Modern Environmental Science and Engineering (ISSN 2333-2581)
January 2018, Volume 4, No. 1, pp. 91-102
Doi: 10.15341/mese(2333-2581)/01.04.2018/011
Academic Star Publishing Company, 2018
www.academicstar.us

Upgrading of Cobalt 60 in Temporary Pool for Dry Storage Irradiation

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Abstract: In any irradiation facility, upgrading of cobalt 60 activity is one of the most important operations which should be done periodically to maintain the dose rate in the irradiation processing to continue achieving the objective of the facility and the decay of cobalt 60. In general, there are two kind of irradiator wet storage and dry storage of cobalt 60 in the facility. In wet are wet storage facility to upgrade cobalt 60 in general the cobalt is shipped in supplier container and transferred in the pool of the facility to the source rake of the irradiators. For dry storage upgrading of cobalt is done in supplier facility by shipping the container of cobalt, is also transport container to supplier to upgrade the activity of cobalt 60. In our Irradiation facility Station d'Ionisation de Boukhalef (SIBO).The facility is a panoramic irradiator with dry store of cobalt 60 in a container used also as transport container in the first loading. We have been faced on a problem of the transport of the container and we need to find a solution to upgrade the cobalt 60. By bringing cobalt in supplier container and transferring the new sources to our container in a temporary pool fabricated in the facility. The objective of this paper is to show a case study experience. This operation has been considered as success story in by IAEA and opened the door to similar irradiators which have the same problem in other countries. And also was a real application of nuclear security system installed in the facility and during the transport of cobalt 60.

Key words: gamma irradiator, temporary pool, roof plug, container of cobalt, transport of Cobalt-60, upgrade cobalt 60

1. Introduction

Gamma irradiators may be divided into two types: self-contained and panoramic irradiators. Self-contained irradiators [1] are specially designed for research and applications that need small doses and relatively small throughputs. A large majority of these are dry-storage irradiators and the source activity is limited. For full commercial-scale irradiations, panoramic irradiators [2] are used. The focal point of the panoramic irradiator is the irradiation room where the product is treated with radiation. Access to this room is strongly controlled and the radiation source is fully shielded when not in use. In general these irradiators are wet storage. To upgrade cobalt in this kind of irradiators the cobalt is shipped in supplier container and transferred in the pool to the source rake of the irradiators.

For dry storage upgrading of cobalt is done in supplier facility by shipping the container of cobalt to supplier.

The transport of the cobalt 60 container is important [3]. in upgrading of cobalt 60 operation in our Irradiation Facility Station d'Ionisation de Boukhalef (SIBO). The facility is a panoramic irradiator with dry store of cobalt 60 in a container used also as transport container in the first loading. We have been faced on a problem of the transport of the container and we need to find a solution to upgrade the cobalt 60.

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The objective of this paper is to show a case study experience this operation has been considered as success story in by IAEA and opened the door to similar irradiators which have the same problem in other countries. And also was a real application of nuclear security system installed in the facility and during the transport of cobalt 60.

2. Irradiation Facility Station D'Ionisation De Boukhalef (SIBO)

The facility is a panoramic irradiator with dry store of cobalt 60 in a container used also as transport container (Fig. 1) in the first loading. It is the first one in Morocco and was installed in 1995 [4], in order to introduce this technology in Morocco the characteristic of this facility are:

Irradiation Cell:

- 6.1 m length
- 5.8 m width
- 2.6 m height

Three exposition systems have been installed around the source (Fig. 1):

- 4 big turn tables for high doses
- 4 small turn tables adjustable in two dimensions for medium doses
- 1 turn table for low doses
- Type of the storage flask: SV-68 B(U) type
- Year of manufacture: 1994
- Dimensions of the flask: Ø 770 mm x 1160 mm
- Material: Stainless steel case poured with lead
- Weight: 4940 kg
- Source holder: Round holder with 20 pencil positions, at present 2 positions contain source pencils.
- Source dimensions: 11.1 mm (diameter) x 451.4 mm height
- Cavity of the flask for sources: Ø 131.5 mm x 615 mm
- Original source activity: 15,684 Ci (on 1st April 1995)

Safety condition: tree independent interlock system, 2 fixed gamma detectors (Fig. 2) and one personnel detector. The unit is controlled by a PLC system (Fig. 3).

Fig. 1 Interior of the irradiator.

Fig. 2 Radiation monitoring system.

Fig. 3 Operation panel of the control system.

3. Upgrading of Cobalt 60 in SIBO Irradiator in Tangier

This operation has been done on 2000 by adding two big turntables [5] in order to prepare the facility to the upgrading of cobalt 60 to 60 kci (Fig. 4).

All preparative has been done to send the container to the cobalt 60 supplier and at the last minute the maritime companies of transport refuse to transport the container with no logical reason. From this day we tried all contact and we bring all facility and document from the authority of the port but with no success.

After 11 September 2001 the situation become more

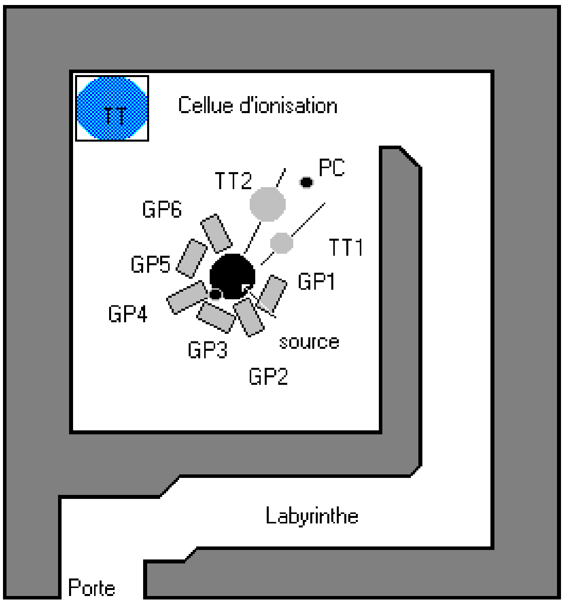

Fig. 4 Irradiation cell with turn table system.

difficult at international level and the transportation of any radioactive material become more difficult.

Another point of difficulty come to be added on 2004 the license of transport of the container has been expired. So other solution has to be proposed

(a) Transport the container in other licensed container and send it to cobalt 60 supplier and bring it back to the irradiator. Everything has been prepared but also the sae transportation still be a problem [6]

This solution has been abandoned with times because of the remaining difficulty to find a sea transporter.

(b) Bring new source in supplier container and made the transfer of cobalt form supplier container to our container in a pool which should be constructed in the area of the facility — This solution has been adopted by All the party and security procedures has been proven with IAEA assistance.

In 2012 a company has accepted the project and work start in 2013-2014 with better solution according to safety principles of the operation: the pool will be temporary inside the bunker [7].

3.1 Preparation of the Site and the Irradiator

The bunker (Fig. 5) will be emptied and the water pool will be installed. Then the Existing sources from the SV-68 irradiation will be unloaded allowing technical check up on the Source holder mechanism of SV-68 by the end the existing two sources will be reloaded in the SV-68 flask, and the flask will be left for temporary storage in the technical room Located on the top of the bunker.

Fig. 5 Removal of SV-68 container.

The supplier source container will be accepted at the Casablanca airport then; Transported to INRA site in Tangier. The new sources from supplier together with the existing two sources will be loaded in the SV-68 irradiator. By the end the SV-68 irradiator will be operational with the replenished sources of approximately 62 kCi.

The vertical cross section of the bunker with the actual dimensions (Fig. 6). The product turning systems are missed from the figure for easier understanding. The SV-68 storage flask is located in the center line of the bunker exactly under the round-shape roof plug. The roof plug is a single item of one piece. The thickness of the ceiling and the roof plug is 1.3 meter.

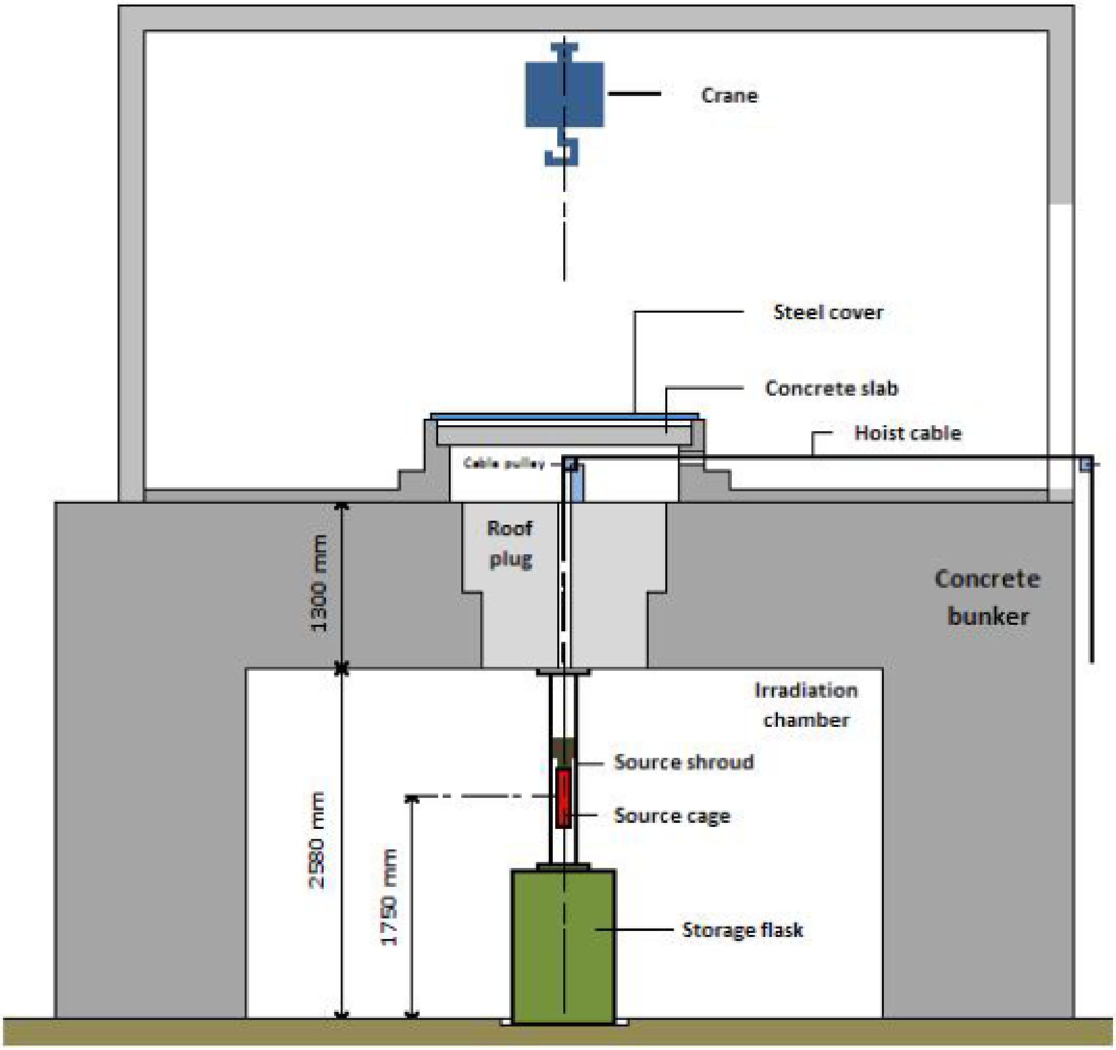

Fig. 6 Vertical cross section of the bunker with the actual dimensions.

3.2 Installation of the Temporary Water Pool

When the cavity in the ceiling of the bunker (Fig. 7) is open, the temporary water pool will be installed there. The water pool will be placed in the bunker through the hole of the ceiling plug of the bunker. The pool size will fit the size of the hole properly. The pool will be provided by supplier in two parts, and these parts will be unified with TIG welding at the site. It is a must since the clearance under the overhead crane in the technical room does not allow the installation of the pool in one piece. The stainless steel wall thickness of the pool will be 4 mm that will allow an easy and safe welding procedure to be carried out by supplier's

Fig. 7 Technical room over the bunker with still over roof plug.

Fig. 8 Cheking the container plug.

Fig. 9 Lowing the SV-68 flask into the pool.

qualified welder. The completed pool will be checked then filled with demineralized water. When the pool is proved as leak-proof, the gap between the pool and the cavity of the bunker ceiling will be filled with steel shot to be provided by supplier. It will stop radiation through the gap when the radiation sources are manipulated in the water pool.

3.3 Placing the SV-68 Flask into the Pool

When the water pool is installed and proved as leak-proof, the SV-68 irradiator flask will be placed into the pool. Prior to taking the flask into the pool the old sources in the flask will be checked for contamination [8]. For this reason, a certain small volume of deionized water will be filled into the SV-68 flask (Fig. 8), then the water will be released through the drain plug of the flask for radiation measurement.

Since the volume of the flask versus the pool volume is reasonable, the water level will increase with approximately 425 mm when the SV-68 flask is entirely sinks into the water (Fig. 9). To avoid spilling from the pool, the pool will be provided with a balancing system pumping a certain volume of water between the pool and a reservoir tank when it is necessary.

The pool will be provided with an internal barrier about 1 m above its bottom (this barrier is not shown on the figures). It is designed for two functions. First function is to separate the pool for two parts. One part will be used for keeping the heavy source containers (both SV-68 and SUPPLIER transport container, respectively) in a certain position when they are loaded in the pool. Other part of the pool is reserved exclusively for the sources, and the barrier has to ensure a safe distance between the source and the container at all times avoiding mechanical damage of the sources caused unintentionally with the container when it is manipulated under the water. The second function of the barrier is to hold an underwater table which will be used for several tasks during the operation. When a source flask is located in the pool a small table is operational in the pool.

3.4 Removing the Source Drawer from the SV-68 Flask

When the SV-68 flask is inside the pool, its top plug (Fig. 10). (source drawer) will be removed carefully

Since it holds the existing two sources, this part will be carefully placed to the cavity of work-table I (Fig. 11) in the pool.

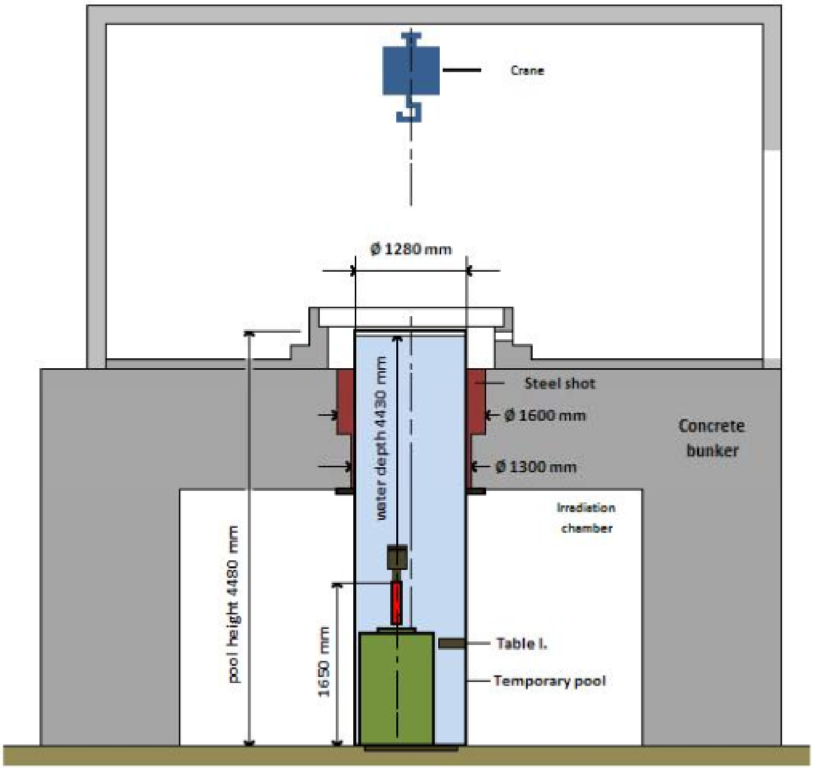

Fig. 10 Lifting the source drawer out from the SV-68 flask.

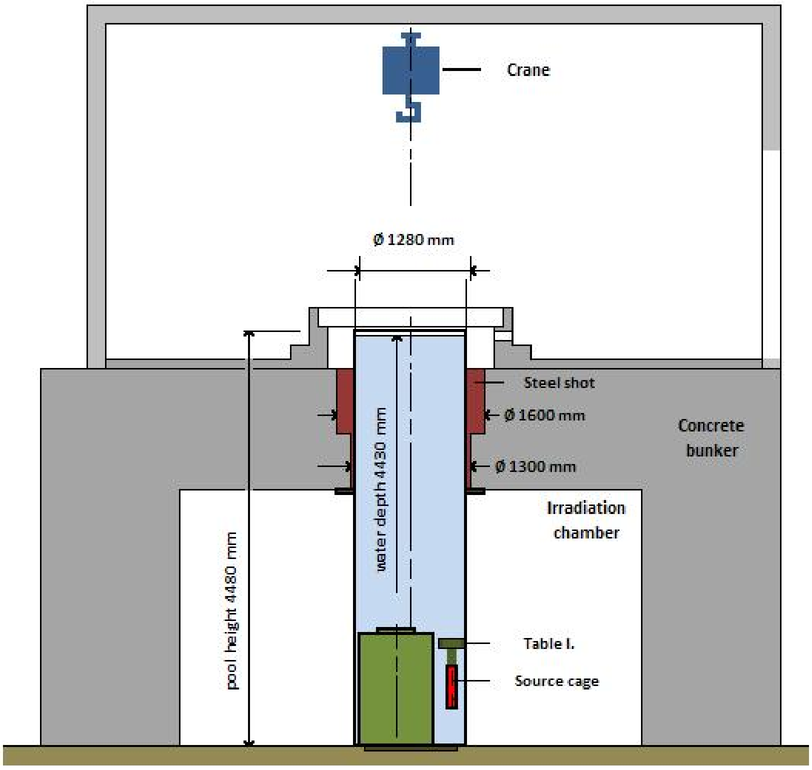

Fig. 11 Sources in to cavity work-table I.

3.5 Removing the SV-68 Flask from the Pool and Manipulation of the Sources

As soon as the source drawer holding the source cage is safely and firmly located on Work-Table I, the SV-68 flask will be carefully removed from the pool.

When the SV-68 flask is off, a second part of the work-table system will be installed (Fig. 12). These two tables together will completely cover the surface of the pool, and will provide stabile and properly horizontal surface for source manipulation (Fig. 13). The sources will be manipulated from the top of the pool with bars and remote tongs.

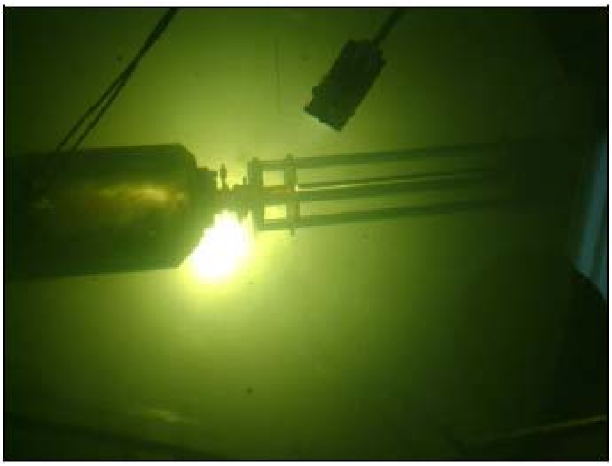

Fig. 12 Manipulation of the source basket (holder).

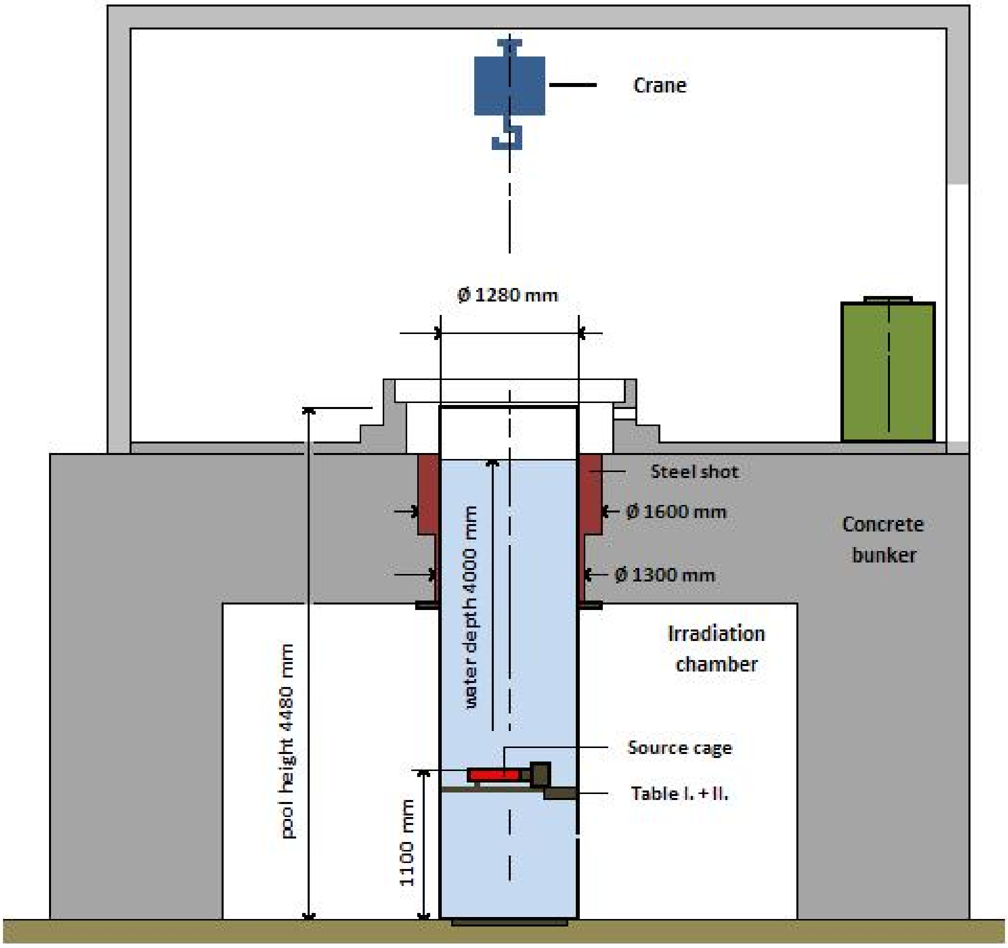

Fig. 13 Source cage is manipulated on the entire work-table system I+II.

The sources will be removed from the cage (source holder) and placed in the cavity of work-Table I. specially designed for this purpose. Then source cage (holder) of SV-68, free from radioactive material, will be taken out from the pool for investigation. At the same time the two old sources (Fig. 14) will be placed in a new, temporary source holder to be provided. Then Work-Table II will be removed and the SV-68 flask will be placed back into the pool again. The two old sources will be placed into the SV-68 flask then the flask will be closed with its own top plug. The SV-68 flask will be removed from the pool and left on the top of the bunker in the technical room until Phase 2 begins. The water will be removed from the pool depending on the expected arrival time of the new sources.

3.6 Loading the New Sources in the Irradiator

When the two supplier transport containers arrive to Morocco Casablanca airport (Fig. 15) they will be transported (Fig. 16) by road under security and escort of Gendarmerie royal and National security [9] and the control of National center of radioprotection [10] to the INRA site in Tangier, they will be lifted to the technical room one by one (Fig. 17).

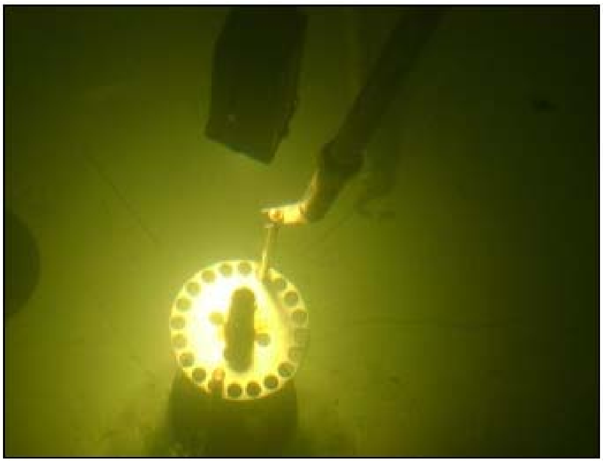

Fig. 14 Removal of old sources from the open basket.

Fig. 15 B(U) type transport packaging at the airport.

Fig. 16 Transportation of the sources to Tangier.

Fig. 17 B(U) Type Package dismantling.

A smear test on the external surface and a leak test on the content will be carried out on both packages to prove that neither external contamination nor leakage of the sources occurred. Then the temporary pool will be re-checked, filled with water. The water level and quality will be maintained precisely. An additional 500 mm shielding will be installed around the upper part of the water pool. It will be needed to improve the shielding capacity of the pool and its surrounding for the higher activity of the fresh sources. This extra shielding will be implemented with filling the cavity around the pool with concrete blocks. Additional shielding applied with temporary concrete fill up around the top of the pool

When the pool shielding is improved [11] and both supplier containers are proved to be free from contamination, one of the supplier containers will be lowered into the pool (Fig. 18).

The proper water level will be maintained during the sinking process. The top plug of the supplier transport container will be removed and the new 3 source pencils will be removed from the cavity of the transport container. The sources will be moved with their own source cage provided by SUPPLIER (Fig. 19). The sources will be placed into the cavity of work-Table I. The same procedure will be rotated with the second supplier transport container either.

3.7 Unifying the Old and New Sources and Loading Them in the SV-68 Irradiator

As soon as all 6 new sources are loaded in the pool, the SV-68 flask will be placed into the pool. The two old sources will be taken out and put on the cavity of work-Table I. Then the SV-68 flask will be temporary removed from the pool again allowing enough clearance for the safe source loading operation. When all 8 the sources are collected on work-Table I., work-Table II will be installed and the source cage of the SV-68 irradiator will be placed onto the table system.

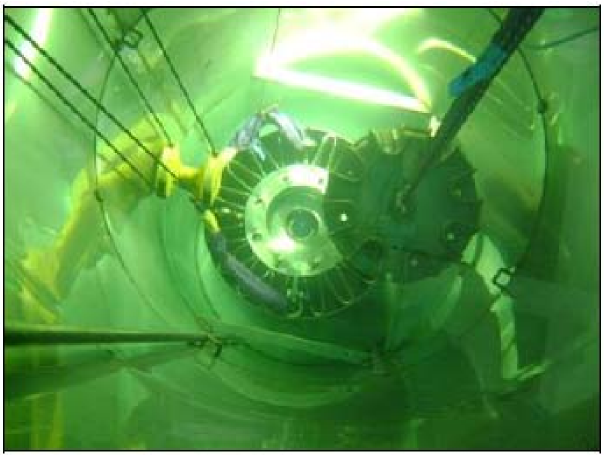

Fig. 18 Unloading sources from supplier container.

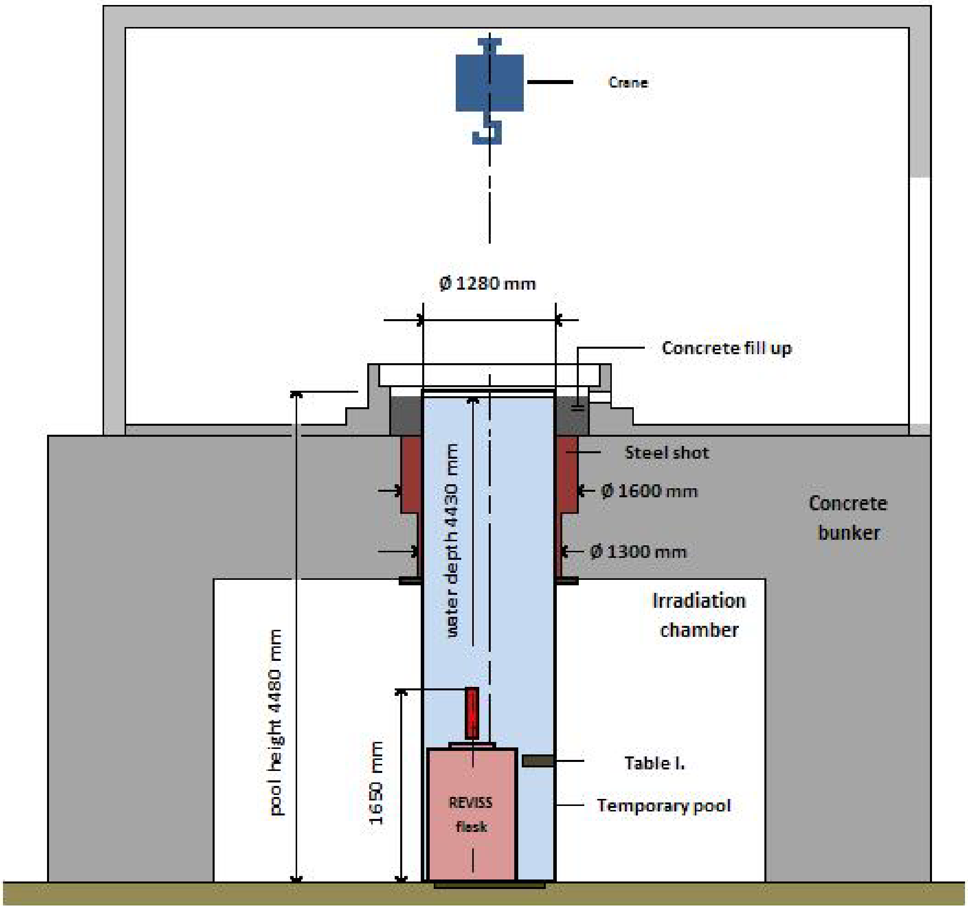

Fig. 19 Removal of the fresh sources from supplier transport container.

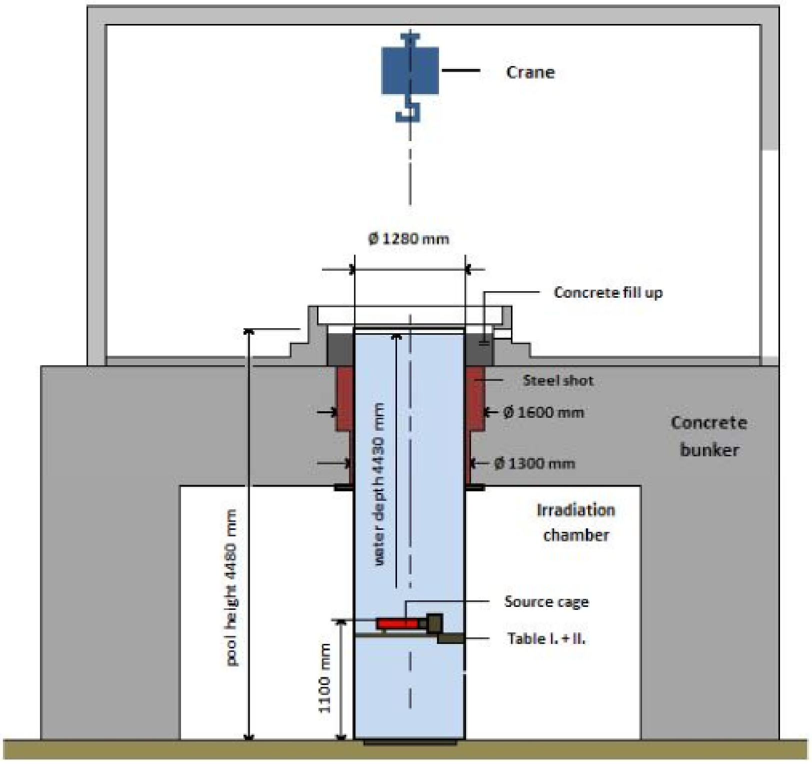

Fig. 20 Source loading is carried out on the work-table system I+II inside the pool.

When all the sources are installed in the source holder of the SV68 irradiator (Fig. 21), and the holder is fixed to the top plug of SV-68, the plug + holder assembly will be placed in the cavity of work-Table I. Then work-Table II will be removed from the pool and the SV68 flask will be put back into the pool. Then the source holder will be taken back into the SV68 irradiator flask (Fig. 22).

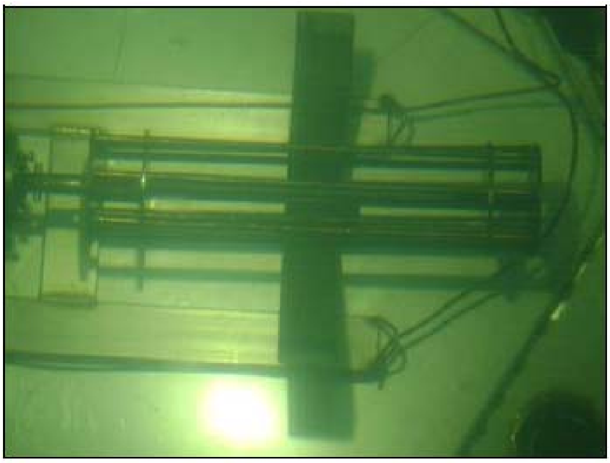

Fig. 21 All the 8 sources are loaded in the basket.

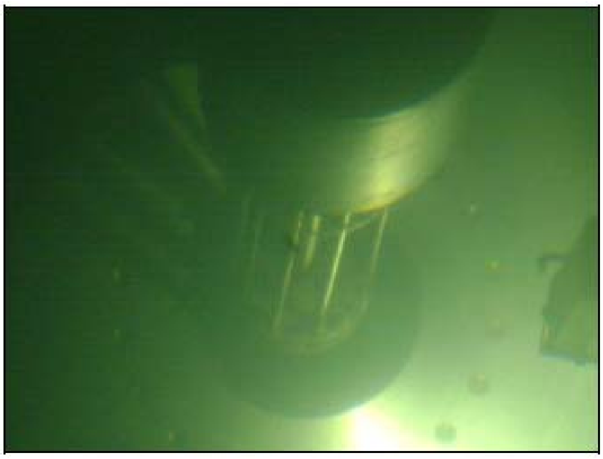

Fig. 22 Source Assembly is placed into the cavity of SV-68.

3.8 Removal of the temporary pool and reconstruction of the original configuration

Following the successful loading of all the sources in the SV-68 flask, it will be removed from the pool then the water will be checked for contamination[12]. The clear water will be pumped out from the pool then the pool will be cut for two pieces and removed from the cavity of the bunker.

The SV-69 flask will be placed in its original position and adjusted precisely. Then the roof plug will be placed into its roof cavity (Fig. 23), and the source hoist cable will be reinstalled in its original position and checked for easy operation. Then the covering lids will be placed back (Fig. 24).

Product turning systems will be reinstalled in their original position and will be tested for smooth running. The source guiding and protection tubes (Fig. 25) will be re-installed and adjusted precisely. Finally all the systems will be checked for proper operation [13].

Radiation protection considerations and dose assessment will be done in accordance with regulation involved in the job

All licenses for importation and transport has been prepared with all authority according national and international regulation [14]

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Fig. 23 Top view on the roof plug after removal of temporary pool.

Fig. 24 Roof cover and plug reinstalling.

Fig. 25 Source guiding and protection tubes.

4. Conclusion

This operation has been done with success and also the supplier empty container has been returned within one week with great assistance of National center of radioprotection and the National security department and Gendarmerie royal for the transport and during the operation. It has been considered a success story of the year 2014 during the general conference of IAEA.

This operation has opened the door to similar irradiators which have the same problem in other countries. And it also was a real application of nuclear security system installed in the facility and during the transport of cobalt 60.

Immediately after this operation, we started the upgrading of safety and technical system of SIBO irradiator in collaboration with IAEA. The details of this operation have been published in other scientific paper.

This combined system upgraded in security and safety and processing purpose offer a new largest system with the best of each one and can give a specific global solution to similar facility which need to upgrade the control system.

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