ML17174B004

To: Michael Vasquez, Region IV Inspector

From: Michael Albanese, Qal-Tek Associates RSO

License # 11-27610-01, Docket # 030-34966 030-34866

Subject: Radioactive material shipment incident

Date: 6/15/2017

**Incident Description**

At 9:40 am on April 13th, 2017, a common carrier delivered a 10-gallon drum (37.48Kg) to Qal-Tek Associates (QTA) facility. The QTA shipping department performed standard QTA receiving/inspection procedures and identified the on-contact and TI readings exceeded the expected and allowed limits.

The receiving and operations management immediately quarantined the container and notified the RSO for further analysis. The RSO and operations management performed immediate contamination and dose survey assessments. It was determined that there was no presence of contamination, but it was confirmed that the dose levels were above limits. The RSO took immediate action to properly investigate and record the cause of the elevated readings and then reported the incident to the common carrier POC and USNRC Operations Center. Upon completion of the proper notification requirements, QTA's incident investigation protocols were initiated.

During the subsequent package inspection, it was identified that the shipment contained three sealed sources, which had escaped their internal containment shield. The 7A drum showed damage to the outer package but did not fail in the release of the sources from within the drum.

The investigation teams lead investigator and the Radiation Safety Committee (RSC), placed an immediate prohibition on all non-exempt source shipments until final investigation review and appropriate corrective action(s) are implemented and approved by the RSC.

**Incident Timeline**

April 7th – RSO, Operations Manager and in-training radiation technician (RT) loaded all five sources (2-Cs137, 1-Co60, 1-U238, 1-Ra226) in the designed pig, viewed by the RSC. RSO and in-training RT loaded the pig and packaged into Type 7A drum. The in-training shipper/receiver said the whole package for the air common carrier needs to less than 150 lbs, The RSO weighed the package and it exceeded the 150 lb. limit. The RSO and in-training RT repackaged the 3 sources (2-Cs137 and 1-Co60) into a pig that met the weight and shielding requirements for the package but did not have a positive closure. The closed repackaged drum was presented to the in-training shipper/receiver and the marking, labeling and paperwork were completed with the RSO's oversight. The package was offered to the common carrier around 2pm.

April 10th – Another QTA RSO assigned to the NY training demo received the package, opened and performed an internal contamination check, resealed and placed in secure storage.

April 11th – The training demo RSO in NY ships package on BOL to training site. RSO opens package and retrieves sources, training is conducted and sources are repackaged into the shipping drum in a similar fashion and shipped back to its storage location on another BOL waiting common carrier pick-up. Common carrier canceled pick-up, RSO completed another BOL and shipped it to the common carrier terminal. Radiation fields were re-verified and offered to common carrier, package was accepted.

April 13th – Common carrier delivers package to Qal-Tek Idaho facility where it is received and elevation radiation fields are identified.

**Incident Investigation Summary**

The investigation team focused on identifying the fundamental root cause of the incident and appropriate corrective actions, which would eliminate any potential for reoccurrence. The lead investigator and Idaho RSO interviewed and collected written statements of personnel who were directly involved to analyze operational knowledge and procedural compliance. The investigation team reviewed all applicable shipping and transportation procedures and gathered pictorial evidence of the package upon receipt.
The investigation team reviewed all relevant individuals training records, curriculum, procedures, and experience. In addition, a procedural review was performed to determine potential regulatory gaps, which may indicate failure modes.

Upon completion of the investigation, the investigation team determined that Qal-Tek had a gap in procedural and operational training processes related to packaging of radiological sources not in gauges. QTA's procedures identify or direct the packaging requirements and instructions for all other types of shipments (i.e., gauges, disposals). The individuals specifically involved in the packaging of this shipment, had undergone and successfully completed external or licensee internal training that meets DOT and IATA training requirements for Class 7 material. However, on the job procedural training specific to packaging and packaging instructions were left to the shipper discretion and experience. As a result, specific controls were not in place to ensure packaging was easily repeatable. The QTA on the job training (OJT) program included shipping processes but lacked specific packaging instruction controls to ensure that the packaging met repeatable conditions to ensure safe shipment.
It was also identified that this is not the bulk of QTA's shipments and only represented a few shipments over the past year, thus increasing the probability of failure due to infrequent packager performance.

Based on the information used in the investigation and the completion of root cause analysis, the teams final root cause was determined to be a failure in packaging instructions and training to ensure repeatable compliance with packaging instructions for source shipments.

**Corrective Action**

The corrective action was assigned with three specific requirements;

- Develop proper packaging instructions that clearly state; 1) the necessity of a robust positive mechanical closure for source shields with a secondary physical inner packaging control that also prevents source or source shield movement to ensure containment of sources and radiation fields do not vary by more than twenty percent during shipment, and 2) ensure the package weight limits per carrier and/or shipping modality are not exceeded when selecting the source shield and packaging which will eliminate the reoccurrence of the shielding containment failure.
- Develop pictorial examples of internal packaging methods which will comply with the packaging instructions

- Perform function specific comprehension training of all QTA authorized shippers to ensure complete understanding of the packaging instructions.
- Future in-house shipper trainings specifically cover function specific training for all applicable job role shipment types via the OJT evaluation prior to working independently.

The investigation team lead and RSC had taken swift action to prevent reoccurrence through a self-imposed ban on source shipments. The action has been assigned to operations management and RSO to prevent any future shipments until the corrective actions are complete, implemented and approved by the RSC.

The final implementation of the packaging instructions will be under the oversight of the investigation team and the radiation safety committee. Prior to any authorization to resume normal authorization, these parties will have performed a thorough review and approval of the packaging instructions and on the training records of those authorized to ship to ensure proper implementation of the corrective actions.

The QTA team and culture reflects a strong desire to utilize operational failures as methods of improvement. This relies on the proper selection of appropriate actions and the effective implementation to ensure the corrective action is efficient and reliable to prevent reoccurrence.

Sincerely,

Michael Albanese

Michael Albanese
Radiation Safety Officer

To: Michael Vasquez, Region IV inspector

From: Michael Albanese, Qal-Tek Associates RSO

License # 11-27610-01, Docket # 030-34966

Subject: Maximally exposed member of the public from April 11, 2017 radioactive material shipment

Date: June 9th, 2017

On June 7th, 2017 M. Albanese made contact with the Idaho Falls common carrier package distribution station manager that was the final handling station for this shipment. The manager and M. Albanese cooperatively agreed on the assumed handling times below and discussed the following detail related to how the radioactive package could have been handled at his distribution station.

> Plane configuration: Wing over plane, main door by cockpit, 6 zones (zone 1 by cockpit, zone 5-6 tail for Dangerous Goods), fixed floor conveyor down middle of plane.
>
> Common carrier reported a scan time from plane to truck of 2 minutes - from the time the 1st person scans in plane to when driver scanned it

The distribution station manager, communicated that the assumed handling times are probably the worst case along this packages transit route in the common carrier airport system as Idaho Falls has more manual conveyor systems that require individuals to physically push packages.

<u>Handling time Assumptions:</u>

The sequence of common carrier handling steps typically performed at Idaho Falls during airplane off-loading of packages to vans at distribution station:

**1st person on plane**

position package with hands for scanning and lifting - 5 seconds

performs whole body lift of package from bottom, onto manual conveyor – 3 seconds

assumed to be 1m from package while loading all other adjacent packages – 5 minutes

**2nd person on plane**

push packages down conveyor on aircraft – 15 sec. hands on top of drum due to drum height (shared work with 3rd person)

**3rd person on plane**

hand pushes package down aircraft manual conveyor – 15 seconds

whole-body lift of package off plane conveyor to belt loader – 3 seconds

**4th person on ground**

escorts packages down belt loader – potentially place hand on drum for < 20 seconds, belt travel time, not likely for this size drum relative to belt size

**5th person on ground**

pushes packages onto roller belt – 2 sec.

**6th person in distribution station**

scans and places tag on package, handling not required - 3 sec. process

**7th person in distribution station**

pushes packages to another belt A or B (it's called a transfer splitter belt that runs down the middle of transfer station to get it to trucks on each side of the station) – 2 seconds

**8th person in distribution station**

verifies split, hand pushes packages down rollers on top or side of package (may push multiple packages at once) - 2 seconds

**9th – 11th persons in distribution station**

van drivers waiting for packages on belt (since this package went to the 4th van station in line three drivers could have touch it) - 1 second

**12th person in distribution station**

station 4 van driver, where this drum was picked up and place in the left rear of the van – 3 seconds

moved the drum from left rear of van to passenger door to stage for Qal-Tek receiver to remove from truck - 4 seconds

<u>Assumptions:</u>

- Worst Case: All 3 sources came out of pig during loading on truck destined for Newark, NJ airport and they remained as found upon receipt at Qal-Tek in Idaho Falls, ID.
- The Idaho Falls common carrier distribution station has more handling time of package due to more manual conveyors than other airport this package has visited (Newark, NJ – Memphis, TN – Salt Lake City, UT)

- Common carrier employees are members of the public
- Detector volume = 349 cubic centimeter
- IAEA Specific Safety Guide # SSG-26 (see attached) dose rate correction factor only applies to on-contact and 1 foot drum measurement (see attached), The 1m measurements were considered to be accurate because the 3 sources would look like a point source at that distance (>11 detector diameters away from sources) with a uniform radiation field. This assumption is made because the 3 most significant sources contributing to the dose rate are positioned at different heights and distances from the drum wall such that the meter could see the radiation from each source along its vertical axis but was not a uniform field considering the small 19.4mCi Cs-137 source on the drum wall would not be considered a point source at such a close distance to the 349cc detector. By using a modified representation of IAEA Specific Safety Guide #SSG-26, the source area of the 3 unshielded sources were considered as the package size so a more realistic "half linear dimension of the package" could be applied to determine a more realistic correction factor. As a result, the distance of the 23mCi Cs-137 source to the drum wall, 12cm, was divided in half for the "half linear dimension of the package". With an "effective half linear package dimension" of 6cm and a "detector to package surface distance" of 7.5cm the interpolated correction factor was determined to be 1.95 from Table 1 for on-contact and 1 ft. measurements.

  Maximum On-Contact Dose Rate Measurement corrected to interpolation of IAEA Table 1 (see attachments)

  Highest on-contact measurement was 1.45 R/hr

  IAEA interpolated correction factor for large detector vs. 3 source "package" = 1.95

  Corrected highest on-contact measurement: 2.83 R/hr
- WB distance when not on contact is 30cm or 1ft.
- Extremity when not on contact is 30 cm or 1 ft.
- Exposure times are estimates for each person's role performed smoothly with no significant delays

Maximally Exposures Common Carrier Individuals:

**Person 1:** Total Estimated Dose: WB = 3.97mrem and extremity = 1.91mrem

5 sec. access and scan package – at 1 foot extremity exposure (foot): 5 sec. x hr/3600 sec. x (118x1.95) mR/hr. = 0.32mrem

5 sec. access and scan package - WB: 5 sec. x hr/3600 sec. x (118x1.95) mR/hr. = 0.32mrem

3 sec. lift and place on conveyor - on contact hand exposure: 3 sec. x hr./3600 sec. x (210X1.95)mR/hr = 0.34mrem

3 sec. lift and place on conveyor - on contact WB exposure: 3 sec. x hr./3600 sec. x(1.45X1.95)R/hr = 0.0024rem or 2.4mrem

5 min. extremity exposure – foot at 1m residence time from hot spot during unloading adjacent packages: 5 min. x hr / 60 min. x 15 mR/hr. = 1.25mrem

5 min. WB at 1m residence time from hot spot during unloading adjacent packages: 5 min. x hr / 60 min. x 15 mR/hr. = 1.25mrem

**Person 3:** Total Estimated Dose: WB = 3.4mrem and extremity = 0.63mrem

15 sec. hand contact extremity exposure: 15 sec. x hr. /3600sec x (36x1.95)m R/hr = 0.29mrem

15 sec. with WB exposure at 1ft. from package: 15 sec. x hr./3600sec. x (118x1.95)mR/hr. = 0.96mrem

3 sec. lift and place - on contact hand exposure: 3 sec. x hr./3600 sec. x (210X1.95)mR/hr = 0.34mrem

3 sec. lift and place – on contact WB exposure – 2.4mrem

**Person 12:** Total Estimated Dose: WB = 2.66mrem and extremity 0.42mrem

3 sec. lift and place – on contact WB exposure: 3 sec. x hr./3600 sec. x (1.45x1.95)R/hr = 0.0024rem or 2.4mR

3 sec. lift and place - on contact hand exposure: 3 sec. x hr./3600 sec. x (210X1.95)mR/hr = 0.34mrem

4 sec. drag using top of drum with hands on contact and body at 1ft for 4 sec.:

4 sec. x hr/3600 sec x (36x1.95) mR/hr = 0.078mrem to hands

4 sec. x hr/3600 sec x (118x1.95) mR/hr = 0.26mrem to body

Common carrier Employee training:

- Package distribution employees: General annual training on hazard identification placement and handling (ALARA principles) what to look for, and what to do or not do for damaged or leaking packages.
- Package pickup employees: General annual training above, plus compliance training.

Sincerely,

Michael Albanese

Michael Albanese, RSO
Qal-Tek Associates

IAEA Safety Standards

for protecting people and the environment

# Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)

Specific Safety Guide

No. SSG-26

IAEA
International Atomic Energy Agency

be created which are measurable. These quantities are 'ambient dose equivalent' for strongly penetrating radiation and 'directional dose equivalent' for weakly penetrating radiation. The radiation level should be taken as the value of the operational quantity 'ambient dose equivalent' or 'directional dose equivalent', as appropriate.

233.2. In some cases, consideration should be given to the possibility of an increase in radiation level as a result of the buildup of daughter nuclides during transport. In such cases, a correction should be applied to represent the highest radiation level envisaged during the transport.

233.3. In mixed gamma and neutron fields, it may be necessary to make separate measurements. It should be ensured that the monitoring instrument being used is appropriate for the energy being emitted by the radionuclide and that the calibration of the instrument is still valid. In performing both the initial measurement and any check measurement, the uncertainties in calibration have to be taken into account.

233.4. For neutron dosimeters, there is, very often, a significant dependence of the reading on the neutron energy. The spectral distribution of the neutrons used for calibration and the spectral distribution of the neutrons to be measured may affect the accuracy of dose determination considerably. If the energy dependence of the instrument reading and the spectral distribution of the neutrons to be measured are known, a corresponding correction factor may be used.

233.5. The Transport Regulations require that, at the surfaces of packages and overpacks, specific radiation levels shall not be exceeded. In most cases, a measurement made with a hand instrument held against the surface of the package indicates the reading at some distance away because of the physical size of the detector volume. The instrument used for the measurement of the radiation level should, where practicable, be small in relation to the dimensions of the package or overpack. Instruments which are large relative to the physical size of the package or overpack should not be used because they might underestimate the radiation level. Where the distance from the source to the instrument is large in relation to the size of the detector volume (e.g. a factor of five), the effect is negligible and can be ignored: otherwise the values in Table 1 should be used to correct the measurement. For radiographic devices where the source to surface distance is generally kept to a minimum, the effect is usually not negligible, and an allowance should be made for the size of the detector volume.

TABLE 1. CORRECTION FACTORS FOR VARIOUS PACKAGE AND DETECTOR SIZES

| Distance between detector centre and package surface (cm) | Half linear dimension of package (cm) | Correction factor[a] |
|---|---|---|
| 1 | >10 | 1.0 |
| 2 | 10–20 | 1.4 |
| | >20 | 1.0 |
| 5 | 10–20 | 2.3 |
| 7.5cm | 20–50 | 1.9.5 |
| | 26cm >50 | 1.0 |
| 10 | 10–20 | 4.0 |
| | 20–50 | 2.3 |
| | 50–100 | 1.4 |
| | >100 | 1.0 |

[a] The reading should be multiplied by the correction factor to obtain the actual radiation level at the surface of the package.

233.6. When monitoring finned flasks or other transport packages, care should be taken where narrow radiation beams may be encountered. A dose rate meter, with a detector area much larger than the cross-sectional area of the beam to be measured, will yield a proportionally reduced reading of dose rate because of averaging over the much larger detector area. An appropriate instrument should be chosen for the work.

**Radioactive material**

236.1. In previous editions of the Transport Regulations, a single exemption value of 70 Bq/g was used to define radioactive material for transport purposes. Following publication of the BSS [1], it was recognized that this value had no radiological basis. The radiological protection criteria defined in the BSS were therefore used to establish radionuclide specific exemption values for transport purposes (see para. 402.3).

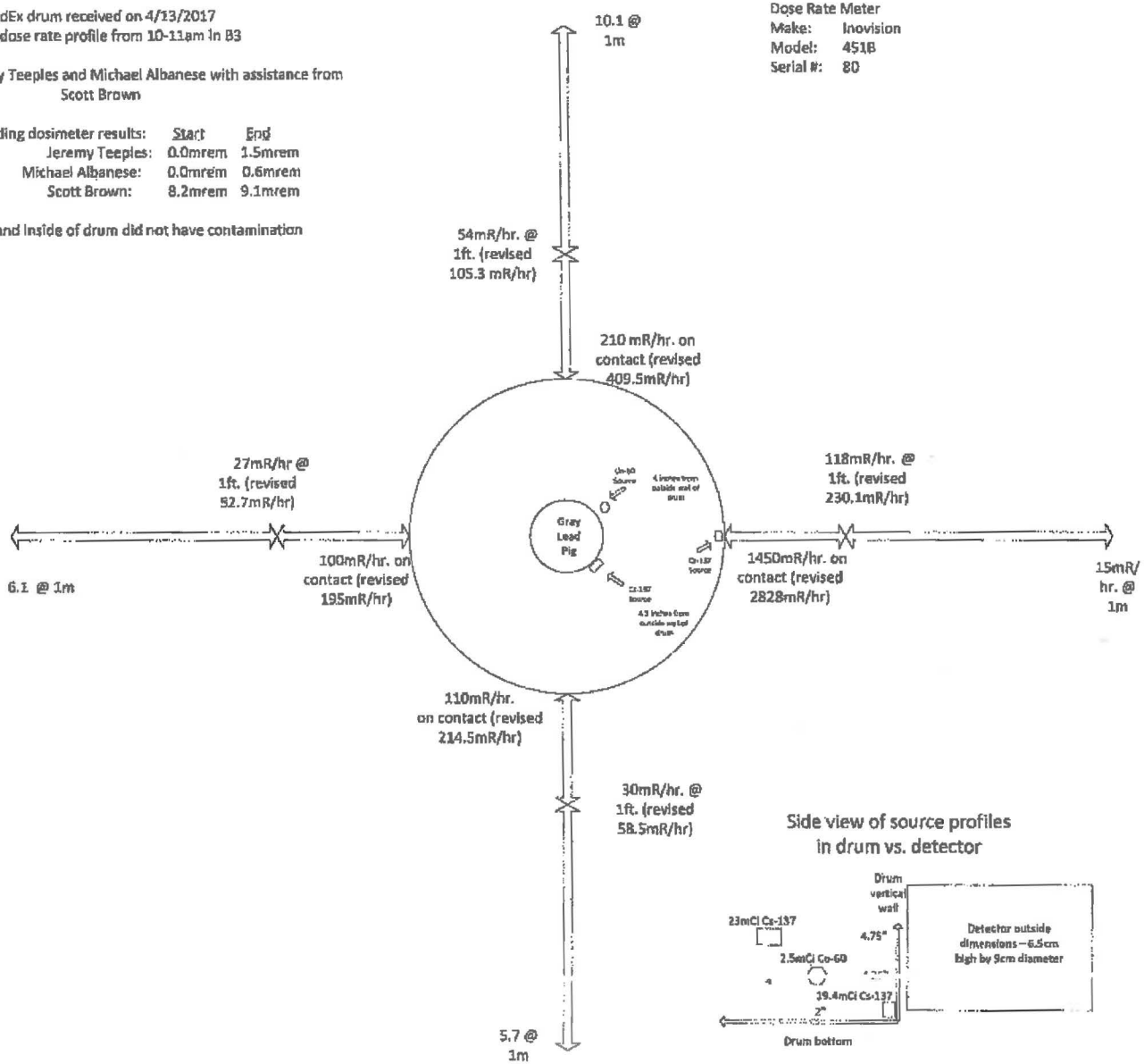
FedEx drum received on 4/13/2017
Drum dose rate profile from 10-11am in B3

Performed by: Jeremy Teeples and Michael Albanese with assistance from Scott Brown

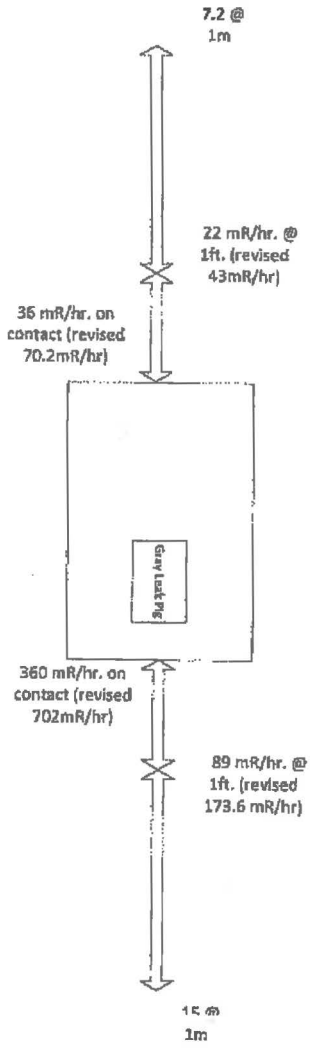
| Direct reading dosimeter results: | Start | End |
|---|---|---|
| Jeremy Teeples: | 0.0mrem | 1.5mrem |
| Michael Albanese: | 0.0mrem | 0.6mrem |
| Scott Brown: | 8.2mrem | 9.1mrem |

Note: Outside and inside of drum did not have contamination

Dose Rate Meter
Make: Inovision
Model: 451B
Serial #: 80




Side view of source profiles in drum vs. detector

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