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RESEARCH ARTICLE

DECOMMISSIONING OF TELETHERAPY MACHINE AND TRANSPORT OF DECAYED TELETHERAPY SOURCE

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Abstract

Radioactive Cobalt-60 teletherapy machines find a prominent place in radiation therapy departments in India. The first teletherapy cobalt machine in SMS hospital (Picker Advance Tele Cobalt (ATC) C/9) was installed in 1995. The initial activity of the cobalt source was 333 TBq (9000 Ci).In March 2019, the source output became lesser than 50 cGy/hr at normal treatment distance (NTD) of 80cm which is clinically not acceptable for patient treatment because of increase in treatment time. The decommissioning of the machine was considered due to ageing of machine and vendor was not providing services anymore. This present study describes radiation safety aspect of the planning of decommissioning of teletherapy machine and transport of the decayed Cobalt-60 source for disposal and personnel dose measurements during the procedure. Decommissioning of the cobalt machine began with preparation of a plan and its submission for approval by competent national authority. Radiation survey of the source head was performed before the source transfer operation by AERB certified decommissioning engineers. Then decayed source was unloaded in shielded container (flask Sl No 112) and was kept in another outer container (type B (U) package). It transported for disposal to BRIT, Kota on receipt of transport permission fromAERB.A radiation survey was done in a matrix format of the all sides of this package.To measure the personnel doses, pocket dosimeter, TLD badge and OSLDs were used. The maximum dose received by the engineers was .03mSv. Maximum radiation level at 1 m from the external surface of the package was found 0.83mR/hr. The development of the new concepts and practices in the field of the decommissioning includes the preparation and approval of a decommissioning plan, the actual decommissioning operations as well the safe management of the waste arising from the decommissioning process. Such plans need to be developed for each facility with radiation sources.

Introduction:-

Radioactive Co-60 teletherapy machines find a place in radiation therapy departments, in more populated and developing countries like India. In the advent of crisis globally in the management of cancer care, cobalt teletherapy machines have an edge over the linear accelerators because of theirs less maintenance cost, less infrastructure

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requirements, low power demands, and simple quality assurance of the beam parameters. Decommissioning is the process by which a radiation facility is finally taken out of operation, in a manner that provides adequate protection to the health and safety of the workers, the public and the environment.When decayed source present in the machine provides lesser output (cGy/min), because of this lesser dose leads to more treatment time for an individual patient (patient static position should be considered here) and to achieve meaningful radiobiological effect, optimum dose rate is needed. It may require more maintenance, and suffer from increasing downtime then we need to decommission it.

The first telecobalt machine for treatment of cancer patients in Rajasthan was commissioned in 1965 in AcharyaTulsi Regional Cancer Treatment & Research Institute, Bikaner and the first teletherapy cobalt machine in SMS hospital was installed in 1995. The machine was Picker Advance Tele Cobalt (ATC) C/9 (Advance Medical Systems Inc., USA model No 181361) with activity of the cobalt source 333 TBq (9000 Ci). This machine has provided the treatment of about 800 patients per year and worked for a period of 24 years (1995-2019).The source output became lesser than 50 cGy/mint in March 2019, and the decommissioning of the machine was considered as the company was not providing services anymore.

Fig. 1:- Picker Advance Telecobalt(ATC) C/9 Machine.

Materials and Methods:-

Decommissioning of the cobalt machine began with preparation of a plan and its submission for approval by national regulatory authority(AERB). The plan has foreseen all necessary steps, which were considered as appropriate to perform this process in a safe manner. The preparation of the facility, as well of the cobalt machine, was prepared in accordance with radiation protection requirements.Expert/ Experience engineers of the company were called from the original manufacturer/vendor of the machine.

The technical documents of the installation and the functioning of the machine as well a short description of the main characteristics of the cobalt source were prepared with the same goal.

Followings steps are done before unloading the source /before decommissioning process

Pre planning and all mock drill/drill checks were performed before decommissioning process.

Necessary monitoring devices (survey meter & pocket dosimeter) were made available with proper calibration and working conditions (backup batteries).

CCTV and Gamma zone monitor functionality were checked. For the radiation safety of the source loading engineer; advice was given for optimal plans to avoid any excess exposure.

Before doing this procedure, Optically Stimulated Luminescence Dosimeters(OSLD) were pasted (using microspore) on the engineer's forehead; thyroid, chest level, both left and right wrists and both lower legs level to measure and

monitor the personnel radiation dose.

Thermo Luminescence Dosimeter (TLD) and Pocket dosimeter were also worn by the engineers. Pocket dosimeters were used to measure the real time instant radiation dose to personnel. It is must for radiation surveillance.

Whoever was involved in this procedure (RSO, Medical Physicist, Radiation TSherapist), were applied the OSLD and TLDs on chest level.

Primarily radiation survey was done of ATC C-9 telecobalt machine before source unloading. Head leakage in source OFF position was measured at 5cm from the surface of the source and 1m from the centre of the source.

Then treatment table and beam stopper were removed and the collimator was removed by the help of tool kit followed by survey of source head through each side.

Then a radiation survey was done. All mechanical parts of the source shielding container were checked for assurance and
lubricated for removal any friction at a time of the source container alignment and before it.

The radiation survey was done of empty source shielding container from each side to check any radiation level.

Alignment of the source shielding container with source head was done with the help of adaptor (composition – Brass, Lead and Tungsten).

Necessary advices were given by RSO to the team to maintain safe distance from the container to maintain the dose levels lesser (ALARA).

After alignment of the source shielding container with source head, again a radiation survey was carried of setup from each side.

After set above all things by the decommissioning engineers, went inside the treatment room with all preparations.

Fig. 2:- Lubrication of shielding container.

Fig. 3:- Dose calibrator.

Procedure of Decommissioning

1. First beam was ON from the control console (source was in its on position).
2. Then loosed drawer stop screw and pulled drawer out to scribe line and verified safety bolt (Fig.4).
3. Gently pushed in'T' handle as far as it went and lower pushed rod.
4. Pulled drawer out until it stops. After that opened shutter pushed in drawer, unscrewed 'T' handle two full turns.
5. Pulled drawer out until stop and rotated 180 degree. Retrieved old source and bring it down.
6. Pushed in drawer and secure, performed leak check. Then, it was ensured that source was inside the shielding container with survey.
7. All these procedures were donebyacertifiedserviceengineerunderthesupervisionof authorizedRSO.Thendecayedsourcewasunloadedinanapprovedshieldedtransportflaskandwaskeptin another outer transport container (Type B (U) package).
8. A radiation protection survey of container was done in a matrix format of the all sides of this package. Radiation levels were measured at 1 m distance from source and the external surface of package.
9. Thedepleteduranium(DU)partsweight 21Kg (15Kgs inHeadand 6KgsinRotor)retrievedfromheadandrotorofTelecobaltmachine.
10. TheDUretrievalwasdoneinthefacilityof wastedisposalagency.
11. Themachinewasdismantledlocallyinsuchawaythattheunitcannotbeputagms foruse.
12. After unloading the source from machine, a swipe test was also performed to check the contamination in the area in which the source moves and on the external surface of source head.Contamination was checked with Dose calibrator (Fig.3).

Fig. 4:- (a) Source drawer (b)T-handle.

Fig. 5:- Depleted uranium removed from ATC C/9 Head Qty 15 Kgs and Qty 6kgs from Rotor.

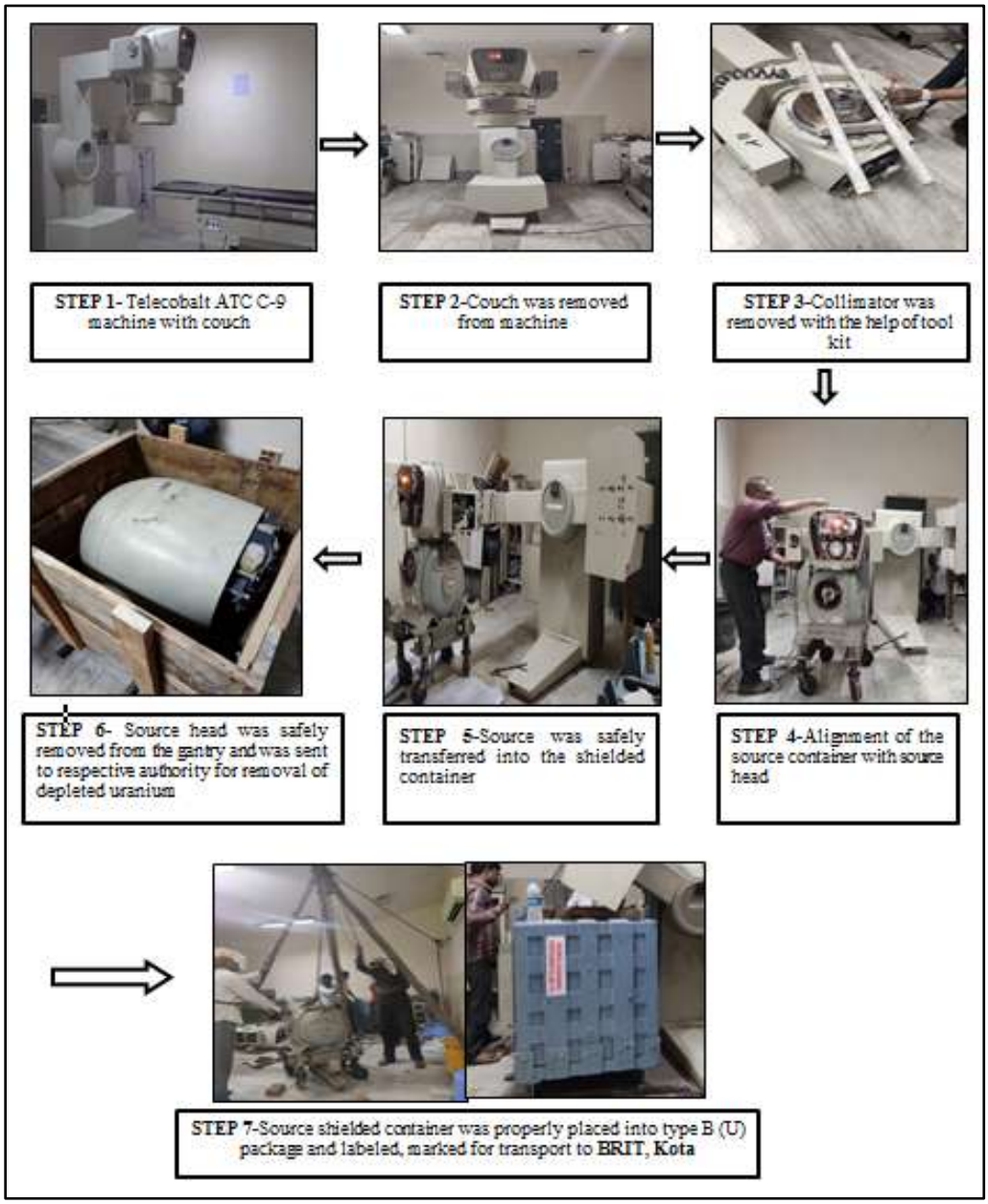


Fig. 6:- Workflow of steps taken in decommissioning.

Fig. 7:- Survey points of source shielded container.

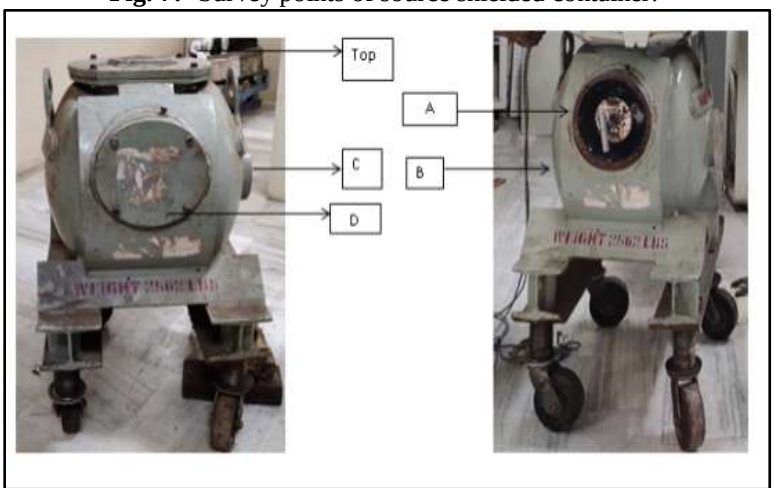
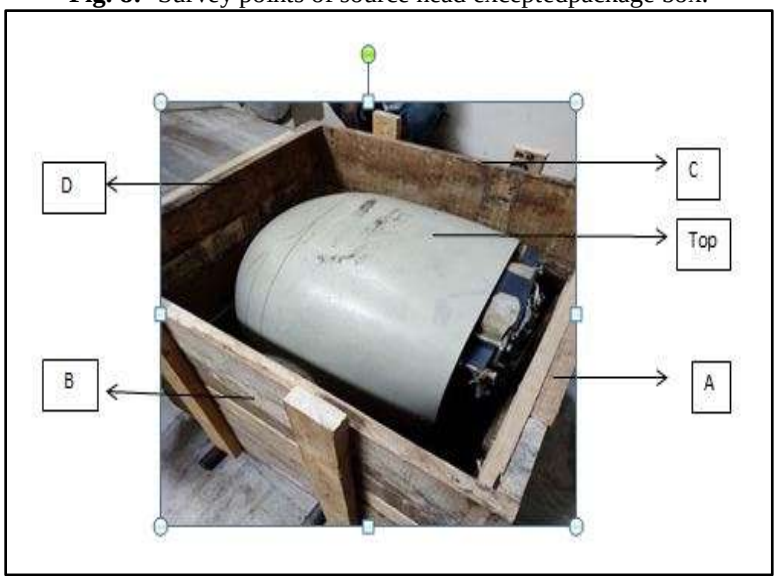


Fig. 8:- Survey points of source head exceptedpackage box.



Result:-

The dose received by the personnel was measured by the pocket dosimeter, TLD badge and OSLD. The pocket dosimeter being an active dosimeter gives instantaneous reading received by the personnel. The maximum dose received by the source decommissioning engineers (.03mSv). All personnel and area monitoring doses were within the tolerance. Radiation exposure caused by carrying out the "Hit and Trial method" based on working experience by service engineers at the time of source unloading warrants a proper protocol for source unloading of decayed source.

The same was informed to the regulatory board through source transfer report. Radiation level was measured 2.3mR/hr around source head after removing the collimator. Maximum radiation level at 1 mt. of shielded container was found 3.89 mR\hr and 18.5 mR\hr at 5cm. Maximum radiation level on the surface of the packagewas found 6.0 mR/hr and maximum radiation level at 1 m from the external surface of the package was found 0.83 mR/hr.On the basis of transport index value, source was kept in category yellow-II. The development of the new conceptsand practices in the field of the decommissioning includes the preparation and approval of a decommissioningplan, the actual decommissioning operations as well the safe management of the waste arising from the decommissioning process. Such plans need to be developed for each facility with radiation sources. Surface Contamination by swipe test of source head measured by dose calibrator was negligible.After the successful operation of source unloading and transport of decayed source the report was sent to AERB through e – LORA. All these operations were done on

4th November, 2019. The decommissioned source was sent on 10th February, 2020 to BRIT, RAPPCOF, Kota by road as per regulatory guidelines.

Table 1:- Survey of shielded container after transferred of the decayed source.

Positions	Reading at 1 mt distance	Reading at 5 cm distance
Top	3.89mR/hr	18.5mR/hr
A	1.97mR/hr	9.3 mR/hr
B	1.03mR/hr	6.9mR/hr
C	0.62mR/hr	3.7mR/hr
D	0.56mR/hr	1.96mR/hr

Table 2:-Survey of source head after alignment ofcontainer with source head.

Position	Reading
Top A	2.3 mR\hr
B	0.80 mR\hr
C	1.85 mR\hr
D	0.67 mR\hr

Table 3:- Source head survey after removingcollimator.

Position	Reading
Top A	126 µR\hr
B	1.04 mR\hr
C	9.8 mR\hr
D	0.9 mR\hr

Table 4:-Survey of source head after unloading the source.

Position	Reading in µR/hr
Top	116
A	109
B	115
C	114
D	111

Table 5:- Readings of personnelpocket dosimeter.

Pocket dosimeter	Reading (mSv)
Engineer 1	.03
Engineer 2	.02

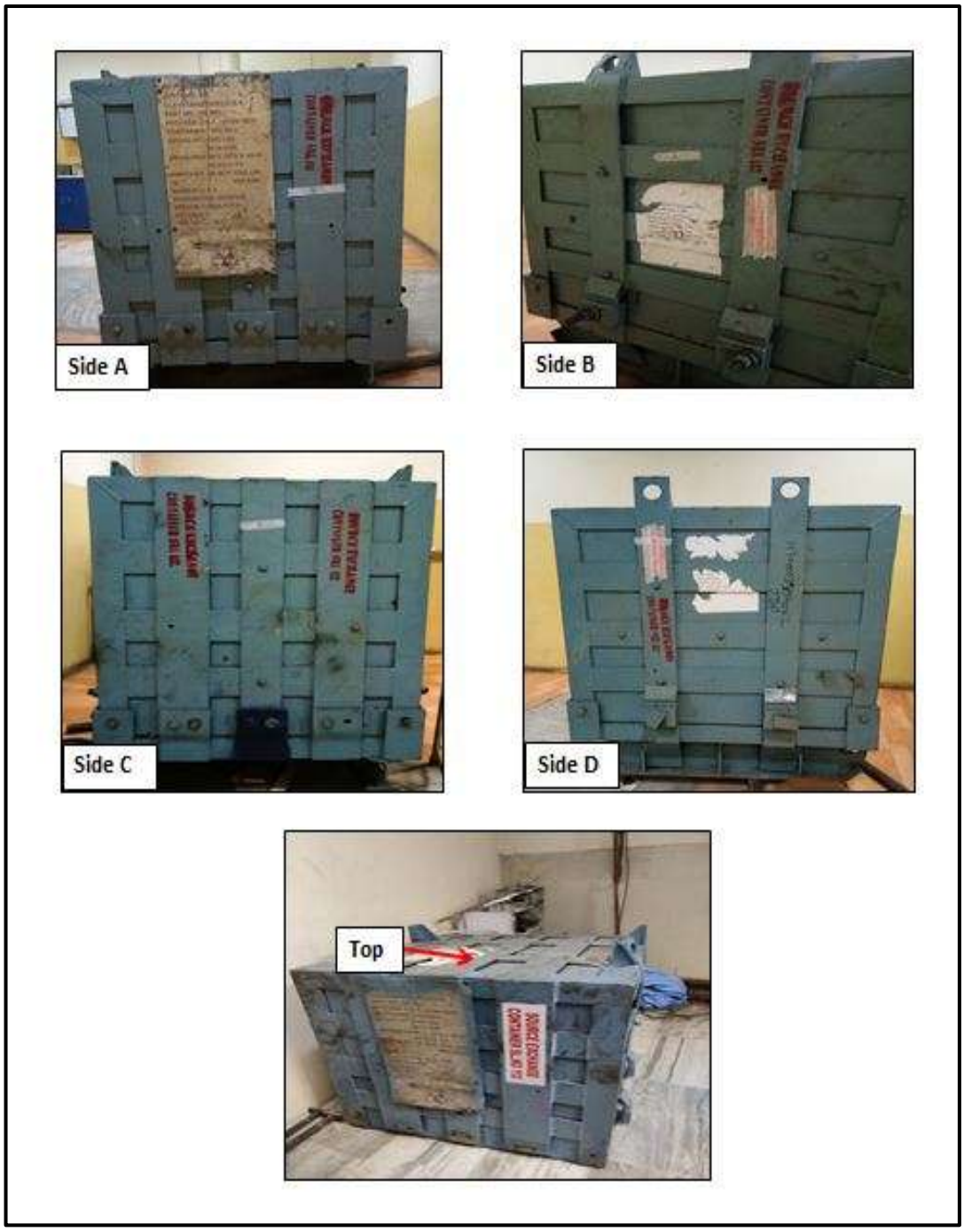


Fig. 9:- Allsides of type B (U) Package.

Table 6:- Radiation measurement on the surface of the transport container (Type B (U) Package) in matrix format of all sides(All readings in mR/hr).

0.41	0.95	1.03	0.50
0.39	0.95	1.09	0.47
0.37	1.02	1.01	0.41
0.32	0.89	0.89	0.37

Side A

0.52	1.02	0.52
0.72	2.7	0.71
0.52	1.28	0.65
0.29	0.55	0.27

Side B

0.41	0.95	1.03	0.50
0.39	0.95	1.09	0.47
0.37	1.02	1.01	0.41
0.32	0.89	0.89	0.37

Side C

0.85	1.77	0.74
1.22	3.6	1.06
1.08	2.8	0.91
0.40	0.95	0.39

Side D

1.47	1.59	2.0
1.62	6.0	1.89
1.21	4.7	2.0
1.28	1.38	1.25

Top Side

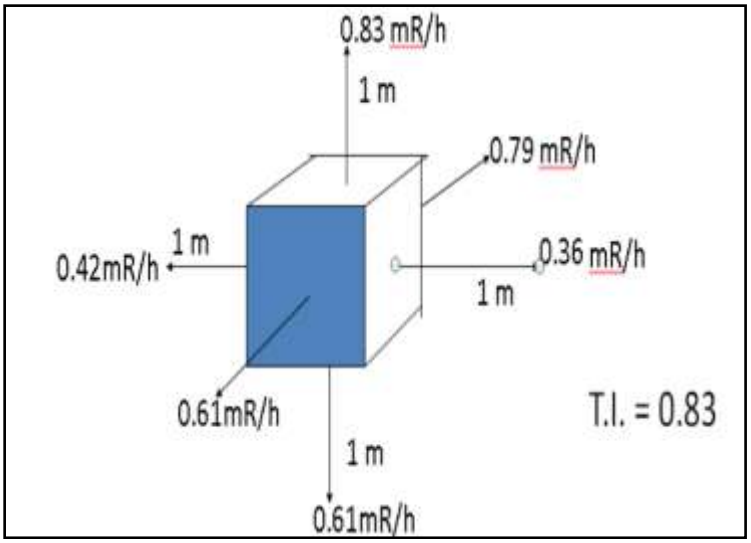


Fig. 10:- Maximum radiation level in mR/hr at 1 mtdistance taken from all sided of Type B (U) Package.

Conclusion:-

Thedevelopmentofthenewconceptsandpracticesinthefieldofthedecommissioning includes the preparation of a decommissioning plan. This study provides guidance for the actualdecommissioningoperationsaswellasthesafemanagementofthewastearisingfromthedecommissioningordismantling of Teletherapy machines. Such plans need to be developed for each facility with radiation sources prior to decommissioning.

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