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French regulations and geomembranes: French disposal concept for hazardous waste and municipal waste

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ABSTRACT : The French concept for disposal of hazardous waste and domestic waste is describe by the ministerial orders of December 18, 1992. It is based on icreased waste selectivity and concept of solidified and stabilized ultimate waste , an oversized, accessible leachate drainage system and final cover on the multilayer sealed site. These elements are the three active safety systems of a waste disposal center that will avoid damage to the natural environlent, i.e. the geological formation accomodating the facility, by the waste or any leachates. The Franch concept for disposal of domestic waste has a few special features related to the nature of the waste.

1 - INTRODUCTION

A fiew years ago, our waste was disposed of in garbage dumps, then in sanitary landfills and now in waste disposal centers. This change in name corresponds to a concrete reallity that is fully visible in these facilities.

Waste disposal is becoming an increasingly technical industrial activity.

This evolution did not occur unaided but resulted from necessary changes in the regulations.

In effect, the nuisance factors related to garbage dumps jeopardized the environment more or less visibly and seriously by odors, presence of birds, insufficient recovery of leachates and biogases, unsuitable geology, etc. Their sociological impact also became very important, giving them an extremely negative image, compounded by media actions to such an extent that it became impossible to create new garbage dumps and even to maintain some of the existing ones.

In 1990, France engaged a reflexion on how to dispose of hazardous industrial waste. The ministerial orders of December 18,1992 relative to the disposal of ultimate, stabilizedhazardous industrial wastes, supplemented by the orders of February 18, 1994, set forth the objectives and the means to be implemented to operate a disposal center.

A similar approach is also engaged for disposal of domestic wastes. It should be soon concluded by the publication of a new ministerial order.

2 - THE FRENCH CONCEPT FOR HAZARDOUS WASTE DISPOSAL

2 . 1 The ultimate waste

The waste itself is the first active safety system. The ministerial order of December 18, 1992 defines it as follow: »The permissible wastes are ultimate hazardous industrial wastes, i.e. waste that may or may not result from treatment of waste that cannot be furter treated under prevalling technical and economical conditions, in particular by extraction of the marketable fraction or by reduction of their polluting or hazardous character. Such waste are essentially solid, mineral with a pollutant potential consisting of poorly mobilisable heavy metals. They are very weakly soluble. In addition, such wastes have to be stabilized in the short term.»

This definition expresses the will to no longer accept organic wastes, fermentable wastes, soiled packaging, wastes with a high liquid fraction or soluble wastes in hazardous waste disposal centers.

To meet this definition, certain wastes must be subjected to special treatment prior to disposal.

2 . 2 The ultimate stabilized waste

The ultimate waste must be stabilized : waste is considered stabilized when its permeability to water

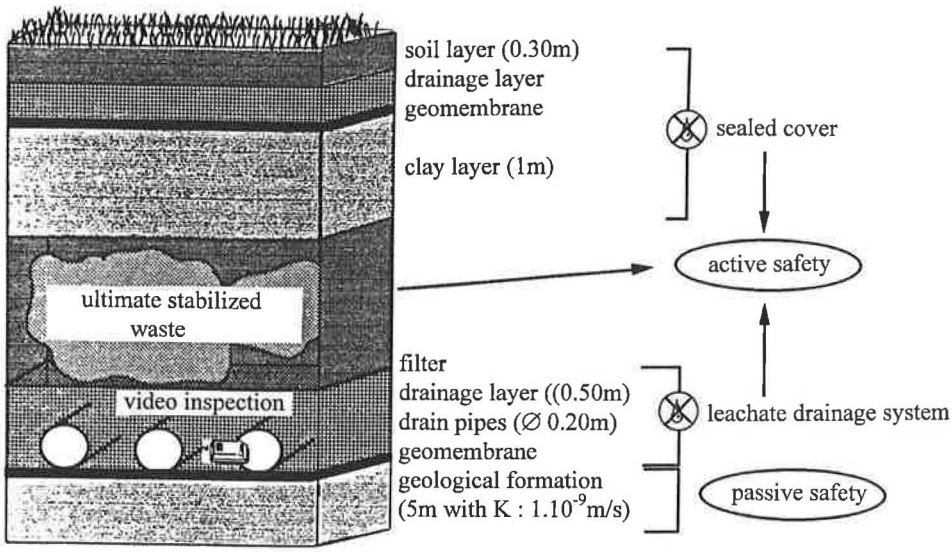

Fig1 Illustration of the French concept for hazardous waste disposal

and its leacheable fraction have been reduced and its mechanical strengh has been improved so that its characteristics satisfy the stabilized waste acceptibility criteria.

2. 3 The leachate drainage.

The regulations define the configuration of the leachate drainage structure in the bottom and on the sides of the waste disposal cells as follows (from bottom to top) :

- A manufactured flexible membrane liner; chemically compatible with the waste stored and mechanically acceptable considering the geotechnical aspects of the project;

- A flexible membrane liner protection system against punching of the flexible membrane liner;

- A drainage layer with a thickness of 50cm made of siliceous materials with a permeability coefficient above 1*10-4m/s

- A network of 20 cm diameter drain pipes for drainage of theleachates and accessible to video inspection;

- A drainage level protective layer acting as filter and can be made of natural or synthetic material.

The drainage network thus configured should allow real-time drainage of any leacheates reaching the bottom of the cells so that there is no hydraulic pressure in the bottom of the site. The drainage pipes are oversized also to allow inspection and maintenance.

The flexible membrane liner required by the rgulations is an integral part of the drainage system. It is the basic component on which the leacheates flow toward the drain lines before being discharged to catch basins or tanks ; it is waterproof component of the drainage system and therefore exhibits very low permeability by comparison with the drainage layer immediately covering it. The drainage system life cycle should be equal to the disposal center operating time plus a few years required for drying out the site.

This flexible membrane liner placed in the bottom of the site should be chemically resistant to the leacheates which with it is in contact and be dimensionned with its protective layer to withstand perforation and the various mechanical, thermal and biological stresses to which it will be subjected, in order to ensure its function and preserve it over time. This sealing-drainage function can only by ensured through particulary careful implementation of each of the components.

Considering the changes in the waste disposed of, in particular its stabilization, the chemical aggressivity of the leacheates can be expected to decrease strongly.

This remak does not apply to domestic waste disposal centers for which the new regulations do not foresee as many changes in the nature and quality of the waste to be disposed of.

2.4 Final cover

The regulation defines the final cover as follows (from bottom to top) :

- A drainage layer creating a depression on the site
- A layer of materials one meter thick with a permeability coeficient below 1 x 10^{-9} m/s
- A flexible membrane liner
- A 30 cm drainage layer with a permeability coefficient above 1 x 10^{-4} m/s and including drain manifolds
- A layer of vegetational soil at least 30 cm thick.

The final cover should provice a long-term guarantee of the absence of meteoric water ingress into the disposal site. In addition to this objective, and insofar as the sites are landscaped, it must have water runoff, storage, evaporation and drainage capabilities guaranteeing its geotechnical stability and its capacity to sustain vegetation in good condition. The prime function of the cover is provided by the sealing-drainage system associating the fexible membrane liner and the drainage layer.

The fexible membrane liner of the cover system is in contact only with meteoric water and is therefore not subjected to chemical aggression ; it must however be capable of withstanding biological, thermal and mechanical stresses related in particular to settling of the waste and possible geotechnical instabilities.

This cover is in addition relatively vulnerable to erosion phenomema.

The sealed cover guaranteeing the absence of water infiltration in the site in the long term is of the highest importance and must therefore be particulary carefully designed and used, even if it is always possible to rework it.

2.5. Geological Context

The geological context is the passive safety system of a waste disposal center. In effect, the active safety systems should prevent the natural environment from being impacted by the leacheates and waste. However, if that were to occur, the risk would be minimized insofar as the stabilized waste produces unaggresive leacheates.

This passive safety system is provided by a natural geological formation already in place or backfilled according to the rules of good workmanship. It has a minimum thickness of 5 meters, with a permeability coefficient less than or equal to 1 x 10^{-9} m/s on the bottom and sides of the disposal facility.

Lacking suitable formations, the passive barrier can be recreated artificially ans should exhibit characteritics equivalent to those of the natural levels in place.

Qualification of the site is carried out by geological surveys including in situ permeability, hydrogeological and geotechnical measurements to confirm the overall stability.

3 - THE FRENCH CONCEPT OF DOMESTIC AND SIMILAR WASTE DISPOSAL

The French concept of domestic waste disposal is inspired to a large extent from the special industrial waste disposal concept, but has special features related to the nature of the waste.

3-1 Waste

The idea of ultimate waste is currently missing from the concept of domestic waste, although reflections are in progress. However, there are two categories of waste that should be disposed of in separate cells :

- Fermentable waste with a high organic fraction which will evolve by biochemical maturation accompanied by the production of biogas. Permissibility thresholds concerning dryness appear for certain waste such as sludges.
- Nonfermentable waste with no organic fraction, which does not enolve and does not produce biogas ; this category includes slag resulting from the incineration of domestic waste, sorting rejects, bulky objects and common industrial waste, certain foundry sands, plastic,metal and glass wastes, mineral waste that is not special industrial waste.

3-2 Leach ate Drainage

The drainage system is in all points identical to that required for special industrial waste disposal centers. The only difference resides in the diameter of the drainage lines which is not specified and is left to the free choice of the projet designers.

3-3 Cover

The cover varies according to the nature of the waste.

For fermentable waste cells, the cover is temporary and is qualified as semipermeable. It

should allow the ingress of water into the cells so that the organic material degradation and biogas production mechanisms can occur fully. It includes from bottom to top :

- A drainage layer participating in the collection and capture of biogas and in which is located the gas drainage and capture network.
- A semipermeable screen made of natural clay materials reworked and compacted in a thickness of at least one meter or any equivalent system providing the same efficiency.
- A drainage layer limiting the infiltrations of meteoric water in the disposal.
- A sufficient layer of vegetational soil to allow the planting of vegetation promoting evapotranspiration.

If, fifteen years after the end of commercial operation, the disposal facilities are still producing large quantities of leacheates, the operator will then seal the cover.

For nonfermentable waste cells, the cover should ensure complete confinement and therefore prevent any ingress of water into the disposal area. The multilayer structure includes from bottom to top :

- A waterproof screen consisting of a flexible membrane liner or any other equivalent system surmouting a level of clay of one meter with a permeability less than or equal to 1×10^{-9} m/s.
- A drainage level with a permeability coefficient above 1×10^{-4} m/s supplemented by drains where necessary.
- A sufficiently thick layer of vegetational soil allowing the playing of durable vegetation.

3. 4 Geological Context

The passive safety concept associated with the geological context should exhibit the following permeability characteristics from top to bottom :

- One meter with a permeability less than 1×10^{-9} m/s.
- Five meters with a permeability less than 1×10^{-6} m/s.

It is possible to add the 1×10^{-9} m/s layer by backfill when it is absent.

However, when the geological context does not exhibit any formation with the required characteristics, the study of the direct and indirect temporary and permanent effects that the facility would have on the environment determines whether or not it can be authorized.

4- CONCLUSION

The French waste disposal concept based on long-term confinement uses flexible membrane liners for specific leacheate drainage functions during operation of the sites and drainage of the rainwater falling on the cover of the sites after their closure.

However, flexible membrane liners can in no case replace geological formations which should, insofar as possible and for a long time, prevent contamination of the soils, the groudwater and surface water by waste and leacheates.