# SCO SHIPMENTS FROM ROCKY FLATS-EXPERIENCE AND CURRENT PRACTICE

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## ABSTRACT

Decommissioning activities at Rocky Flats Environmental Technology Site (RFETS) are expected to generate approximately 251,000 cubic meters of low-level radioactive waste. Almost half of this will be characterized and shipped as the Department of Transportation "Surface Contaminated Object" (SCO) shipping class. In the 2 years since an SCO characterization method was implemented, almost 11,000 of the 18,000 cubic meters of low-level waste were SCO. RFETS experience to-date using an SCO waste characterization method has shown significant time and cost savings, reduced errors, and enhanced employee safety. SCO waste is characterized prior to packaging, near the point of generation, by any of the site's 300 Radiological Control Technicians using inexpensive radiological control survey instruments. This reduces on-site waste container moves and eliminates radiometric analysis at centrally located drum or crate counters. Containers too large for crate counters can also be characterized. Current instrumentation is not adequate to take full advantage of the SCO regulations. Future improvements in the SCO characterization and shipping process are focussed on use of larger and/or reusable containers, extended-range instruments, and additional statistical methods, so that the full extent of the SCO regulations can be used.

## INTRODUCTION

The U.S. Department of Energy's Rocky Flats Environmental Technology Site (RFETS) is well on its way to permanent closure. Kaiser-Hill and its subcontractors plan to complete the work required for closure by 2006. This is an aggressive schedule that relies in large part on the Site's effectiveness in characterizing, packaging and shipping waste for disposal. Disposing of low-level radioactive waste is a critical activity for Site closure. In 1996 the U.S. Department of Transportation (DOT) issued regulations establishing a shipping class called Surface Contaminated Object (SCO) (1). For an object to meet the SCO definition it must not, itself, be radioactive and it must have surface contamination that is less than the limits specified in the regulations. Two subclasses of Surface Contaminated Object exist in the regulations: SCO I and SCO II. SCO II is for objects with very high surface contamination levels. SCO I is for objects contaminated to a lesser extent. The regulations also provide packaging options that could be used for over-the-road transport of these materials. Packaging requirements are more rigorous for SCO II shipments.

RFETS has developed a characterization method that provides high confidence that the DOT regulations and disposal site waste acceptance criteria are met. Bracken and Colby reported this characterization method in a WM-99 paper (2). Radiological Control Technicians (RCTs) using conventional contamination meters and survey methods obtain data required for characterization. The method has been largely responsible for a significant reduction in time and cost of SCO waste packaging and in the amount of rework necessary to correct packaging errors prior to shipment for disposal. This paper describes experience to-date and projects future improvements.

Decommissioning activities at RFETS are expected to generate approximately 251,000 cubic meters of low-level waste. Almost half of this total will be characterized and shipped as SCO waste. Prior to developing the methods and procedures for SCO waste characterization, RFETS packaged low-level waste for radiological characterization by non-destructive assay using centrally located assay equipment. This equipment accommodates 55-gallon drums and 4'x4'x7' waste crates. Due to historical practices and the capabilities of the assay equipment, waste materials were segregated into various types (metal, wood, plastic, glass, etc.) prior to packaging and assay. This waste handling and characterization approach yields accurate assay information; however, it requires expensive counting equipment, extensive waste handling and several onsite container movements prior to shipment for disposal. Figure 1 is a flow chart comparing the steps in characterization and packaging of surface-contaminated low-level radioactive waste by the prior method (which is still used for Low Specific Activity waste) and by the current SCO method.

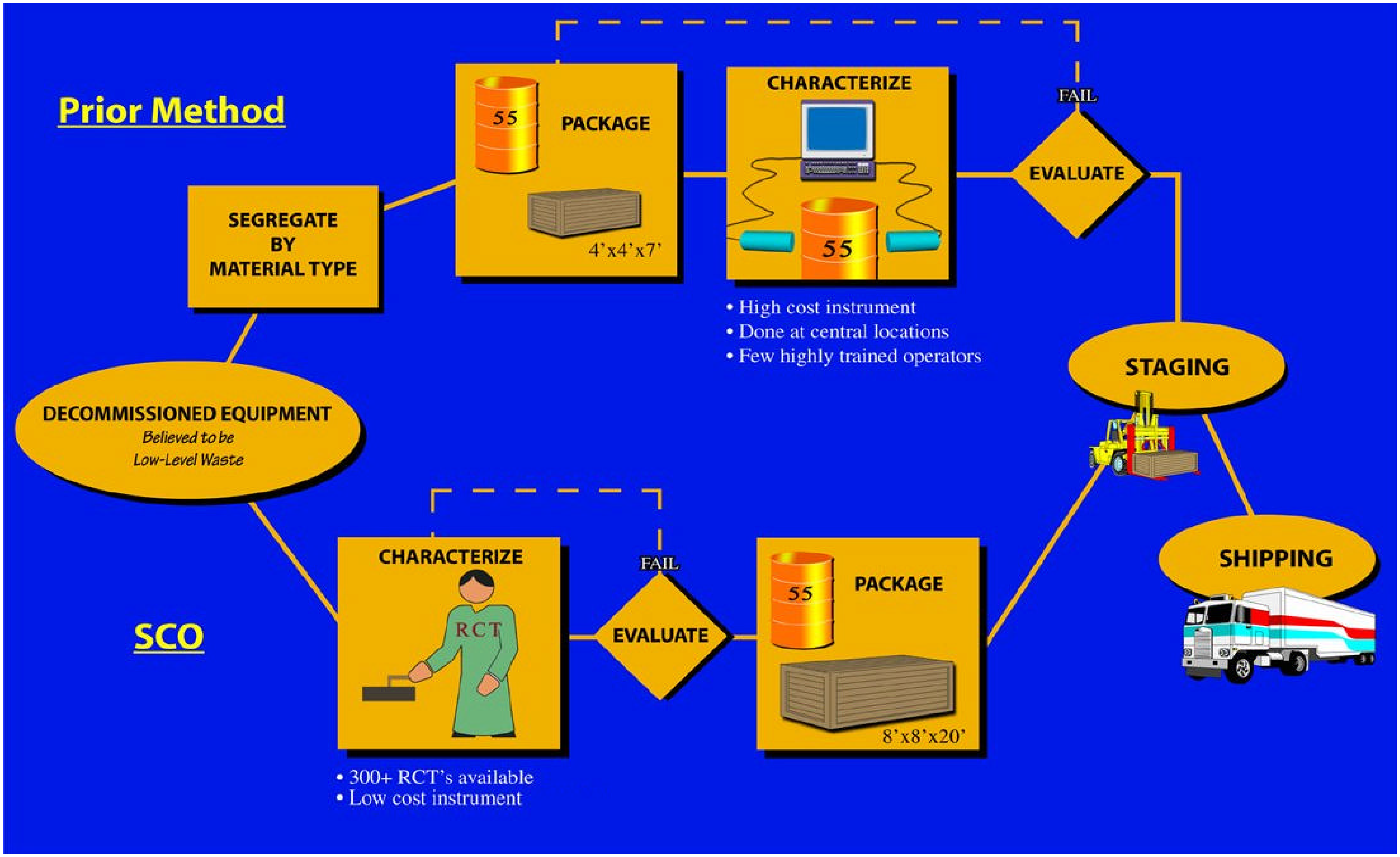


Fig. 1. Flow diagram comparing the prior method and the existing SCO waste characterization and packaging steps as performed at RFETS. In the SCO process, characterization is done prior to packaging, near the point of generation, using inexpensive instruments by RCTs who are readily available to perform the measurements. This minimizes repackaging and avoids a bottleneck at crate or barrel counting that occurred in the prior method.

## EXPERIENCE TO-DATE

Since 1998, when the technical basis for quantitative characterization of SCO waste was established and the implementing procedures and training were developed, RFETS has generated over 18,000 cubic meters of low-level waste. Almost 11,000 cubic meters of that were SCO wastes. Characterization of SCO waste begins with a judgement, based on process history, that a population of waste items has a reasonably similar process history and can therefore be characterized as a single population (3). The population of SCO waste items with similar process history (called a survey unit) is sampled at a minimum of 30 survey points to establish a statistical description of the survey unit with 95% confidence. To accomplish this, certain statistical restrictions are placed on the survey results:

- the median of the surveys must be less than or equal to one half the relevant DOT SCO limit,
- the standard deviation of the surveys must be less than one-half the relevant DOT SCO limit,
- no single measurement may exceed the relevant DOT SCO limit.

An extreme value, the 95% upper confidence level, of the sample distribution is assumed to exist on every surface in the waste container. This extreme value is carried through the calculations of package activity and activity concentration, which has the effect of overestimating these quantities. These restrictions establish considerable conservatism in the characterization and packaging of the waste for shipment and disposal. The very manageable minimum number of survey points (30) is traded-off against the conservative treatment of the resulting data. Much of the low-level waste from decommissioning operations is very slightly contaminated or is considered contaminated by virtue of the fact it is impractical to verify what is essentially the total absence of radioactive contamination required for free release. The conservatisms built into the characterization approach have not, in most cases, been a significant limitation.

Because the field characterization process does not rely on fixed-geometry non-destructive assay equipment to complete the radiological characterization of waste materials, the size of the waste packages is no longer restricted. A significant portion of the SCO waste has been packaged in cargo sized waste containers. This in turn has improved the safety of waste handling in that larger SCO waste items (e.g. heavy shop equipment, large laboratory equipment, etc) may often be packaged directly in a cargo container without disassembly or size reduction. Because radiological characterization of SCO waste items is completed prior to selecting an appropriate waste package, there has been a reduction in the rate of waste packaging errors. The SCO process has been a significant factor in reducing rework of waste packages to a ten-year low.

Another benefit to larger waste packages has been an improvement in shipping efficiency. The content of one 8'x8'x20' cargo container is nearly equivalent to 11 standard waste crates. The reduction in paperwork, certification/inspection resources and container handling has been significant. Sixty percent of the SCO waste packaged has been in large cargo containers. The number of moves for an SCO waste container prior to its being ready to ship for disposal has been reduced. The cost savings for waste characterized, packaged and shipped as SCO waste, compared to historical characterization, packaging and shipping practices, has been estimated at $500 per cubic meter.

The approach taken during the development of the field characterization process for SCO waste was to make field implementation as simple as possible. In addition, the statistical requirements for the characterization data were established in such a way to assure a conservative radiological characterization result. The staff of the primary waste disposal site evaluated the process prior to implementation. Overall, the SCO characterization and packaging method has worked well. Widespread acceptance and use of this entirely new characterization approach for RFETS occurred in a relatively short period of time.

## LESSONS LEARNED

The implementation of the SCO waste characterization process has been a significant step forward for RFETS closure. The simplicity of the implementation procedures was a big factor in the rapid acceptance and use of the process by the entire site population. Radiological characterization of the waste prior to selecting waste containers has contributed to a significant reduction in the amount of waste packaging rework.

The procedure that implemented the characterization method allows for professional judgement – with appropriate peer review and approval - by the Radiological Engineer who prescribes the sampling plan and interprets the data. This has proven to be useful, as some parts of the characterization problem vary between facilities and with isotopic mixtures. Conservative assumptions regarding the ratio of surface area to mass for objects allows the surface area to be indirectly measured. This saves time and avoids an error–prone part of the analysis. Subsequent procedure revisions have made this estimation step more rigorous. Calculations used by Radiological Engineers are now standardized, but the flexibility remains to adapt the calculations as necessary if unusual problems emerge.

The dynamic range of conventional alpha contamination survey meters has limited the applicability of the existing characterization method. Typical alpha survey instruments have an upper detection limit of a few million disintegrations per minute per 100 square centimeters. For alpha emitters found at RFETS, items may be shipped using the SCO II classification when fixed contamination levels are as high as 80,000 Bq per square centimeter (480 million disintegrations per minute per 100 square centimeters). The need for calibrated instrumentation with a much higher dynamic range has been identified. Contamination at these very high levels on all surfaces of objects packed in a waste container is likely to result in activity concentration that exceeds the low-level waste site acceptance criteria, so this constraint must be considered prior to packaging and shipment.

Wiping efficiency is not included in the non-fixed contamination limits defined in the SCO regulations. This means that a wiping efficiency must be applied to any measurement of non-fixed surface contamination. NUREG-1608 (3) explains that SCO contamination limits are different from the "wiping limits" that apply to most other removable contamination measurements in which the regulatory limit incorporates an assumed wiping efficiency. NUREG-1608 allows a default factor of 10% wiping efficiency to be assumed, which is the current practice at RFETS.

## FUTURE IMPROVEMENTS

SCO waste packaging at RFETS is implementing a continuous improvement process to enhance the time and cost savings that have already been realized. Larger waste containers that facilitate safer loading of bulk items and higher packaging densities are being pursued. Some combination of reusable and throwaway containers is expected to be in service in the near future.

Kaiser-Hill has funded work to extend SCO characterization procedures so the full range of activity that may be shipped under the SCO classification is in scope. The work, which is currently in progress, is focussed on two fronts: extended range instrumentation, and more powerful, less conservative, statistical analysis.

### Extended Range Instrumentation

Instruments and calibration methods necessary to characterize surfaces contaminated in excess of 1700 Bq per square centimeter (10 million disintegrations per minute per 100 square centimeters) are being identified. The following approaches are being considered:

- Modified conventional alpha meters
- Electret Ion Chambers
- Gamma spectroscopy

Any instrument operating in this highly elevated contamination range must confront the problems of lack of NIST-traceable contamination standards and cross-contamination of the detector. Applicable standards in this contamination range are subject to debate, as these measurements are not made for compliance occupational radiation protection rules.

A conventional air-filled proportional alpha meter was modified by reducing the open area of the detector face with a perforated metal faceplate. The upper range on the modified detector is about 33,000 Bq per square centimeter (200 million disintegrations per minute per 100 square centimeters). The meter is calibrated without the add-on faceplate at normal contamination levels where NIST traceability is available. The faceplate reduction factor is characterized separately using long, scaler counts. The uncertainties of the two processes are combined in quadrature to define the total uncertainties of calibration. The potential for cross-contamination of the probe is especially severe in this method because any contamination barrier applied to the probe would render it useless.

The upper detection limit for Electret Ion Chambers is about 3300 Bq per square centimeter (20 million disintegrations per minute per 100 square centimeters). Several ideas for extending this range are being tested, including reduction in the size of the sampled area, use of a thicker chamber entrance window, and use of a new, highly-insensitive electret. Cross-contamination may be less severe in this approach because the Electret Ion Chambers are relatively inexpensive and may be considered disposable. Calibration of the method remains to be demonstrated.

Gamma spectroscopy using a room temperature, shielded probe is being considered. Sodium iodide and other room-temperature detectors are being considered. Counting of higher energy plutonium-239 gamma rays and counting of the 60 keV americium-241 gamma ray will be separately evaluated. One advantage of the gamma spectroscopy approach is that alpha self-absorption is not a factor, which minimizes the calibration problems. Another advantage is that contamination may be fixed in place prior to making the total contamination measurements, reducing the risk to workers. The challenge in this method is gaining appropriate sensitivity and making the process easy enough for any radiological control technician to perform without extensive training.

## More Powerful Statistical Approach

An additional statistical approach, which is aimed at populations of highly contaminated objects, is being developed. In this approach, the items included in the characterization unit will be narrowly defined so there is a high likelihood that the population of surfaces has normally distributed contamination levels. After an appropriate number of sample measurements are made, a "goodness of fit" test will be used to confirm the assumption of normality. As in the current SCO characterization method, no individual sample measurement will be allowed to exceed the applicable SCO limit. The mean and standard deviation will be used to calculate the 95% upper confidence limit, and that value will be compared to the full value of the applicable SCO limit.

The mean contamination level will be used to estimate the amount and concentration of radioactivity in the waste container. The use of a mean estimator instead of an extreme estimator for package activity and activity concentration is consistent with other radiometric characterization methods and makes it possible to explicitly define the desired safety factors. More accurate characterization of the package activity concentration allows more packages to be shipped appropriately as low-level waste at much less cost than the alternative Transuranic Waste disposal option.

## REFERENCES

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