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Identification and determination the decontamination process and waste storage of radioactive materials in nuclear fuel cycle

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In nuclear industry, the implementable safety standards by people are mostly like the common safety regulations in industries and if these regulations are implemented correctly, pollution of this industry will stay in low level. The significant difference between this industry and other industries like medical or chemical industries shows that radioactive materials such asmicrobial bacteria or the present chemical materials in factory can't be removed, but only can be cleaned from the contaminated surface and stored in a specific place. Anyway, when there is contamination, it is necessary to have effective decontamination for radioactive installations and also used materials and levels in this industry. It is felt that first making contamination should be prevented by a proper and principal planning, finally proper actions be conducted for decontamination properly, and each type of waste is packed properly to prevent from transmitting materials in environment and people exposure. According to half-life of radioactive materials, this packing can be burnt and stay healthy for hundreds years to prevent from radioactive transmitting to environment. In this article, decontamination procedures of the used installations in nuclear industries with decontamination of the exposed people to radioactive materials or by accident was prepared by waste storage technique, because radioactive contamination happens, when the radiative materials may contact with object surface at any way.

Keywords: decontamination, nuclear waste, radioactive contamination.

1.INTRODUCTION

Decontamination is a proceeding technique on decontamination the radioactive levels. The contamination can be prevented by proper designing of working with radioactive materials, selecting surface materials properly, using proper protective cloths, training employees, and using needed monitoring installations.

The used decontaminating system for radioactive materials must be in a way that necessary installations and facilities remove radiative contaminations in contacting installations and objects. For example, some parts are considered to take apart the contaminated installation and also a place was considered to keep temporary or montage. Decontamination can be described as following in summary: each process that reduces or generally remove radionuclides from the contaminated surfaces. The decontamination seems necessary to cope with the destructive radioactive effects. Some reasons for this action are as following [4]:

1. Endangering healthy: size and amount of radioactive materials must reduce in environment until exposing people and contamination production aren't more than the permitted limit.
2. The accurate measuring won't be possible for contaminations on monitoring installation, because there are always amount of radioactive materials on surface.
5. The necessity of doing particular or ordinal operations on repairing devices in nuclear centers that some of them have radioactive materials and will produce contamination.
6. Disposing contaminated materials in environment or its recycling from installations.
7. Achieving proper and low level of contamination for reusing installations.
8. Contamination of environment to radioactive materials by accidental or intentional events.

The most caused dangers by contaminations happen when it is directly exposed to body. Decontamination is effective, when it is with accurate monitoring and examining. The waste that is caused during decontamination will have contaminating materials that must be mentioned in calculations. It must be noticed anyway that the mount of contamination and consequently the decontamination operations must minimize the toxic effects and radiations. Studying the contamination nature, contamination mechanism, and decontamination reactors nature are the necessary actions to prevent contamination process accurately.

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2. EXAMINING AND MONITORING

Each installations and equipment having radioactive materials must be monitored and examined as an ordinary and permanent action. The common contamination measuring techniques include surface direct monitoring technique and contaminated spot test (Smear test).Searching tool in direct monitoring technique is above the contaminated surface, but the spots move to the position of monitoring instruments in indirect pots technique. It must be considered that the accurate monitoring of employed people in contaminated surfaces will prevent from transmitting contamination to other parts. The position of monitoring hands and legs in employees of the contaminated places will be to prevent transmitting contamination.

3. CONTAMINATION RESOURCES AND PROCESS

The made contamination by radioactive materials can be divided into three classes: soluble materials (as ion), particles, and colloids. Soluble compounds that are usually placed in non-metal surfaces can be removed from physical absorbance or ion exchanges by reactor groups (usually acids) from surface. The ionic materials aren't absorbed by negative loads but are desorbed. Therefore, Small amounts of the substances can be absorbed by materials with negative ions. However, the positive ion was absorbed in acidic levels and under the desirable condition, low concentration particles, and also polyvalent cations are absorbed in lower limit. Unfortunately the maximum decay products and all natural heavy radioactive elements are in this class. The colloid and particulate pollution can be absorbed by suspension solution and precipitate on the substrate surface [2].

The most important and principal and yet the minimum contamination resources will occur, when the radioactive materials are put in surface and is worked even with no event. The clearest materials about contamination transmission in such condition can be mentioned as following:

- Insufficient evaluation of risk taking in working with radioactive materials both in laboratory and application;
- The great event- this problem happens mostly, but it can be minimized in preparing map with accurate and précised planning;
- Putting the radioactive materials on surface and recycling it from transportation tanks;
- The resulted contamination from the uncontrolled tanks;
- Putting the radioactive materials inside the glove box;
- The chemical reactions in surfaces such as evaporation, solution extraction, various chemical reactions, stirring in beaker, breaking glass devices and aerated solution;
- Leakage from filters;
- The leakage of the contaminated vapors from airon air volatile locations on filters;
- Mechanical work on solid materials by CNC lathes, grinding machines for cutting, and crushing machines.

3.1 Effect of nature and surface kinds on contamination

When the quality of surface that may be radiated and materials are indicated, another important issue is contamination mechanisms and the cleaner substances type needed to remove contamination. The selected surface should resist against contamination removal; otherwise, the contamination proceeds on surface and will be resistant against contamination. Generally, surfaces are in three types: metal, organic, and glass. When the contaminated surface is metal, there would be a proportion between this surface and the contaminated cations, and this issue cause contamination to be formed on surface. Decontamination in this condition is obtained by separating the contaminated ions from the surface. Most metals have an oxidized surface on their surface acting as a protective layer, and pollution is trapped mostly in this area. Cutting this layer is the first step of decontamination the metal surfaces. The organic and glass surfaces contamination will mostly be made by ion exchange processes, all organic materials such as colors, plastics, and textiles, and glass surfaces such as glass and porcelains have acidic reactions groups with a specific ion exchange valence. During ion exchange called resins, the ion exchange valence of these surface is so low, but is still efficient in high absorbance of radioactive materials. The surfaces acidic groups may be prepared ordinary or by oxidative breakdown of different materials with extreme polarity such as hydroxyl, carboxyl and silicates. Therefore, they desorb these ions and absorb any cationic contaminated group well.

3.2. Designing and preparation working surfaces with radioactive materials

There are various coverages for surfaces to be used which have both beauty or surface and protect it. It is expected that these coverages are resistant against environmental conditions or using chemical

materials, and tolerate heat and erosion. A good surface to be used in radioactive working environment must have the following characteristics:

- To be non-absorbent and non-porous, because decontamination is impossible in porous materials.
- To have acidic groups as many as possible.
- To have the minimum humidity.
- Not to include softeners and other solutions with solubility of materials
- To have good stability chemically against the used materials in decontamination;
- To be resistant against any erosive operations.
- To be completely smooth and without edges and cracks not to have possibility of accumulation contamination particles amidst the surfaces.
- In addition, to be resistant against radiation and heat.

3.3. Working tables with radioactive materials

The working tables without porosity are made by materials such as spotless steel or enamel tray, PVC, or polyethylene sheets. When accessing to these materials is impossible, the waterproof papers are used. In many cases, the contaminated protective coverages go to the waste storage.

3.4. Flooring materials

The flooring materials of many buildings aren't made properly, while they are exposed to contamination, the workshops floors must tolerate the natural mechanical works on its surface and show efficient resistance in processes such as erosion, and penetration in surface. This action must protect building against liquid penetration wherever the lubrication is used to prevent liquid penetration inside surfaces. Using PVC layers will be proper as sublayer while mechanical working on the surface. It prevents from humidity penetration while surface sealing, lubrication and, scouring.

The most appropriate materials to be used in flooring are ceramic tiles. They must be lied tightly beside each other and caulked well. Tile must be totally smooth with low water absorbance. If cement is used for this purpose, it must have good quality. The epoxide resin cements or furan resins are usually used.

3.5. Pipelines

The pipelines must show necessary resistance against temperature, pressure, and intensive erosion. The preferred materials for pipelines includeceramics, rubber, steel, and polyethylene. Decontamination is relatively easy in ceramic and polyethylene surface. Decontamination from rubber surfaces seems difficult, unless specific compounds are used in manufacture will good decontamination. Installing pipe must be done with efficient accuracy to be efficiently used in removing the accumulated points and trapping contaminations such as bends and joints and also precipitation materials must be mentioned precisely.

4. TECHNIQUES AND PRINCIPLES OF DECONTAMINATION

The first issue in decontamination is to know the type of contaminations in installations. For example, to know these materials are lubricants such as grease or oil, or materials such as soil to be removable, or whether to know the coverage liquid on surface has contamination or not, or this contamination penetrated in surface or not. Another issue in decontamination is to know which levels are contaminated. For example, the contaminated surface is plastic, smooth, and soft? Or is porous and rigid surface?

One of the most important actions is to limit contamination and prevent from its transmission to other neat points. The protective coverages such as PVC and polyethylene, or tarred waterproof papers must be put in floors of exposed places to contamination. Decontamination is the first action in each process by the soft factors such as water or solutions to remove grease. When the brooms are used to remove contamination, the most important issue is deposing them after each cleaning operation. After cleaning, the brooms are contaminated and reusing them transmits contamination. If the first simple operation, washing with water and solutions, isn't useful, the diluted acids or alkaline detergents are suggested. The most difficult decontamination techniques must be used to reach the favorite product in the last step. The decontaminative system has three important parts as following:

1. Decontaminative system on the contaminated and great installations;
2. Decontaminative systems on small equipment such as bottles and contaminated valves;
3. Finally the related installations to decontamination on the flexible pipes.

4.1. Using materials in decontamination and applied techniques

Generally, all detergents are considered as a decontaminative factors. These materials are beneficial, because they are easy to provide and cheap. The structure composition is so effective for

decontamination. Some existed compounds in a proper detergent are as following:

- The synthetized detergent or the moisturizing factor;
- Sodium polyphosphate that is used as the complex factor for calcium and magnesium in hard waters;
- Carboxymethyl cellulose: this materials suspends the contaminated spots and prevents from their precipitation;
- Using EDTA that makes active complex with their radioactive cations to suspend them in solution.

The other constitutional elements such as bleaching agents aren't used in these types of detergents. Immersion in acid or solutions that remove the layers of objects such as phosphoric, sulfuric acid inhibitors, and nitric acid solutions were mostly used to remove the hard contaminations from surfaces. One of the most effective techniques to remove the cationic contaminations is complexing with the chelating or complexing agents such as citric acid or ethylene diamine tetra-acetic acid (EDTA). The complexing agents under the optimum conditions of diluting solutions makes anionic complexes with metals which will be removed by anionic surfaces. The complex agents can prevent from recontamination of the solved materials on surfaces and also non-following on surface.

Various levels needs to various contaminative factors to remove it. One important issue in this field is using extra detergents that may destruct polymers, or extra washingpeels plastic agents. When the mineral acids are used, it must be mentioned not to damage the substrates, and if sulfuric acid is used, it must be mentioned not to make hole by erosion in surface.

4.2. The main installations and devices for decontaminations

These tools are used in decontamination. Generally, they can includes the named systems and machineries in following. Of course, their amount and numbers depend on the performance volume and also design:

A) The essential equipment and facilities to dismantle the manufacturer (taking apart)
B) The essential equipment and facilities to measure contamination
C) The essential equipment and facilities to remove the contaminated parts including:

1. Necessary tanks including oil decontamination, citric acid, two tanks of distilled water, and feed storage tanks
2. Pimps and their installations
3. Electric heaters and temperature setting system
4. Ultrasonic stirrer and fluid spurring system
5. Crane and rail transferring system
6. Air conditioner system on isolation table
7. Flow controller system and fluid surface in each tank
8. Fluid rotation system inside tanks
9. Essential installations for fluid rotation inside pipes and valves
10. Baskets for the contaminated pieces before entering to tanks.
11. Transmitting fluid pipes and other accessories
12. Electric furnace.

Some actions are done in decontamination workshops that are in common in spite of the contaminated pieces in all fields and no need for their separation. These parts include:

- Contaminated gas extraction system: this system remove the toxic vapors and gases from the decontaminative parts and isolation table of the separated pieces and guide to filter.
- Oil returning system: this part and its installations must receive oil from the polluted pumps and other parts before contamination and make them reusable besides treatment.
- Water supplement system for washing in bathrooms
- Compacted hot air supplement system: this installation produce necessary air to dry pieces besides workshop favorable air.
- Essential energy supplement system: duty of this part is providing essential electricity to make power in the existed systems in workshop.
- Solid waste collection system: this system collects solid waste such as cloths, textiles, and also muds and assures us not to transmit the contaminated particles to outside of building.
- Liquid waste collection system: this system has duty of collecting the made liquid wastes n workshop.
- Water distillation system and supplying necessary distilled water: this system supplies the necessary distilled water for final removal and cleansing the remained citric acid on installations.
- Laboratory: the selected samples from the decontamination tanks and other parts to examine the present uranium in them and also solution acidity are guided to this part and necessary experiments are done on them.
- Heating and cooling systems and ventilation of workshop: This system has the main function of air conditioning in workshop.

- Safety system of entry and exit to the workshop.

5.DESCRIPTION THE DECONTAMINATION OPERATIONS

Decontamination starts with entry and preparation of the contaminated pieces in proper places. The present process includes series of isolation the construction pieces and washing with hot water to remove extra substances and fat on them. Some pieces include the broken ones needing repair are transmitted to the related parts. These devices and pieces must be cleansed from any contamination types fully in order to prevent from contamination penetration to surrounding and repairers before starting the essential repairing and potential dangers [2].

5.1. Decontaminating surfaces

The following specific techniques must be used while decontaminating the surfaces:

First step is limiting on traffic conditions and detecting radiative places. Then, the contaminated surfaces must be observed just by proper devises by employees and protective cloths. The protections must minimize the external irritation and reach to the acceptable level.

A tent can be installed, if necessary, at the entrance of contaminated sites. An obstacle must differentiate contaminated and non-contaminated parts well. If tent and the contaminated surface have indentation (low pressure) than the out surface, air flow penetrates inside the contaminated part and prevent from air flowing to the contaminated surface and contamination transmission. The floor must be covered by plastic for protection.

In order to prevent from contaminationout by employees, it is necessary to control the commuting inside and outside of surface. If contaminated waste collection containers, decontaminative solutionstanks, and also washing water don't make any danger in tent, they must be kept under the tent. In addition, it is necessary to use full coverage fluxes to take out beta and gamma high emitting contaminators and other decaying materials.

All the used monitoring installations must be wrapped in proper coverage to prevent from being contaminated. Monitoring installations are kept out of contaminated surface and are transferred there whenever it is necessary. The local safeguards are used to protect against gamma and beta beams in monitoring levels of air and also probable sites of contamination. Employees must use the needed gloves and, if necessary, use protective coverages and proper respiration tools permanently in decontamination workshop. If there are many dusts contaminations in air, they can be prevented from transmitting to surrounding by two ways: one is humidification to prevent transmission in air and second is cleansing them by proper vacuum from location. The main decontamination starts from the nearest surface then proceeds to other surfaces. Working tables and other installations will be cleansed. If they are portable, they moved out of location by a proper coverage to prevent from more contaminating of the contaminated place. In each decontamination technique, walls, working tables, and floor of workshop must be washed by a cleansing agent such as cleaning for contamination or a helping detergent to clean all types of dusts, etc.

Brushes and brooms can be used for washing. The best type of brushes is paper tissues. The brushing machines that are capable of sucking liquids accelerate decontamination process of workshop floor.

Other installations that can be effectively used in decontamination, if used, aresteam cleaner systems, pressurized water system, and steam blower units. If there is still some contamination, the second washing y more condensed solutions, a stronger decontaminative agent such as organic solutions can be used for polymers or the inhibitor acids for ionic compounds and spotless steel. If surfaces are painted, the gel type cleanser will be ok to select. The inhibitor sulfuric acid can be used to clean tiles and concrete.

If these techniques are not useful for decontamination, colors and exchanged flooring materials and also the concrete of flooring will be repaired by mechanical helping tools. Monitoring operations are done for measuring the remained contamination after each cleaning step. In addition, it should be mentioned whenever spot test is used for final control, the working surface must be totally dry. When decontamination operations finish, the flooring and tent coverages must be accurately collected and acted as the radioactive wastes.

5.2. Decontamination the installations and materials

It is necessary to know the size of installations to clean each one for decontamination various types of contaminated installations. The contaminated installations may include air hood, glove box, or firm shelf with different sizes that are first cleaned by the pressed air. Another technique for smaller and medium size is floating in the washing

materials such as cleaning metal tools, brooms, or brushing them. The washing materials include decontaminative cleaning solution, but also specific detergents such as inhibitor sulfuric acids (1% dioxide), mineral acids, or a mixture of nitric and hydrofluoric acids are used. The glass containers can be decontaminated by floating in chromic acid. The ceramic installations can be cleaned by the described technique for mental tools.

If decontamination wasn't desirably efficient, the mechanical actions are used on surfaces including cleaning by steam, pressured water, and intensive wind to erase the contaminated installations. When the air pressure is used for decontamination on surface, these materials are separated and distribute on it. However, these techniques are used for high yield of processes.

Electric installations must be cleaned precisely by a proper solution. However, it is better to keep the electric installations in outer space of a radioactive containers as much as possible if they are highly contaminated.

5.3. Decontamination the big pieces

First, the installations and pieces to be decontaminated must transfer to the decontamination workshop with controlled principles. The most transferred pieces are vacuum pumps which need to repair while working or when a piece is separated from system may be transferred to workshop for decontamination. Before transferring to workshops, these pieces must be kept in closed specific packages and containers to prevent from transmission contamination to surrounding while transportation. The input and output of pumps must be blocked before putting in packages to prevent from probable contaminated gas penetration to environment and its compound's with steam and the made radioactive particles, and transmission the toxic materials. These pieces were moved to workshop after ensuring no release to the environment. The workshop entry is in a way to open the door automatically after transferring pieces to it to prevent from hand contact with them. After entering to the first door, an individual was put in an enclosed space and the second door is opened when the first door is automatically closed. After opening the second door and people entrance to workshop entrance space, and the automatic closing of the second door, the air of two doors is ventilated. This action prevents from penetrating contamination to workshop outside.

The pieces and devices must kept in workshop until the end of decontamination. Pieces must be taken out of packages and put on baskets after separating the constitutional elements on the related tables. These baskets are moved by rail crane without human. The separation step of contaminated pieces by workers the air above working table must be ventilated to prevent from workers vulnerability while working. After degassing pumps, their pieces are separated. If pumps are brought with their accessories such as containers, these pieces will also decontaminated. In the next step, the pieces in baskets are transferred to the oil removal tank from the contaminated devices by a crane. Oil and grease are separated from the pieces and float inside tank by hot water, under pressure, and ultrasonic stirrer. The exited fomblin oil from pumps will transfer to the related part after evaluation the amount of contamination. Other hydro carbonic or the existed radioactive materials can be separated from oil to reuse it after examining its health. The remained solution inside tank, if has high contamination level and is discerned not proper for decontamination, are transferred to 5 liter tank and prepared to send to waste storage sector.

The tank used in degreased part must have 800 liters volume and inside flow will stream out during degreasing time. The tank floor is sloppy not to contain contamination in drying it at the end of work. A surface must be considered around tank to prevent from transmission contamination in environment while transferring by leakage of the contained solution around tank. The ultrasonic stirrer with rotation of fluid by pump was used to make turbulence. This stirrer makes it possible for particles to separate midst surfaces and pores and stay in suspended form by fluid rotation easily.

At the end of degreasing and removing the attached particles on surface, which was explained in previous part, pieces were examined according to lack of grease etc. if there would be no spot of oil or other particles, the packages will guide to washing tank with acid by crane. This tank has equipment such as pump, sloppy surface, stirrer, and solution collector levels in surrounding such as degreasing tank. The washing tanks by acid and hot water are considering end-closed. Finally, they sent to drying after transferring to washing tanks with distilled water that is conducted in two steps. The washing tanks with distilled water are open-end, and the remained acid after washing of the first tank goes to the final washing in the second tank. The residual time in acid is 15 min. both tanks have distilled water and sloppy surface. This tank has fluid rotation pump and ultrasonic stirrer, and other essential operations like the previous tanks. The temperature of all tanks is controlled by an electric

heater in 60°C. In order to reduce the waste from decontamination operations and more utilization of distilled water and also acid in this process, the distilled water is just added to the final tank, and the last tank water is transferred to its previous tank, and that water will be transferred to acid tank for dilution.

The surface, temperature, and contamination level controller systems are installed in all tanks to be able to exchange the present uranium concentration, acidity, and comparison with the permitted level if contaminated. The water is used to clean the tanks surfaces after decontamination. Of course, the water in this step is ordinary water and there is no need for distilled water. The sloppy surface facilitates leaning all contaminations and drying. The pieces in baskets must be fully dried by hot air after being exited from the final distilled water tank.

After exiting pieces from washing tanks, the remained solution was sent to waste storage part. As it was stated, the remained particles and muds suspended or solved by water and guided to waste storage by a pump.

Releasing dangerous gases in workshop space and also radioactive particles make danger for employees and also contaminate spaces. To solve this problem, the air above the isolation table and total decontamination environment must be ventilated properly and find way to atmosphere by removing the contaminated materials and before entering workshop air to outside of building in order to bee ensure of its health.

5.4. Decontamination the small pieces and contaminated valves

Separated places are considered to maintain and separation of their constructing pieces in order to decontaminate the small pieces and contaminated valves in workshop. If the contamination of these pieces don't have grease or organic materials, the oil washing is not necessary for them and washing with acid is better. The containers are full of acid and the existed materials in container are solved in acid. After solving them, the obtained solution is transferred to waste storage. The containers are full of distilled water and remain for 1 hour.

Valves should be in series for washing, and citric acid pump will run from s small tank inside it. The acid is cycled in a round path and is guided to waste storage after finishing washing. The distilled water is also pumped among valves and will wash the remained acid. Passing the citric acid among valves will take time for 1 hour. Of course, it must be mentioned that valves and bottles will be washed by distilled water in two steps. Finally, they were dried after being sure of cleanliness by the compacted hot air, and the remained contamination and corrosion will be tested. Since humidity is an important factor in reaction between hexafluoride uranium and water, being sure of full drying before reuse is essential. Therefore, the electric furnace even can be used for drying. Finally, the pieces were kept and transferred for montage after drying.

5.5. Decontamination pipes

In order to decontaminate pipes, they must put in series like valves and flow water and acid among them. The pipes are put in a cycle path between water and acid and the needed fluid is pumped inside it. They are prepared by hot air after two washing steps by distilled water. Finally, they sent to laboratory again to laboratory to control contamination and resistance.

The pump is equipped to a system not to have leakage in starting to control leakage from pipes, bottles, and valves. In addition, temperature and fluid flux are controlled. Washing is done by acid for 15 minutes for both washing, and solution temperature is controlled in 60°C.

5.6. Locational decontamination

The maximum probability of contamination is by pouring the radioactive materials and their distribution in laboratory floors while working with them. The only way to prevent from contamination with radioactive materials in laboratory is to install hood or tray as the initial obstacle against contamination and collecting the pouring or distributing materials in laboratory. Some coverages can be used to prevent airborne emissions by liquid absorbance. The suspended particles in air while sweeping or the cleaning agents can be collected from environment using the vacuum technique. On the other hand, the gel materials can be used for better cleaning, this materials is able of solving in water well, so it can easily be removed from environment by washing with water. Decontamination mostly will have footprint. Therefore, before entering to laboratory, people hands and legs must be checked to prevent from entering contamination inside laboratory. In order to discern the contamination of the room floor, it must be monitored. Each footprint contamination is removed by an organic solvent. This solvent can be polishing wax or sometimes a marker color. A direct control by monitoring will occur immediately. This technique is effective, quick, and cheap. This action be be done by anyone

familiar with instruction of working with radioactive materials.

5.7. Decontamination techniques for people

The external decontamination starts just by the most effective action that is undressing outer garments of the contaminated person. This action helps to more removal of surficial contamination. The undressed garments must be sealed in a container. (For example, in a plastic package). Name place, date, and packing time of each patient must be written on package. In other words, "don't move away the radioactive" is explicitly written on it. These packages may be analyzed later to determine radionuclide or maybe determination the particles sizes to determine and evaluate internal dose resulted from respiratory. According to the amount of contamination and patient medical conditions after taking out the dresses, total body shower is used. If the contamination is focused in an area, s simple washing is efficient. In order to prevent from hyperemia increasing contamination absorbance by skin, the hot water should never be used. The cold water shouldn't also be used, because it caused skin contraction, close skin pores, and make skin indent. And radioactive contamination is trapped in them. Using lukewarm water with moderate cleaner or without cleaner can be so useful. Decontamination should start from the maximum contaminated points on skin and continue to less contaminated parts. Since the healthy skin is very protective barrier against internal contamination; therefore, prevention from abrasion or any threat to the barrier must be scrutinized.

Actions such as scraping, rubbing, and sever abrasion are not good; although, it is usually necessary, if abrasion hear is essential, it is better to cut hear not shave it. Decontamination should start with the minimum motivating technique and continue with more motivating techniques, it m must always be mentioned that to to wound or scratch the skin. The sample of removed radioactive from the patient body must be cut for the next analysis and determination its nuclide. If a patient is doubted to breathe the radioactive materials, this respiratory samples from both nostrils using two neat cotton for the next analyses.

The complete decontamination is not possible, because some radioactive materials can stay constantly on skin. Decontaminations reducing pollution two times bigger than field is evaluated properly and efficiently. Whenever it is detected by x-ray system that decontamination doesn't have advance, the decontamination must stop temporary. In other words, it must suspended. It is noticeable to say it is necessary contamination is conducted fully up to practical establishment. When patient is transferred to medical center, the final evaluation of radiology condition is conducted. Finally, the patient condition is registered after contamination. The same information as what was said must be recorded. The summary of event is provided later. After the full initial decontamination, patients are ready to go to the medical centers. The coordination is needed between event and the accepting hospital. It is necessary to be assured that medical team is ready to help patients.

Internal contamination has more problem than external contamination. Therefore, some methods are designed to minimize patients and nurses internal contamination resources. Radionuclides on the healthy skin rarely lead to dangerous radiation of patient or medical team.

5.8. Decontamination cloths and protective coverage

The protective cloths used by employees are mainly made from cotton and wool. If contamination on cloths is little, the decontamination is possible by washing in laundry. When contamination is sever, better coverage must be used. This coverage may be cheap PVC on the ordinary cotton cloths. At the end of operations, if contamination is high, these cloths are disposed. Alternatively, such cloths can be made from stronger PVC with easier decontamination. Such cloths can be covered with respiratory equipment. Finally, it includes face masks and respiratory safeguards. When working is in high contamination level, particularly against alpha ray or dust, it is recommended to use the pressured cloths or the existed external air. These cloths are usually made from PVC. However, when contamination is so high, it is recommended to use a thin PVC coverage to decontaminate, then it is disposed.

6. THE RESIDUAL WASTES BY NUCLEAR MATERIALS

Total produced wastes such as the ones from the decontamination must be packed desirably before transmission for burial. According to the half-life of radioactive materials, this packing can burned for hundred years without damage and stay healthy to prevent from transmission radioactive materials to environment. The probable dangers from the radioactive waste are in two forms:

- The first and biggest danger of releasing the decayed product to environment, this leads to unpermitted radiation in human food and

consequently high internal dose of external radiation by congestion in consecutive biomass of radioactive materials through the plans and animals in food chain.

- Second threat is less dangerous than the first one that is resulted from the external material radiation.

Generally, all produced garbage in nuclear sector can be classified as solid, liquid, and gas called waste. These materials will produce in six steps that are described in summary as following.

6.1. The obtained materials from uranium extraction from ore

The first step in nuclear fuel cycle with many wastes is extracting uranium from ore. The essential operations in this step include grinding ore and crushing it then different washing operations with acidic and alkaline. The produced materials in this process are as diuranate ammonium that is separated as sediment. (Khazaneh Roshan Zamir, 1997)

In order to determine the amount of produced garbage in this step, information such as used ore, the concentration of the present uranium in ore, and also process quality are used. If the uranium concentration in ore 1 is 1000, more than 1000 ton ore is used for each uranium tone. It is natural that 100% process was not ideal and finally a little amount of uranium will remain in ore that the real disposed weight is more than the usable ore for adding chemical materials in process besides initial value. Although, the existed uranium in it is natural and its value is reduced. The danger of its transmission necessitates to have more attention in waste storage.

6.2. The produced waste during treatment and enrichment of uranium steps

The produced uranium in previous step is as diuranate ammonium that must be treated and change intouranium fluoride after purification to be used for the next step. Sometime uranium must be enriched that the produced waste in both steps of treatment and enrichment will be collective and burned in specific barrels. The significant part of the existed materials in enrichment step is uranium hexafluoride whose uranium 235 is reduced and called the depleted uranium. If uranium hexafluoride is not used, it must change into solid and burned in specific barrels, and also it can be changed into uranium oxide and then burned, because uranium hexafluoride substance is volatile and reactive and there is probability of leakage too outside. In addition, the produced wastes from washing, factory repairing, and damaged tools must be considered.

6.3. The resulted wastes from production of nuclear fuel rods

The fuel rods are in series in each reactor heart. The production of fuel rods includes mixing, compressing, coagulating, and grinding steps. Part of radioactive materials may change into waste during operations that must be collected in barrels and burned.

6.4. Reactor waste

For corrosion and neutron bombardment in a nuclear reactor parts and also activation the reactor structural materials and decaying products that were leaked from fuel rods, the made contamination enter to the cooling circuit. The contaminated parts in reactor such as structural materials consists the significant part of nuclear wastes which was produced in this step. A great nuclear reactor produces the consumed uranium about $3m^3$ (25 to 30 ton) annually. These consumed materials are made from some of uranium, some plutonium, and other decaying products.

The used fuel rods are maintained in specific ponds. The water of ponds prevent from output radioactive emissions besides cooling uranium. After decades, the fuel is taken out from ponds which reduced their radioactive properties significantly and transferred to dry stores. In these stores, fuels are maintained inside metal or concrete containers. In this step, the made irritations by fuels are still dangerous. Fuels containing duration in this step depending on the fuel type can vary from several years to decades, but fuels must stay in this step up to lose all their radiation to reach the standard level.

Since the half-life of each reactor is estimated 30 years, the reactor must be buried after this period. Its precondition is to separate all pieces with high probability of leakage to environment, if reactor is buried, and bury them after guarding it specific barrels.

6.5. The consumed and unprocessed fuel waste

After consuming fuel in reactor, its remains include the produced radioactive materials, too at least for 10 years for cooling. Then they can be buried as waste in steel cylinders.

6.6. Resulted waste from reprocessing

The consumed fuels complexes were put in acid solutions after fragmentation to solve the fuel of rods in acid. There are some parts of radioactive

materials that penetrate in pod surface of fuel rods or stick to each other, the pod itself becomes radioactive. These materials with other parts of fuel complexes and the remained unsolvable materials in acid were changed into waste and must be buried. The used acid solves the radioactive materials such as thorium, uranium, plutonium, and other products from decaying nuclear. Uranium, thorium, and plutonium are separated as solid. A little waste is produced in this process that must be collected and buried.

7.COLLECTION AND DISPOSAL WASTE

Collection and disposal the nuclear waste are considered as the main part of controlling and protection against radiation. Although, it is not possible to dispose all radiative wastes completely, their effects can significantly reduce. Wastes can be classified in three irritating levels: high, middle, and low levels. The low level wastes are called to the ones diluted with smaller than 1000 coefficient and release in environment. Middle levels have dilution coefficient of 1000 to 100,000 and release in environment. The dilution coefficient for high level is more than 100,000. Of course, it should be noticed that these figures have descriptive aspects and don't means that materials can be diluted and sent to environment. (Ayatollahi, 2000)

The high level wastes are obtained from accumulation and production of decaying in nuclear reactors and also spent fuel or chemical processes to separate uranium and unused plutonium in consumed fuel, and middle and low level wastes will be resulted from various resources such as nuclear hospital waste (the hospital where the nuclear material is used for the treatment such as chemotherapy) or research labs and nuclear fuel reprocessing plants. Today, processing methods and nuclear wastes removal include compression- chemical processing- glassmaking- reservation and storage.

7.1. The high level liquid waste

These wastes are significantly in form of acidic solutions obtained from the consumed fuel chemical processing in specific activities. In initial years of nuclear knowledge development, these waste could be stored in underground tanks by the evaporation of these liquids and reducing the remained materials. The issue of storing high level liquid wastes will be sophisticated for high rate of heat production. Some points must be mentioned in designing the tanks for high level liquid wastes such as strength and resistance to corrosion, heat dissipation, and leakage from tanks. The tanks are usually constructed in reinforced concrete products with steel liners that are placed in a steel shell to prevent from leakage and an integrated monitoring system is added to it for detecting leakages. Although, storing the radiative materials is practical in these tanks, the resulted dangers from materials leakage is considered for maintenance for hundreds of years.

7.2. Low and middle level liquid wastes

The middle and low level waste can be disposed to sea in a certain conditions or buried under the ground or separate the radioactive solutions by chemical, physical, or biological ways from the non-radiative solutions. The apparently high ocean volume makes it an ideal environment to dilute and distributed the low level liquid waste, but determination the maximum permitted radiation level to sea and not harm the food chain is difficult.

The low and middle level wastes underground with desirable conditions of hydrologic factors, ion-exchange properties, and population density is a proper solution to dispose them. This method can be called "delay and decay", because the slow movement of radiative materials in underground is enough opportunities for decay the radiative materials. The desirable specification to bury wastes includes the following cases:

1. The existence of a deep water bed
2. The proper ion exchange to separate relatively great parts of radiative nuclides from wastes while penetration in ground
3. The low level of superficial waters to maximize movement time of the underground streams.
4. The sever underground water stream for as much dilution as possible of the radiative materials
5. The very low population in wastes burying place.

While burying, the pit with wooden internal coverage called "bin" with proper capacity in ground, then is filled with pebbles. Liquid wastes are pushed inside bin and penetrate slowly inside the ground. When the radiative wastes are distributed in ground, the tracking the flow of underground and surface water control will be so important.

A proper way to prevent radiative materials in liquid waste is changing liquid to solid and packing the solid waste in impermeable tanks and finally burial them in depth of seas and grounds. There are several packing methods for solid radiative waste. The simplest method is to pure a little concrete in several thickness at the floor of 208 liter barrel and stirring the mixed radiative materials, sealing the

barrel, and covering it. If the waste is high level, the radiative concrete is poured inside the metal tank, then it put in the 208 liters barrel with concreted floor, its surroundings are covered with concrete, then the barrel is sealed.

7.3. Airborne wastes

The transmitted radiations in air are called airborne waste. These materials are in gas or suspended particle. Gases may be resulted from the cooling air neutron activation in a reactor, from the gas decay products, or chemical reactions with the produced gas. The suspended particles may be produced from very varied processes of the condensed drops made in liquid wastes processes to the obtained resulted dusts from the furnaces of burning solid wastes. The best way to control the resulted dangers from the airborne wastes is limiting their production in resources of wastes. If the airborne wastes are produced, the present air must be decontaminated efficiently then sent to atmosphere after passing from a proper filter and removing its radiative materials. If the radiation of the airborne is low, the waste can be released unfiltered by dilution and in environment.

When the contaminated materials are excavated from chimney, it is assumed that this material moves in direction of wind, while it is distributed in lateral and vertical directions, too. Important results of this distribution include the dilution of the radiative materials and returning to human body by respiratory and entering to ground by rain that finally will enter to human body through the nutritional substances.

7.4. Solid wastes

There are not many actions to reduce the solid wastes radiation. The most important action in this regard is condensing these materials before burial in dry lands or sea. Long time storage is usually conducted in high level solids and may be done using the underground concrete arches, the desirable packed wastes can be buried. It means they can be put directly in a specific areas in soil. The type of packing depends on the half-life and amount of the radiative material activity. The high level wastes can be put in concrete steel barrels. However, it is enough to put the low level wastes in polyethylene bags, then bags on steel barrels, and then being sealed. Factors such as corrosion resistance and sufficient strength to withstand water pressure at the bottom of the sea must be mentioned in burial in sea.

The great amount of combusting low level waste such as paper towels, protective and old clothing, feces, and carcasses of infected animals, as well as other non-combustible materials such as contaminated needles and glass impregnated with radioactive material are produced in nuclear centers and hospitals. He combusting materials are separated from other materials and are packed for burial that are remained as ash by burning and destruction of non-radioactive materials and reducing the volume of material remained, along with radioactive material.

The generated waste by nuclear fusion reactions with storage is usable after one hundred years. In contrary, the produced wastes from the nuclear fission can have radioactive effects for 10000 years.

One way to remove the radioactive materials in environment is to change them to glass balls; therefore, the radiation will be trapped in glass, if thee radiative beads find way out and enter to environment, and won't be absorbed by plants and animals. If an animal eat these beads, beads will be disposed from gastrointestinal tract. Of course, the tracts will have external radiation, but animal and this structure won't contaminate to the radioactivity. The next action about the balls is isolating them by putting the glass balls in a proper container and then burying them in proper geological structures such as burying in salt dome.

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