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| **Item ID Number** | 03917 ☐ **Not Scanned** |
| **Author** | |
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| **Report/Article Title** | Decontamination Program for the Dioxin-Contaminated Areas of Seveso and Meda |
| **Journal/Book Title** | |
| **Year** | 1976 |
| **Month/Day** | August 18 |
| **Color** | ☐ |
| **Number of Images** | 18 |
| **Descripton Notes** | |

# Ministero della Sanità

GIUNTA REGIONALE DELLA LOMBARDIA

ASSESSORATO ALLA SANITA'

## DECONTAMINATION PROGRAM FOR THE DIOXIN-CONTAMINATED AREAS OF SEVESO AND MEDA

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Milan, August 18, 1976

## 1. INTRODUCTION

In a report issued on August 11, 1976, the Technical Commission appointed by virtue of the Ministerial Act of August 4 set out a series of proposals concerning reclamation of the TCDD-contaminated areas, without however providing the information and evaluations necessary for their practical application.

This report is intended as an elaboration of those proposals in practical terms, in the context of a general operational plan. The means, ways and timing of each operation have been specified insofar as this was possible.

The main data concerning the areas to be decontaminated is given below. These areas were defined on the basis of laboratory analyses, clinical and epidemiological findings and data on the animal population.

The A area: high contamination (dioxin concentration $\geq$ 0.001 ppm).

The inhabitants of the area were evacuated in three stages, on July 26, July 28 and August 2. The area is located south south-east of the ICMESA factory, and was downwind of the factory at the time of the accident. The area is triangle-shaped and covers approximately 100 ha (the vertex of the triangle corresponds to the ICMESA factory). Of the 700 inhabitants of the area, approximately 200 (43 families) were living in the northern part (60 ha) and 500 (138 families) in the southern part.

The B area: low contamination (dioxin concentration < 0.001 ppm).
The area was not evacuated. It includes two adjacent zones located south south-east of the A area, covering approximately 200 ha. The area has a total of 4,280 inhabitants (1256 families) divided between a large urban center and an extensive rural area with some small residential aggregates.

## 2. THEORETICAL AND PRACTICAL BASES FOR DECONTAMINATION

It is clear that the object of any decontamination operation is to completely eliminate the harmful substance. In the case at hand this task is made all the more difficult by dioxin's high resistance to chemical and physical agents; by our insufficient knowledge of its distribution in the environment; and by the difficulties involved in the destruction of dioxin, especially due to the presence in the area of material objects of high economic, cultural or sentimental value, which, if contaminated, should also be destroyed.
Combustion at 800-1200° C. definitely destroys dioxin, although at 160-500° C. dioxin can be formed from the trichlorophenol present. This method can be easily applied to vegetation, wastes, etc., while application to materials that do not burn well is difficult, and at times impossible. Metal equipment, machinery, etc. and building materials, in which the poisonous substance can survive for long periods of time,

should be buried or walled into structures with impermeable walls such as those used for radioactive wastes; but burial is unacceptable if there is a risk of contaminating the ground water, and both methods are unfeasible when dealing with a substantial amount of material. It is asserted that light favors the natural degradation of dioxin, and experiments are cited in which the compound, dissolved in alcohol, is rapidly decomposed by ultraviolet rays. However, no one knows if, or to what extent, one can count on photolysis in practice, or if and how this action might be activated and speeded up (perhaps with the use of special chemical agents). It is due to this lack of knowledge, to the widely divergent opinions on the matter, and to the urgent need for public health measures, that the Commission has proposed a program of "differentiated" action, that is, the concurrent adoption of different techniques in different areas, or on different materials within the same area, depending on the extent of the contamination, the target levels to be reached, and so forth. All the operations will contribute to the final goal, which is that of reducing the exposed population's risk to the lowest possible level.

Any one of the operations alone - whether aimed at destroying the poisonous substance, preventing it from coming into contact with man (through physical contact, food, air, etc.), or promoting active defense (prevention) with rules for the population to follow - cannot solve the problem: this can be

accomplished only through a series of well-planned, well-coordinated and well-supervised operations. This is, of course, a well-known fact in the field of public health, but the serious Seveso accident makes it all the more evident.

## 3. THE DECONTAMINATION PROGRAM

The decontamination program was formulated on the basis of the above premises, taking into account the proposals presented by the Technical Commission. These proposals are outlined on the following page.

### 3.1. The ICMESA plant

The elimination of risks connected with the ICMESA plant has been a source of special difficulties, which have been handled separately. Such will be the case in the future as well, due to the restrictions imposed by judicial authorities.

### 3.2. Setting up the A area as a base for decontamination operations

The execution and completion of most, if not all, of the operations is dependent on proper preparation of the A area. This includes:

a) Choice of an appropriate location - within the A area, easily accessible from the A and B areas, and of adequate size - for the following facilities:

OPERATIONS PROPOSED BY THE TECHNICAL COMMISSION FOR DECONTAMINATION OF THE A AND B AREAS

| Substrate to be decontaminated | Operations | |
|---|---|---|
| ICMESA FACTORY | Elimination of risks connected with the factory and isolation of the plant, to be fenced off with a 4 m. high small-link fence, covered with sheets of plastic or other suitable material. | |
| | A area | B area |
| VEGETATION | Defoliation of trees and transportation of the material to the deposit<br>Mowing and removal of all other vegetation and transportation to deposit | As for the A area. In addition, cultivation of the land prohibited for 1 year. |
| GROUND | Areas where dioxin concen. > 0.005 ppm: topsoil removal and incineration<br>Areas where dioxin concen. $\leq$ 0.005 ppm: constant monitoring of the fate of dioxin and testing of decontamination techniques | - |

PROPOSED OPERATIONS con't

| Substrate to be decontaminated | A area | B area |
|---|---|---|
| BUILDINGS | Isolation; removal of any material or object absolutely prohibited | Decontamination, where necessary, according to the contamination level of the outer and inner surfaces |

- entry point
- building space for administrative and organizational offices, filter area (dressing rooms for workers, etc) and storage of experimental equipment
- area reserved for storage, decontamination and repair of motorized vehicles, machinery and equipment used in the A area
- incinerator
- deposit for material to be incinerated (foliage, grass, branches, etc)

b) choice of a limited area for field experiments

c) building and equipment design

d) rapid construction of buildings and equipment

e) adequate preparation of road connection between the access zone and all parts of the A area. Particular care must be taken in the experimentation area so that traffic will not disperse the substances being monitored.

Note:

As far as incineration is concerned, it would be preferable to have two average-sized incinerators rather than one large one, to ensure the continuity of the operation. The incinerators should be capable of incinerating soil as well as vegetation, and should be convertible to garbage combustion once the area has been decontaminated. The deposit basin should have impermeable cement walls and an overshade; it should be 5 m. deep with base area of 5,000 square meters.

5000 sq.m., giving a 25,000 cu.m. capacity.[1]
A building complex similar to that designed for the A area, equipped with its own vehicles, machinery, decontamination equipment, etc. will be built just outside the B area.
The above preparations must be started immediately; administrative and technical positions must be staffed, and equipment assembled, as soon as possible.
The access zone, building complex and deposit basin must be ready by the end of September.
The incinerator must be operable by the end of 1976.

3.3. General recommendations for carrying out the operations and checks

a) All decontamination operations, regardless of the environmental material being treated (vegetation, soil, buildings, etc.) must begin at the outermost parts of the B area and then be extended first to the southern part of the A area, and then to the northern part.
b) The effectiveness of the decontamination work will be checked by repeated samplings and analyses before and after each operation, using standardized techniques and following a pre-established program.
c) The widespread use of a particular substance, or of a particular field-tested decontamination procedure, will be

[1] The volume of foliage, branches, etc. to be removed from the A and B areas is estimated at 10,000 cu.m., or 2000 metric tons.

evaluated by the Technical Commission on the basis of the results obtained.

3.4. Removal of foliage and low-growing vegetation

The following operations are to be carried out, in the order listed, in both the A and B areas:

a) Preliminary dissemination of a substance capable of fixing the contaminant to the vegetation, for the purpose of protecting the workers and avoiding, or minimizing, the dispersion of the contaminant into the air.

b) Removal of the foliage and low-growing vegetation using the method described in section 4.1.

c) Transportation of the material to the deposit basin in the A area, and then to the incinerator.

These operations must be carried out as soon as possible, as much of the poisonous substance has adhered to the vegetation. Moreover, the summer season is almost over, and when the leaves begin to fall and disintegrate, there is a much greater possibility of the contaminant's being dispersed into the air.

The above operations should be completed in two months' time.

3.5. Soil

1) In the northern part of the A area immediately surrounding the ICMESA factory: extremely high contamination (dioxin concentration > 0.005 ppm):

a) Removal of a 10 cm. layer of topsoil along with the low-growing vegetation present

b) Transportation of this material to the deposit in the A area

c) Incineration (for which fuel will be added to the collected material)

This area covers approximately 15 ha.

2) In the A and B areas:

a) Study of the fate of dioxin in the soil through the analysis of samples gathered at increasing depths, beginning at the surface. Sampling will be performed with a special drill. Both the sampling and analyses must be carried out according to a well-defined plan, at fixed points and pre-determined intervals, corresponding to examination of vegetation from the same area. To begin immediately.

b) Removal of the low-growing vegetation (concurrently with the removal of vegetation and topsoil in the northern part of the A area).

c) Treatment of the soil with agents capable of speeding up the natural degradation of the dioxin. This operation should begin as soon as suitable agents are selected on the basis of the experimentation to be done in the specially reserved section of the A area.

d) In the B area, cultivation of the land will be prohibited for one year.

Removal of topsoil around the ICMESA factory will not only eliminate a large amount of the dioxin present but will also minimize the risk of its spreading into the surrounding areas (due, for example, to changing weather conditions) and into

the acquifer.

3.6. Buildings

1) In the A area only:

a) "Isolation": This does not mean demolition, as many people seem to believe: such an operation would be difficult, dangerous for workers, and would give rise to serious problems concerning the final destination of the material, as mentioned in section 2. Isolation means the adoption of special measures to keep people from entering the buildings and removing objects, where fencing off is not considered sufficient.

b) Experimentation with physical and chemical agents such as ultraviolet rays throught to be capable of speeding up the natural degradation of dioxin, and with methods such as washing, scraping, application of a layer of durable, highly adhesive impermeable material, removal and replacement of roofs and floors, etc. To begin immediately.

2) In the A and B areas:

a) Determination of the level of contamination on inner surfaces (walls and floors) and outer surfaces (walls and roofs).

b) Treatment of the inside and outside surfaces with agents or methods chosen on the basis of the experimentation described in point 1)b above.

c) Constant monitoring of the fate of the contaminant on both inside and outside surfaces (roofs and balconies having a north northwest exposure). To begin immediately.

3.7. Streets and squares (asphalted, non-asphalted, paved; etc.)

In both the A and B areas:

a) Determination of the level of contamination

b) Application of a suitable fixing agent, perhaps tar, possibly containing substances which activate the degradation of dioxin.

c) Checking of the effectiveness and durability of the procedure using the methods described in point 3.3.b.

The fixing agents will be chosen on the basis of the tests being carried out in the experimentation area; different agents may be required for asphalted streets and non-asphalted country roads.

The intervals at which the fixing agent should be re-applied must be determined.

The decontamination of streets and squares should precede the removal of foliage and vegetation to avoid dispersion of the contaminant by the heavy traffic involved in the second operation.

## 4. DETAILS CONCERNING THE REMOVAL OF VEGETATION; EXPERIMENTATION; SURVEILLANCE

### 4.1. Defoliation and removal of low-growing vegetation

The leaves and low-growing vegetation will be collected first in the B area and then in the A area, in order to maintain the necessary separation of personnel and equipment used in the two areas.

All low-growing vegetation - flowers, vegetables, bushes, hedges, etc. - whether in fields, gardens or road-side beds, plus all conifers, will be cut down to the ground.
Ornamental and fruit trees will also be cut down, and others planted in their place in three years' time.
Forest trees will be carefully pruned.
After mowing, leaves and low-growing plants will be put into sacks; branches and cut-up tree trunks will be made into bundles for easier handling.
All the material will be transported to the deposit in covered trucks. In order to prevent the passage of trucks from the B area into the A area, the material will be transferred by cranes into A area trucks at the borderline between the two areas.
All of the above operations should be carried out, insofar as is possible, with automated, mechanical equipment in order to minimize manual operations.
Clearly, these operations raise numerous questions as to the organization and training of personnel, their working conditions, and the availability of vehicles and equipment of the type and number required. These questions, particularly those concerning personnel, are now under study; specialized firms have been contacted concerning the equipment to be used. The personnel will be trained by technicians and employees of the national electric company, who are experts in the decontamination of radioactive materials. It may be possible for personnel in the B area to use a simpler uniform than that required for work in highly contaminated areas.

Decontamination operations will be supervised by highly qualified inspectors.

4.2. Experimentation

The Technical Commission recommends:

1) that proposals for research and experimentation presented by outside groups be approved by Regional authorities after consultation with the Technical Commission;
2) that the Region allocate a limited area and/or buildings within the A area for the purpose of experimentation;
3) that the experiments be coordinated by the "Istituto Superiore di Sanità," a special agency of the Italian Department of Health, in conjunction with the Regional authorities.

The characteristics of the experimentation area, the duration of the experiments and the procedures to be used will be decided by the research groups together with the Regional authorities and the Italian Department of Health.
Experiments will not be carried out in the B area.
The results of the experiments will be evaluated by the Technical Commission which will then make recommendations concerning possible continuation of the experiments and the applicability, within the A and B areas, of the decontamination procedures discovered or developed during experimentation.

## 4.3. Surveillance

The objectives of surveillance in the A and B areas are:

a) to follow the movement of the dioxin, carried by wind, precipitation, run-off water, food, and animals present in the area;

b) to monitor the natural degradation of dioxin in the environment;

c) to study dioxin's leaching into the soil.

Rabbits will be placed in different areas as test animals. The studies must be carried out according to a well-defined program, with highly qualified personnel and specialized equipment. It is therefore essential that suitable personnel and equipment be assembled as soon as possible; in the meantime, presently available resources may be redistributed to aid environmental studies and experimentation.

Some of the aforementioned studies are already going on. Research on the fate of dioxin in the soil is of special importance, since it must serve as a basis for evaluating possible effects on the acquifer.

The following measure have been taken for the Respect area:

a) The population is under clinical and epidemiological surveillance.

b) Fruit, vegetables and other food products are subject to periodic examinations.

c) Breeding farms - especially rabbit farms - are under close surveillance by the veterinary service.

Examinations of the air, water and soil are also to be performed in this area.

## 5. CONCLUSION

Decontamination of an environment contaminated by dioxin is particularly difficult, due to the substances's resistance to chemical and physical agents. Combustion, which constitutes a highly effective method of decontamination under proper conditions, is unfeasible where a large quantity of poorly combustible material is involved. Reliable data on the effectiveness of chemical and physical agents in activating the natural degradation of dioxin is quite scarse; there is to date no known procedure which can ensure the elimination of dioxin in a reasonably short time.

The program outlined in this report is based on the principle of eliminating a health hazard at its source, wherever this is possible. This may be achieved, in the Seveso area, by removing and incinerating all leaves and low-growing vegetation, on which most of the dioxin has come to rest. Recent analyses have shown that there is still a considerable quantity of dioxin on this vegetation, despite the heavy rains. This operation should take approximately 2 months, and should be followed by treatment with chemical or other agents to eliminate the dioxin present in the bare soil and the buildings. The evacuated and fenced off A area will serve as the base for decontamination operations: the incinerators, depos-

its, experimentation area and all related facilities will be located here.

It is evident that the success of the decontamination program is contingent upon the results obtained from experimentation; however, the removal of all vegetation, and therefore of a considerable quantity of dioxin, constitutes a first important step toward total reclamation of the environment.