) Filters and evaporator sludges:

Volume of sludges was not evaluated.
The annual production of included sludges was approx. 30 drums/y. (6 m^3/y).

Activity values are not available.

c) Other wastes:

Radioactive solid wastes: 60 drums/y (12 m^3/y).
Mechanical filters: approx. 10 filters/y, less than 1 m^3/y.

Activity values are not available.

VIII. DECONTAMINATION FACILITIES.

1. Method used: ultra sound; microballs; hot and pressurized water, brushed, chemicals, etc.

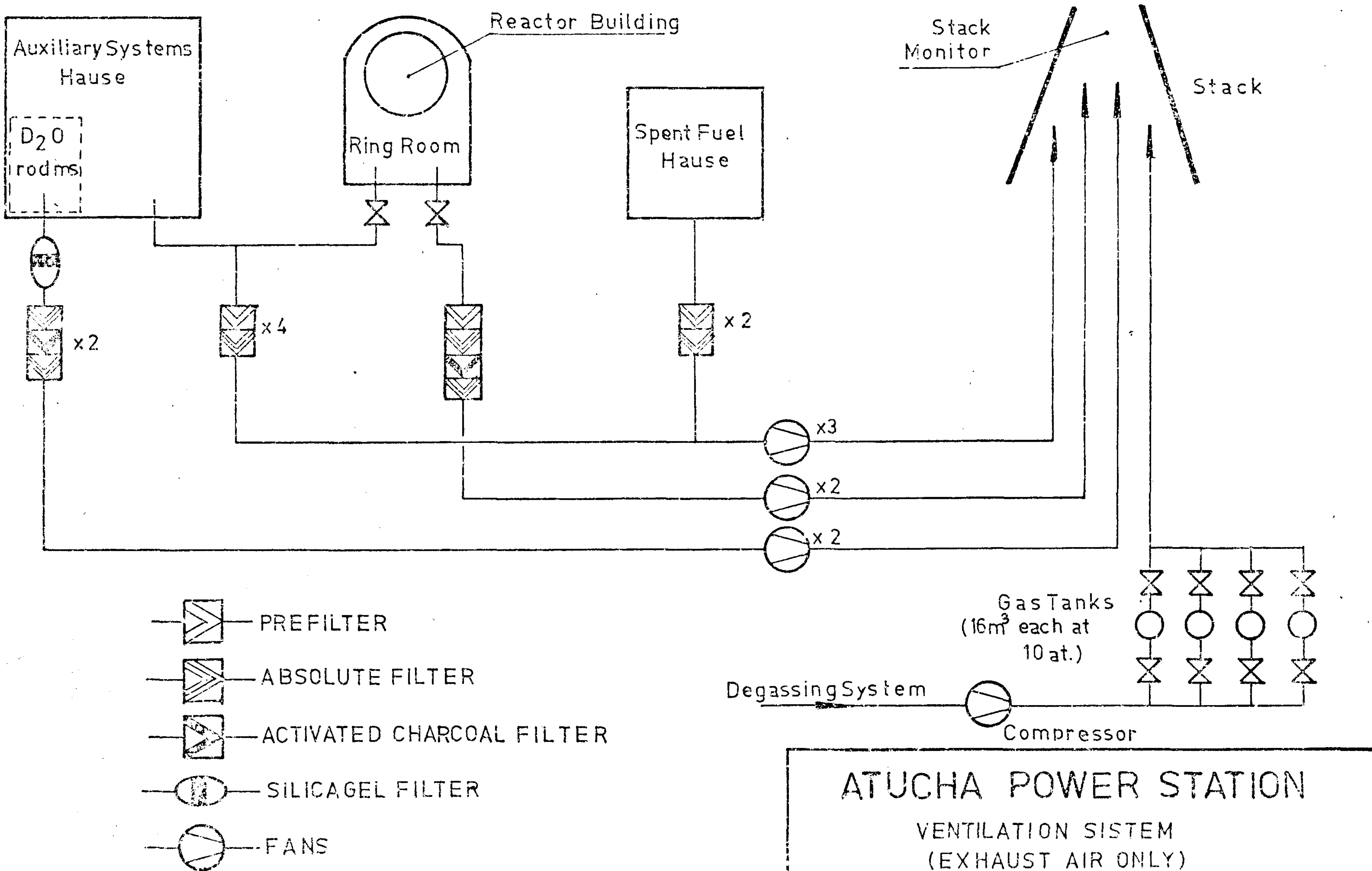
2. Floor area of decontamination facilities: 20 - 30 m^2.

IX. CAPITAL AND OPERATING COST OF WASTE MANAGEMENT FACILITIES.

Values not available.

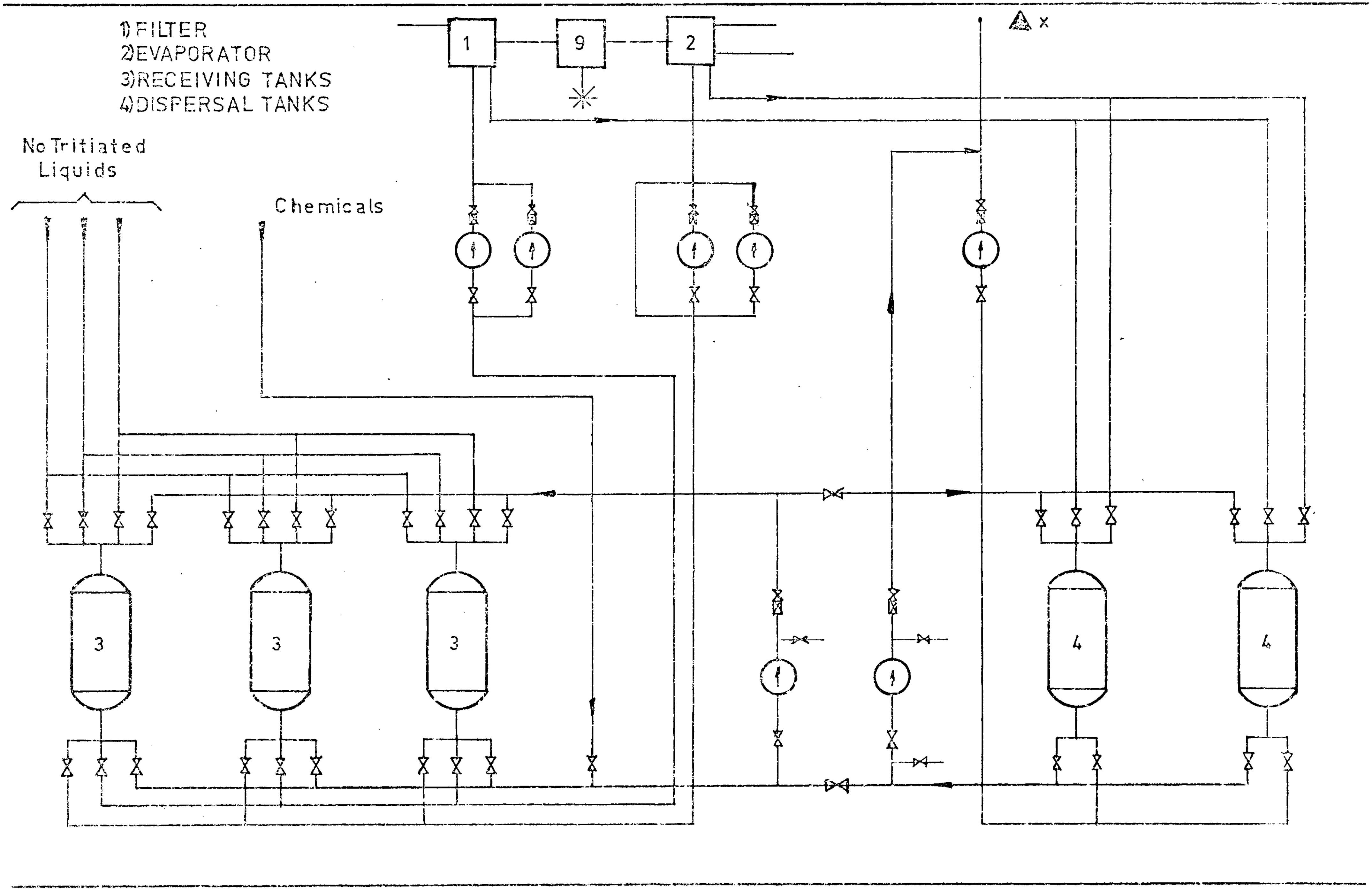
X. MAN-HOURS SPENT ON WASTE MANAGEMENT AND DECONTAMINATION.

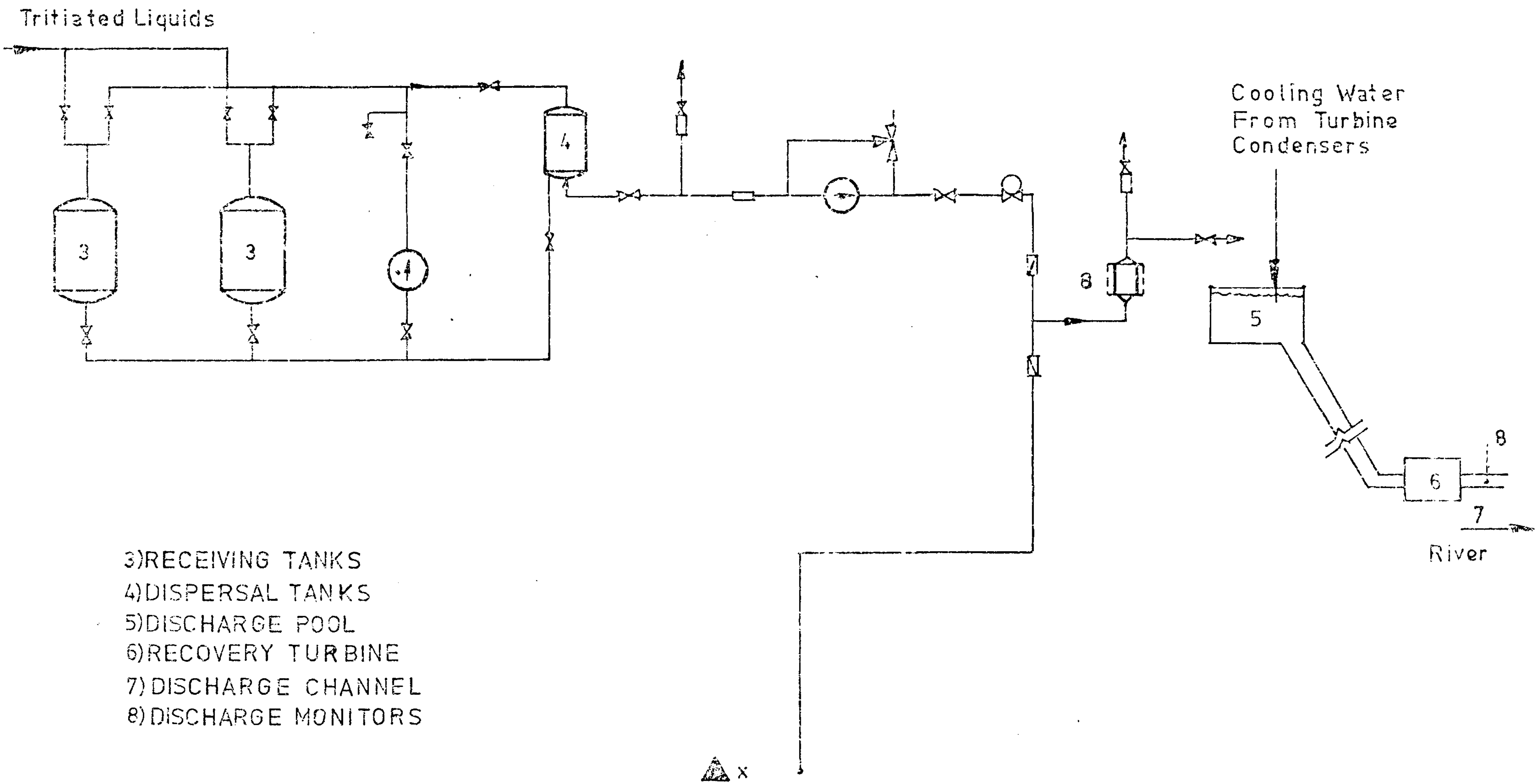
Approx.: 800 man-hours/year.



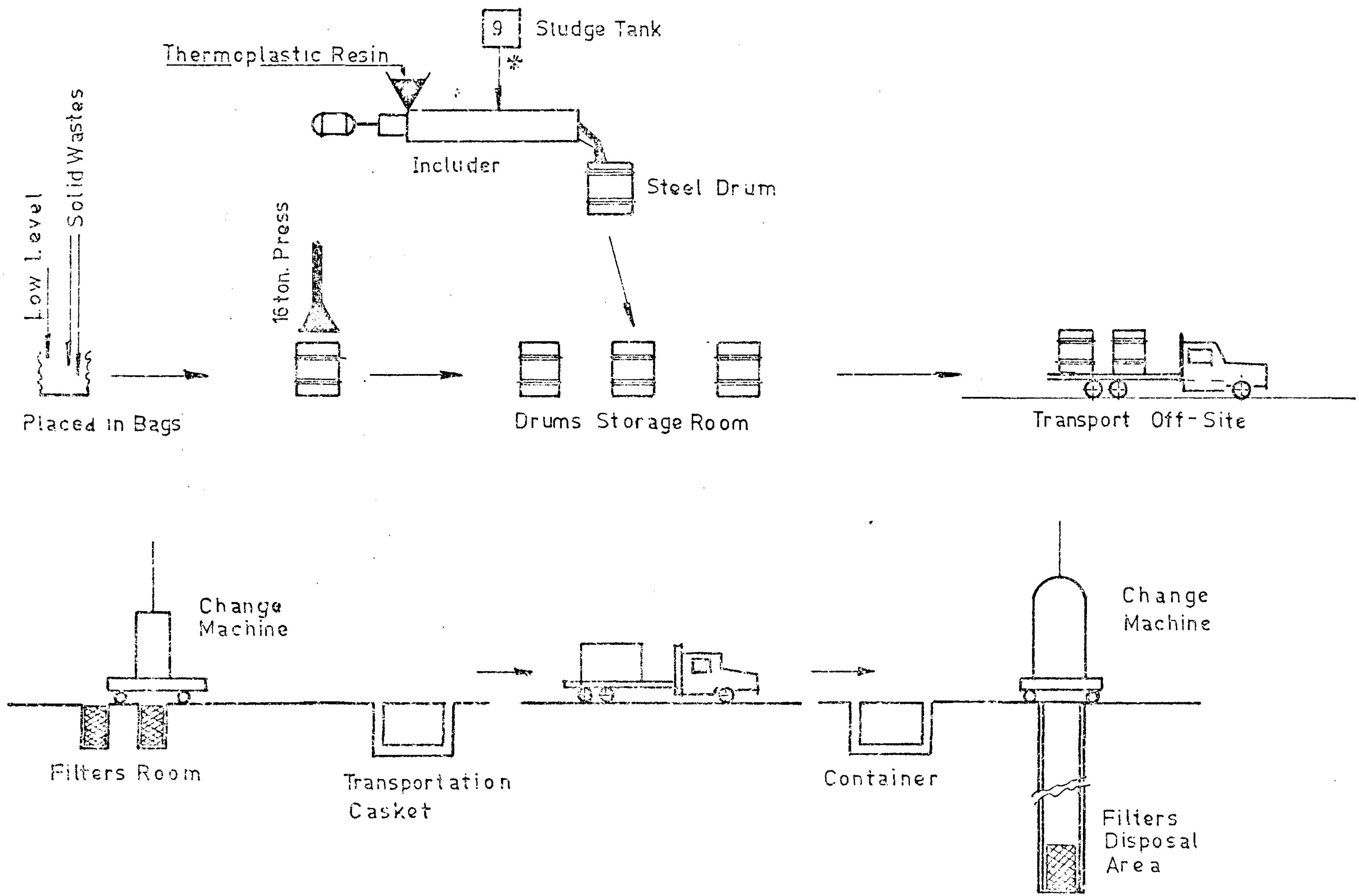
ATUCHA POWER STATION

VENTILATION SISTEM
(EXHAUST AIR ONLY)


1) FILTER
2) EVAPORATOR
3) RECEIVING TANKS
4) DISPERSAL TANKS
No Tritiated Liquids
Chemicals
1
9
2
x
3
3
3
4
4



3)RECEIVING TANKS
4)DISPERSAL TANKS
5)DISCHARGE POOL
6)RECOVERY TURBINE
7) DISCHARGE CHANNEL
8) DISCHARGE MONITORS


Sludge Tank
9
Thermoplastic Resin
*
Includer
Steel Drum
Low Level
Solid Wastes
16ton. Press
Placed in Bags
Drums Storage Room
Transport Off-Site
Change Machine
Filters Room
Transportation Casket
Container
Change Machine
Filters Disposal Area