



## Cobalt-60 Contaminated Metal Source Recovery Djibouti City, Djibouti April 2011





### Situation



One 20 foot container scanned by a Megaport Radiation Portal triggered a gamma alarm due to high levels and was sent to secondary inspection. In secondary inspection, officials conducted measurements with a Detective HPGe (high resolution) and a Radioisotope Identifinder (low resolution), both identifying Co-60. The concern was the presence of Co-60 in cargo listed as metal hardware. Djibouti Officials and DOE further assessed the radiation signature and conducted a source recovery to ensure the cargo poses no risk to the public.





### **Megaport Radiation Portal Data**



Gamma Profile



The data show elevated gamma levels which were not uniformly distributed along the container. The manifest shows 1015 cartons of machetes and standard  $\frac{1}{2}$ " gate valves both of which should not be radioactive.

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The spectra shown above were acquired by a Megaport operator and sent to DOE Triage for analysis. Both spectra clearly show the two characteristic gammas from Co-60 at 1173 and 1332 keV.



### Main conclusions:

### Co-60 confirmed

Common industrial radioisotope

Estimate of activity is 20-40 MBq (0.5-1 mCi)

Not indicative of a threat but a potential health risk to public

## **DOE Triage Report**



#### Short synopsis of the analysis results.

The spectrum submitted was not indicative of a threat. The material resulting in the Unknown spectrum was cobalt-60 (Co-60).

#### Technical details of the analysis

The material was identified as Co-60, a common industrial radionuclide. An estimate of activity for shielded Co-60, assuming a one meter distance from the radioactive material to the detector was approximately 0.5 to 1 mCi (20 - 40 MBq).



Figure 1. Identification – Cobalt 60 from the unknown item is in black, and matches a reference spectrum of Co-60 taken by the same type of instrument, shown above in blue.











**HPGe Spectral Measurements** 

A radiological safety evaluation was conducted on the container to verify no external contamination, safe dose rate levels and confirm the identification of Co-60. The information was used to develop the source recovery plan.







A cargo container with contaminated products may appear as a *distributed source* over a section of the container

Metals are contaminated in blast furnaces when radioisotopes such as Co-60 are accidently smelted; examples include rebar, metal parts and elevator buttons

	H 4.5 M 6.1 L 0.3	H 2.1 M 4.5 L 0.38	H 0.2 M 0.25 L 0.2	H 0.1 M 0.02 L 0.1	H 0.02 M 0.02 L 0.04		
H 6.3							H 0.02
M 6.1							M 0.01
L 0.6	All readings in uSy/h						L 0.01
_ 0.0	H readings 2 m above ground $D$						
н 63	M readings 1 m above ground 0						н 0 02
M Q 1	L roadings 0.2 m above ground 0						M 0 01
		Liead	lings 0.5 i	n above gr	ounu	r	
L 1.0						I I	L 0.01
H 4.5							H 0.02
M 8.0	20 ft						M 0.01
L 0.6	<b>—</b>					$\rightarrow$	L 0.01
	H 5.0	H 2.5	H 0.14	H 0.02	H 0.02		
	M 8.3	M 2.3	M 0.15	M 0.02	M 0.02		
	L 1.0	L 0.6	L 0.04	L 0.02	L 0.01		

The radiological characterization map shows a radiation source distributed over a triangular area with highest levels at the back of the container.



## How does a Co-60 source end up in products?





A high activity orphan Co-60 source is discarded in scrap metal and sent to a recycler. These radiography, medical and sterilization units can contain over 3700 GBq (100 Ci)



At the metal foundry, the Co-60 is smelted in a blast furnace with the scrap metal and ultimately distributed throughout the batch of molten metal.



The Co-60 contaminated metal is then formed into billets which are sold to manufacturers to make commercial products.



### **Source Recovery Operations**





A three day I-RAPTER Port/Customs course was conducted on container alarm adjudication and source recovery. Once the container was determined to be safe for source recovery operations, a concept of operations was developed and incorporated into the training agenda.



### **Concept of Operations**



Pre-job safety briefing will be provided to all participants and observers.

Initial hotline/support area will be at entrance gates to the storage yard.

Initial personnel forward for container opening will be: Host Country Representatives, Entry Team 1 and a Scientist. Each will be provided an alarming dosimeter.

Container will be opened while performing dose rate monitoring with a calibrated dose rate meter.

Entry team 1 will perform contamination surveys with a calibrated beta/gamma probe and swipes prior to opening doors and immediately after opening doors.

After initial swipe results are evaluated, the students will be allowed to approach opened container to see the contents in the original configuration. After viewing, students will be moved back to allow operations to continue.



### **Concept of Operations**



Depending on cargo configuration, surveys will be performed and layers of cargo removed and placed in interim storage location.

Entry Team 1 and scientist will perform additional measurements as needed to locate the radioactive material.

Entry Team 1 and Entry Team 2 can exchange positions as needed.

If dose rates exceed 50 mSv/h (5 mR/h), a temporary hold will be enforced to ensure all participants are comfortable proceeding.

If loose contamination more than twice background is discovered, protective clothing will be used.

Note: If any suspicious packages, wires or anything with a hazardous, explosive or other indication of dangerous material is noted, all activities cease, personnel will return to a safe distance and the plan will be reevaluated.



# External Container Surveyed for Contamination and Dose Rates





Two instructors don rubber gloves and dosimetry to conduct a survey of the door latch, door handle and vent using paper swipes to collect removable contamination. A third instructor uses a health physics beta/gamma probe to measure the swipes for contamination.



## **Container Opened and Surveyed for Contamination and Dose Rates**





No contamination detected on the inside and dose rates inside door are near background. The contents are found to also contain hardware items to include hammers and nails which provide shielding of the radiation source at the rear of the container. Using an extendable tele-probe, dose rates on top of the boxes were 0.13  $\mu$ Sv/h (13  $\mu$ R/h) middle container and 0.27  $\mu$ Sv/h (27  $\mu$ R/h) rear container.



## Path Cleared along Right Side of Container to Source





Contamination and dose rate surveys conducted after each column of boxes removed. Contamination negative and dose rates near background. Boxes contained tools and hardware (hammers, nails, scrapers, machetes, etc.) which provide good shielding of the Co-60 source in the back of container.



## Trainees Participate in Transferring Boxes to Second Container





Volunteer trainees participate in source recovery operations. They wore rubber gloves as a precaution and were not allowed to handle boxes having elevated readings.



## Box with Elevated Dose Rate Readings Removed from Container





Contamination and dose rate surveys were conducted on a box with elevated readings. Removable contamination was negative and the dose rate was 6  $\mu$ Sv/h (600  $\mu$ R/h) on contact and 0.4  $\mu$ Sv/h (40  $\mu$ R/h) at 1 meter. The box contained 20 water meters and weighed 14 kg.



### **Single Water Meter**





Each water meter is 7.6 cm (3 inch) diameter x 10 cm (4 inch) long with threaded input and exit ports. Housing appeared to be brass metal. The Co-60 was smelted into the metal at a foundry and then the metal made into the housing. Swage nuts and washers in plastic bag showed no evidence of Co-60 contamination.



### HPGe Measurement of a Single Water Meter





Preliminary assessment of activity gives ~ 18 kBq (0.5  $\mu$ Ci) Co-60 per water meter. Assuming each water meter has about the same activity, the total activity for the 102 cases is estimated to be 37 MBq (1 mCi).



### Water Meters Segregated in Separate Container





The water meters were segregated in an empty container and inventoried. The dose rate on the center side of the pallet of water meters was 0.01 mSv/h (1 mR/h). The container was locked and secured. The detained container is surveyed to ensure all radioactive materials removed.



### **Customs Applies Seals to Container** with Contaminated Water Meters









### Lessons Learned



- If a Co-60 source is detected and shows a distributed area signature, then it is most likely a contaminated metal product where the Co-60 is embedded in the metal
- Loose contamination is uncommon with Co-60 in a container but it can occur so always survey for loose contamination
- An entry team should be equipped with gloves, swipes and a calibrated health physics beta/gamma probe to measure dose rate and survey for contamination
- If loose contamination is detected greater than 2x background, then move a safe distance upwind of the container and call in experts



### Summary



- No loose contamination found on container or contents
- Radiation readings are consistent with Co-60 source located at the rear end of the container
- Detective HPGe spectrum of one of the water meters was similar to the initial spectrum acquired externally
- Spectra were sent to DOE Triage to complete the process
- The contaminated water meters were locked in a separate container and secured in the secondary detention area