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The Radiological Contamination in AL-Tahreer Tower Building at Baghdad City

Haydar Ahmed Hasan, Takrid Muneam Nafae, Yousif Muhsin Zayir, Zeki Abduljabbar Mansoor

Ministry of Science and Technology (MOST), Radiation and Nuclear Safety Directorate (RNSD), Baghdad, Iraq

Email address:

alnajjar_1964@yahoo.com (H. A. Hasan), taghreed_nafea@yahoo.com (T. M. Nafae), yousif_zayir@yahoo.com (Y. M. Zayir), zeki_alqaisy@yahoo.com (Z. A. Mansoor)

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Abstract: In this study, evaluation of the radioactivity for AL-Tahreer Tower Building (the Turkish restaurant previously) which located in the center of Baghdad city was implemented. The contamination resulted from bombing the Building by the depleted uranium projectiles. The building consists of 14 floors besides the basement. Radiological characterization was implemented using field and laboratory measurements. The results of radiological surveys by using portable survey meter (CAB-counts per second (cps)) indicated the presence of contaminated soil reached to 60 cps (more than 120 the background radiation level) in addition to the presence of small particles of depleted uranium shells with high levels of contamination reached to 90 cps, compare with (0.5 cps) the background level. While the results of maximum exposure dose rates were 0.6 μSv/hr when the detector of survey meter (Ludlum) put on the contaminated regions at a distance about (0.5 cm). The natural background level of the building at distance one meter was 0.9 μSv/hr. Soil samples had been collected and prepared for measuring according to the international standards and specifications, using gamma spectrometry system which consist of High-purity Germanium Detector with efficiency of 40% and resolution 2.0 keV for Energy 1.332 MeV of ^{60}Co, The laboratory results indicated the presence of high concentrations of Th-234 and Pa-234m isotopes (1550.1 & 3179 Bq/kg respectively) in the soil samples taken from the floors, while the concentrations of Th-234 in natural background soil sample were nearly 40 Bq/kg, Pa-234m not detected. According to the results of radiological characterization (field and laboratory), which showed an increase in radioactivity in the AL-Tahreer Tower Building the protective procedures had been adopted, where the contaminated soil and wastes resulted from decontamination processes collected in the 26 drum of capacity 220 liter, after the transfer of drums to the temporary storage at Tuwaitha site with cooperation of the Directorate of Radioactive Waste Management & Treatment at (MOST). Now the building within the background radiation levels and released by the regulatory body “Radiation Protection Center (RPC)/ Ministry of Environment (MOEN)”.

Keywords: Depleted Uranium DU, Evaluation of the Radioactivity, The Radiological Contamination, Decontamination Processes

1. Introduction

Uranium is found in trace amounts in all rocks and soil, in water and air, and in materials made from natural substances. It is a reactive metal therefore; it is not present as free uranium in the environment. In addition to the uranium naturally found in minerals, the uranium metal and compounds produced by industrial activities can also be released back to the environment. Uranium can combine with other elements in the environment to form uranium compounds [1].

In nature, uranium is found as ^{238}U (99.2742%), ^{235}U (0.7204%), and a very small amount of ^{234}U (0.0054%). "Depleted Uranium (DU)" is so called, because the content of the fissionable ^{235}U isotope is reduced from 0.7 to 0.2 during the enrichment process. All uranium, not just DU, is composed almost entirely of ^{238}U. Natural U and DU differ only in their radioactivity, the depleted Uranium is roughly 60% as radioactive as naturally occurring uranium metal. ^{238}U has a half-life of 4.5 billion years emits alpha particles at 4.2 MeV and 4.15 MeV that cause significant internal ionization with consequent cellular damage. In addition, daughter products emit beta particles and gamma rays that

may cause further radiological damage. ^{238}U is still very dangerous as an internal hazard because the alpha particle emissions are not reduced but proportionally increased [2, 3, 4].

DU may not be an external hazard, but an internal hazard, and with consequent inhalation, ingestion, and wound contamination, poses significant and unacceptable risk [5].

DU being about half as radioactive as natural U. Behavior in the body is identical to that of natural U, such that both are internal hazardous. Inhalation and/or ingestion of these isotopes should be as low as reasonably achievable (ALARA). In general, natural U and DU are considered chemical health hazards, rather than radiation hazards because the radio chemical toxicity of the metal is secondary to the toxicity of the metal itself [6]. The target organ of Uranium body in the kidney it is deposited in kidney tubules and may cause kidney failure

The weapons that enter the depleted uranium in the manufacture of multiple terms in the form of alloy consisting of 99.27% DU and 0.75% TI-TI9V, and other types consisting of 98% DU 2% Mo. Different sizes and dimensions of missiles exist depending on the uses and the type of weapon, of radioactive depleted uranium, the effectiveness of alpha particles in depleted uranium; less than natural by about 43% [4, 7]. Environmental contamination with depleted uranium would lead to public exposure to radiation chemical toxicity through many exposure pathways. This exposure could be external such as standing on contaminated land or internal through ingestion of contaminated foods and inhalation of depleted uranium particles attached to resuspended soil [8, 9].

2. Description of the Building

AL-Tahreer Tower Building located in front of AL-Tahreer Monument at the center of Baghdad, in the west side of the building is Tigris river and it is surrounded with shops and buildings of a commercial nature. It consists of 14 floors beside the basement, the area of each floor is approximately 640 m^2, each floor has stairs that are on the right and left, elevators and bathrooms which are currently cannot used. During 2003 most floors in the building were exposed to barrage (vertical and horizontal) of missiles, which led to damages in the structure of the building in some locations. During the initial radiological survey by using hand held survey instruments, radioactive contamination were found in many floors as (4^{th}, 8^{th}, 12^{th}) resulting from direct hits with depleted uranium projectiles, and the spread of radioactive contamination the ground, walls and ceilings of the building.

3. Materials and Methods

3.1. Field Measurements

The exposure dose rate measurements of the background and for AL-Tahreer Tower building for Beta & Gamma were conducted by using the scintillation counter type Ludlum (model 2241-2 survey meter Sweetwater Texaco, unit of measurement in μR/hr to R/hr). The detector consists of thallium - activated sodium iodide" NaI (TI)" crystal, the instrument was calibrated using Cs-137 standard source of activity 1.1 μCi, while the contamination levels were performed using hand-held survey meter type CAB (model-18351 probe model SAB 70, Canberra, for measuring Alpha & Beta in counts per second (cps)), The instruments are held close to the surface and moved sufficiently low to allow detection of changes in the radiation field.

The radiological surveys of the building were implemented according to plan by dividing the floor into grid boxes according to recommendations of the IAEA and by selecting the front wall to the point of entry and give it the symbol (W1) and identify the rest of the walls counter-clockwise (W2,W3,W4) and apply this method on the ground(G) and ceiling(C), So the floors were approximately divided into 44 grid boxes of (4.5 m x 1.5 m) for walls, 200 grid boxes of (3 m x 1 m) for ground, and 20 grid boxes of (20 m x 1.5 m) for ceiling, in each grid box measurements were taken at location near the center of the grid box as much as possible [10].

3.2. Laboratory Measurements

Soil samples were collected from the area surrounding AL-Tahreer Tower building with a depth of about (5-10) cm. All sampling information were recorded in the site such as, time of sampling, sample location and sample number. The collected soil samples were, grounded, sieved by using 2 mm sieve, and then dried in a temperature-controlled oven at 100^oC for 8 hours to remove the moisture from the soil. The weight of soil samples ranged between (0.750- 1) kg using electrical balance was taken and contained in clean Marinelli Beaker geometry, [8, 11]. Gamma spectrometry system was used for estimation the activity concentrations and analyses of the soil samples at the laboratory of Radiation &Nuclear Safety Directorate (RNSD), Ministry of science and Technology. Gamma spectrometry system consist of High-Purity Germanium (HPGe) detector with efficiency of (40%) and resolution 2 keV at 1.332 MeV gamma ray photo peak of ^{60}Co source, the data are collected using digital spectrum analyzer (DSA-2000). Calibration and efficiency of the system was carried out using multi–gamma ray standard sources (MGS-5 Canberra, activity 1.1 μCi, made in 2004) of Marinelli Beaker geometry. The analysis of samples was conducted by dedicated software programme (Genie-2000, USA). The measuring time for each sample is one hour. Activity concentrations of soil samples were reported in (Bq/kg) [12, 13].

4. Results and Discussion

More than 80 exposure & contamination readings around the building indicated the natural background level of exposure rates are 0.09 μSv/hr & contamination level is 0.5cps. Firstly the portable survey meter (CAB-cps) was used for measuring the contaminated areas in the building, because the high sensitivity of portable contamination survey

instrument compared with exposure survey instrument. Figures (1- 5) show the results of the contamination measurements before decontamination processes in all floors.

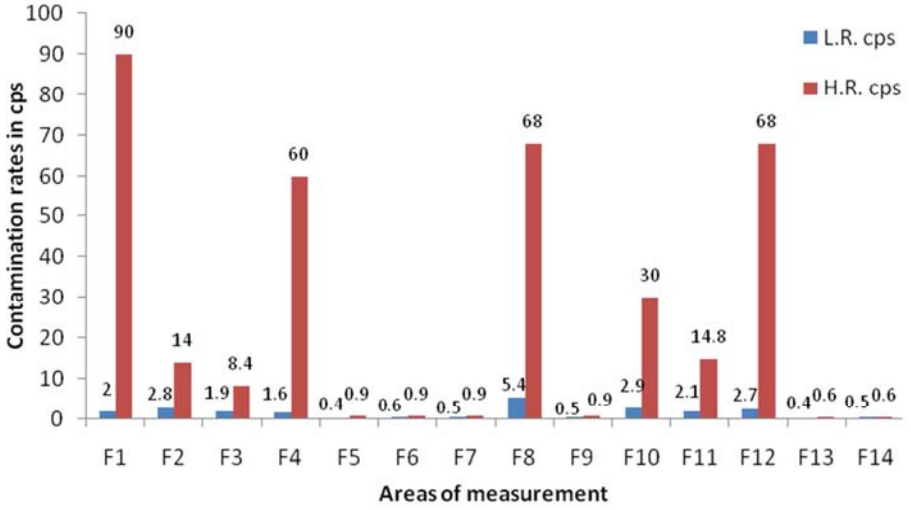

Figure 1. *Contamination levels on ground of floors before decontamination processes.*

Where:
L.R.: Lower Reading for contamination regions
H.R.: Higher Reading for contamination regions

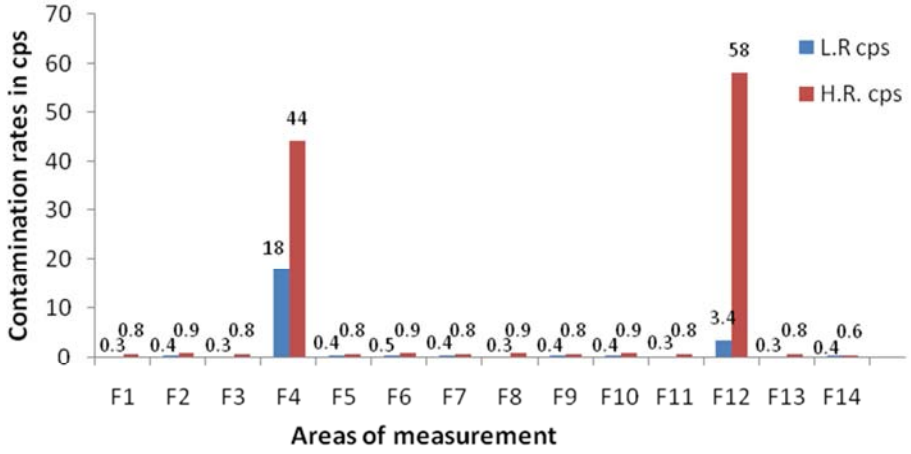

Figure 2. *Contamination levels on walls of floors before decontamination processes.*

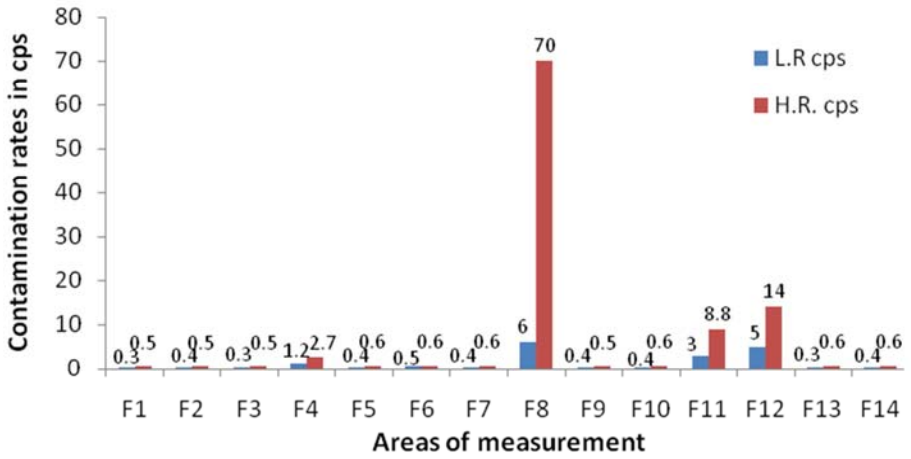

Figure 3. *Contamination levels on ceiling of floors before decontamination processes.*

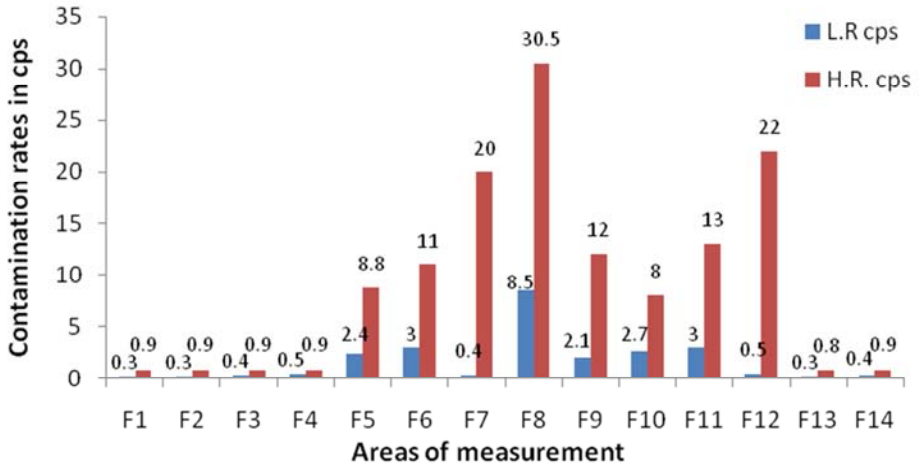

Figure 4. *Contamination levels on stairs of floors before decontamination processes.*

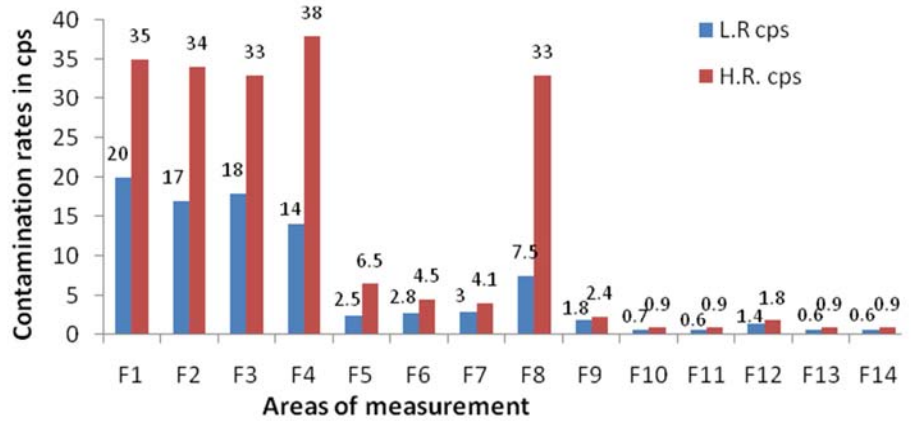

Figure 5. *Contamination levels on bathrooms of floors before decontamination processes.*

The results of contamination survey indicated that the readings for contamination regions before decontamination processes ranged between;

(1.6 – 90) cps in ground as shown in Figure 1,

(3.4 - 58) cps in walls as shown in Figure 2,

(1.2 - 70) cps in ceiling as shown in Figure 3,

(2.1 - 30.5) cps in stairs as shown in Figure 4, and,

(1.4 - 38) cps in bathrooms as shown in Figure 5.

The high readings of contamination levels resulted from presence of small particles of Depleted Uranium shells, because when a Depleted Uranium (DU) projectile strikes a hard surface up to 70% of the metal is oxidized and scattered as small particles in the environmental [1].

The results exposure dose rate measurements were performed before the decontamination processes are presented in Figures (6- 10).

The results of exposure dose rates indicated that the readings for contamination regions, before decontamination processes were more than twice the background level ranged between;

(0.19 – 0.60) µSv/hr in ground as shown in Figure 6,

(0.24 – 0.46) µSv/hr in walls as shown in Figure7,

(0.19 – 0.60) µSv/hr in ceiling as shown in Figure 8,

(0.20 – 0.45) µSv/hr in stairs as shown in Figure 9, and

(0.20 – 0.48) µSv/hr in bathrooms as shown in Figure 10.

The results indicated the large spread of contamination in most of floors because some materials have been transported from the building to other areas without taking any protective considerations, in addition to the movement of the winds caused contamination transport. Therefore, the work has been focused on decontamination processes to lift the contaminated soil which is considered two times higher than the natural levels when using the portable radiation detection equipments. Mechanical decontamination techniques were used for the removal of some thickness of the material of construction walls, cutting the pipes of waters and iron of the building especially in the fourth & eighth floor.

The laboratory results indicated the presence of high concentrations of Th-234, and Pa-234m (as indicator radionuclide's for the presence of Depleted Uranium the soil samples in almost all floors (1st, 2nd, 3ed, 4^{th}, 6^{th}, 7^{th}, 8^{th}, 9^{th}, 10^{th}, 11^{th}, and 12^{th}) [8]. The soil samples results are shown in Figures (11, 12).

From Figures 11 and 12 indicate the high concentration of Th-234 and Pa-234 in most floors before decontamination processes, and The laboratory results after decontamination

processes can be considered normal are slightly higher in comparison with natural background level, and these concentrations of the radioactive isotopes can be considered within the regulations limits of the environment. The building was released by the regulatory body Radiation Protection Center (RPC)/Ministry of Environment (MOEN).

The contaminated soil and other scraps were collected in 26 special barrels of capacity 220 liter and transfer to temporary storage at AL-Tuwaitha site.

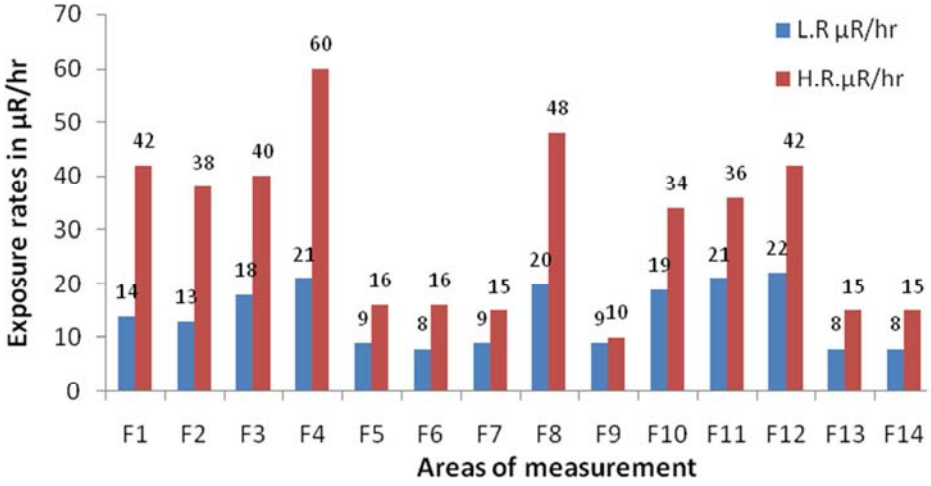

Figure 6. *Exposure rates on ground of floors before decontamination processes.*

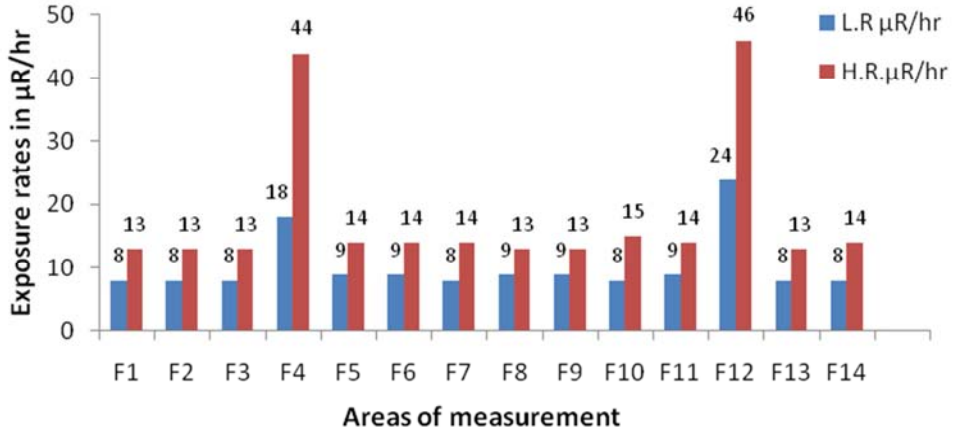

Figure 7. *Exposure rates on walls of floors before decontamination processes.*

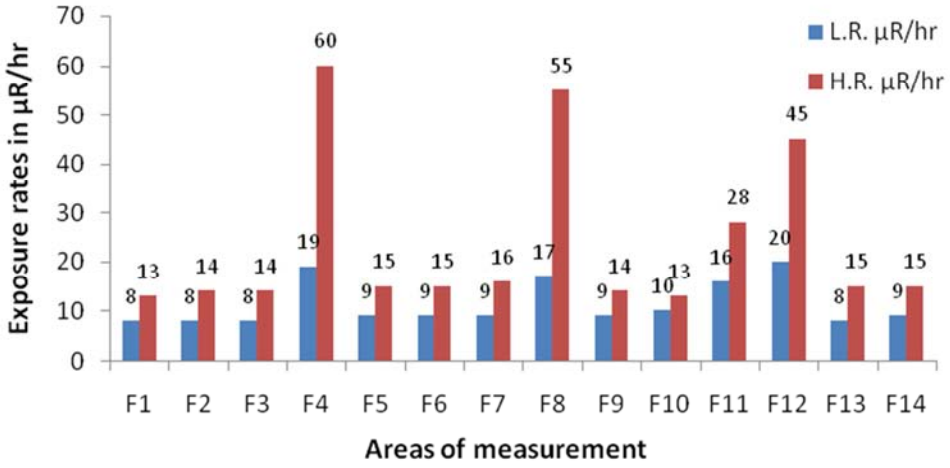

Figure 8. *Exposure rates on ceiling of floors before decontamination processes.*

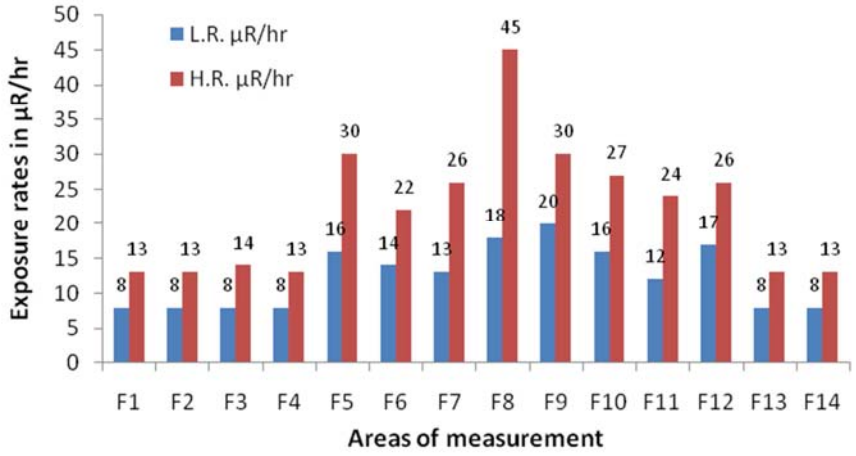

Figure 9. *Exposure rates on stairs of floors before decontamination processes.*

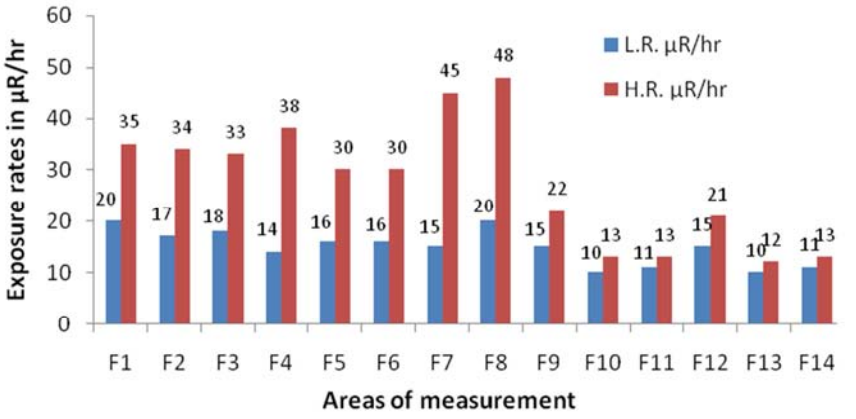

Figure 10. *Exposure rates on bathrooms of floors before decontamination processes.*

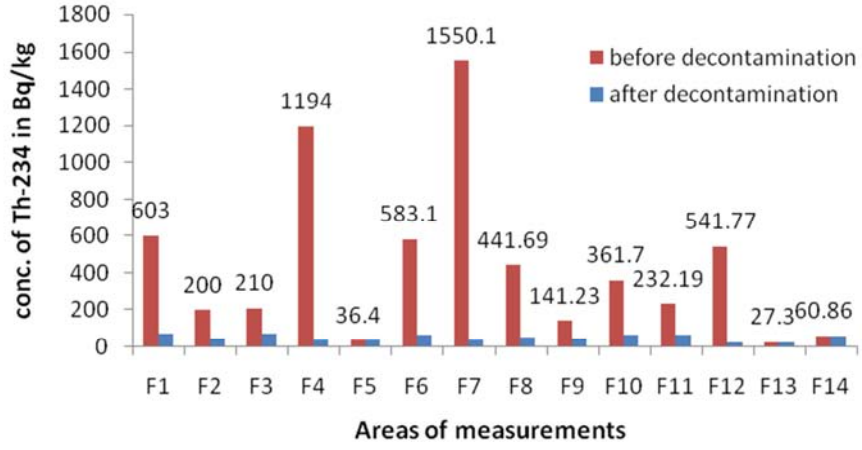

Figure 11. *Concentration of Th-234 in soil sample before and after decontamination processes.*

5. Conclusion and Recommendation

5.1. Conclusions

There is an increase in the radioactivity in the floors of AL-Tahreer Tower Building because some floors (especially 4th, 8th, and 12th) were exposed to direct hits by depleted uranium projectiles. Furthermore Spreading of contamination in the building may be obtained when many of materials have been transported from the building to other areas without taking any protective considerations, and the building is exposed to movement of winds.

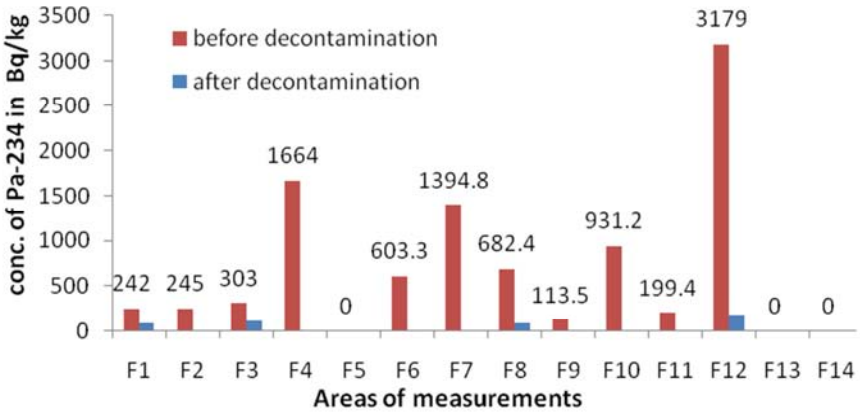

Figure 12. *Concentration of Pa-234 in soil sample before and after decontamination processes.*

The readings of exposure and contamination levels especially near the contaminated regions are higher than the background level with the range of (12-60) µR/hr and (0.5-90) cps respectively while the background level varies between (8-10) µR/hr and (0.4-0.6) cps. While samples of contaminated soil were taken from floors indicated high concentrations of Th-234, and Pa-234m, which ranged between (141.23-1550.1) Bq/kg and (199.4-3179) Bq/kg respectively while, the natural regional background is about 40 Bq/kg for Th-234 only.

5.2. Recommendations

1. The international community must work together to promote a decision to prevent using DU weapons.
2. Education and awareness-raising efforts on DU-related issues should be scaled up throughout the country to avoid that the population be accidentally exposed to DU.
3. The radiological survey will be needed for all metal scrap yards that have the potential presence of DU.
4. Radiation& Nuclear Safety Directorate (RNSD)/ Ministry of Sciences and Technology (MOST) must receive support from the international community to increase the experience of the staff responsible on radiological characterization of contamination with DU.

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