Recovery of a 1521 Curie Co-60 Source in a Very Unique Situation

(ESH-RPS-2005-00090)

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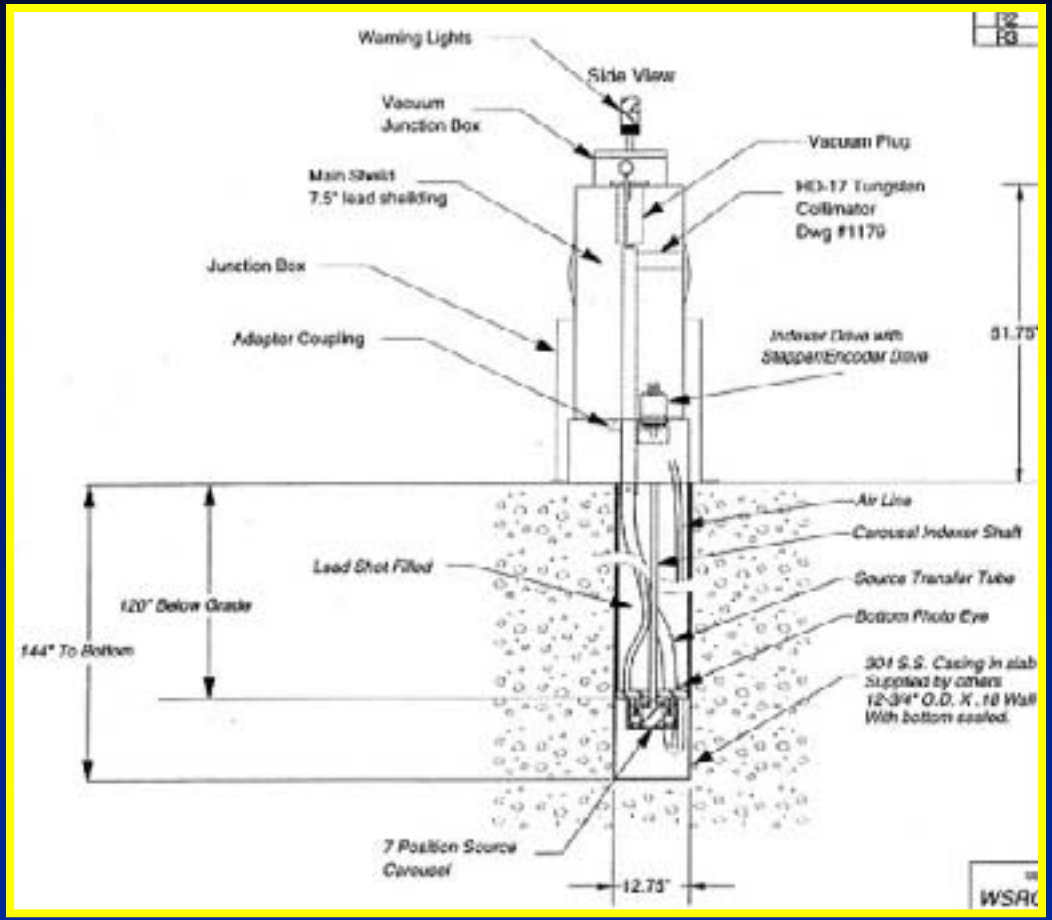
Health Physics Instrumentation Calibration Facility (HPICF)

May 2, 2005

Gamma Beam Irradiator (GBI)

- **GBI Background Information**
  - **Purpose: Used to calibrate a variety of fixed and portable instrumentation**
  - **One of nine irradiators that's been in operation since 1996**
- **GBI contains 6 sources for instrument calibrations**
  - **1 Curie Cs-137**
  - **1 Curie Co-60**
  - **25 Curie Co-60**
  - **40 Curie Cs-137**
  - **1,300 Curie Cs-137**
  - **1,521 Curie Co-60**



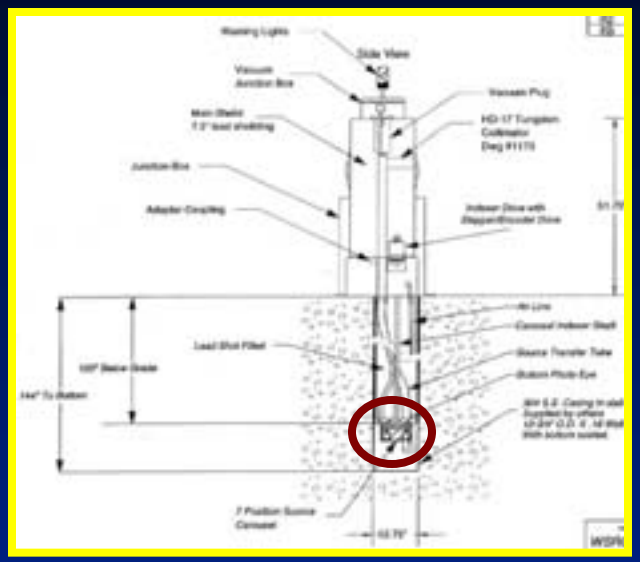
Background Information

- **Hopewell Designs (Designer and Manufacturer)**
  - Installed all of the irradiators systems in the HPICF in 1996
  - Hopewell provides service and maintenance for the HPICF irradiators on a quarterly basis
  - Over 25 years of experience in irradiator design, installation, and service
  - Since 1996 Hopewells has installed these same type of irradiators for DOE Idaho, Los Alamos, Brookhaven, NIST, IAEA, commercial industry, Universities, etc.
    - Over the years they have performed hundreds of source transfers for this type of irradiator

Gamma Beam Irradiator (GBI)

- Prior to January 19, 2005 the GBI started to exhibit problems (rotational) with the source carousel

- Hopewell was called and they (HPS Staff and Hopewell) determined that the spring was the probable cause
  - Plan
    - Need to remove sources (6) to GBI storage unit or cask
    - Lift the GBI out of ground
    - Replace springs in carousel
    - Put back together



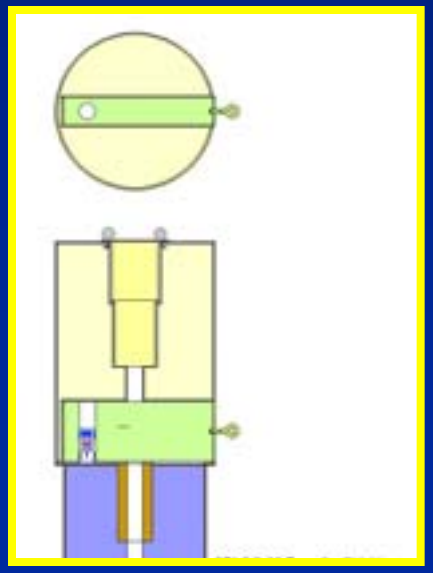
GBI Event
January 19, 2005

- **GBI Event**
  - That morning transferred 5 of the sources using the tube transfer system and transfer cask. No issues
  - 1 source remaining (1521 Ci Co-60)

1521 Ci Co-60
Transfer Cask

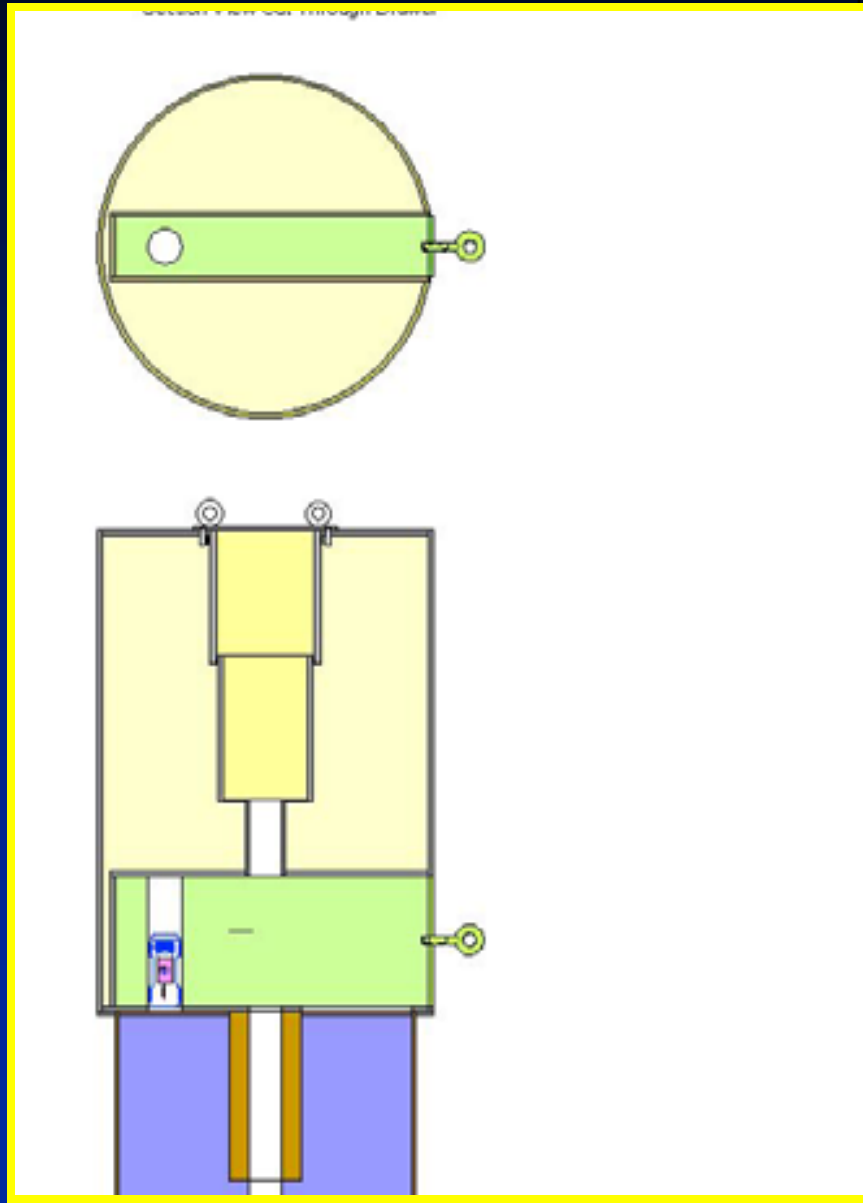
Tube Transfer
System

1300 Ci Cs-137
Transfer Cask



Explanation of Cask

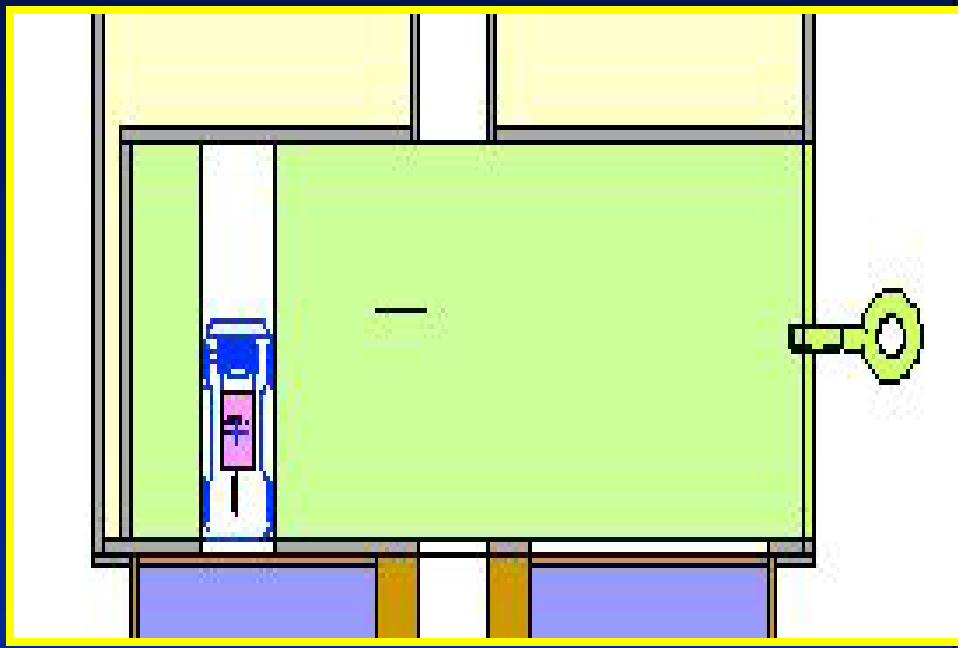
- **The cask servers two functions**
  1. **DOT transportation of source to facility**
  2. **In house transfer of sources from GBI to GBI storage unit**
     - **Used so that maintenance and service can be performed on GBI**



GBI Event – cont'd

Problem

- **The transfer cask has two penetrations (air voids) per design**
  - **Primary void is used for capturing and transferring the source inside the facility**
    - **Maximum lead shielding**
      - **Provides 9 inches of lead shielding around the source (center of shield)**
  - **Secondary void is required to allow the source transfer to the GBI shield.**
    - **Minimum lead shielding**
      - **Only 2 inches of lead shielding is provided in that location**



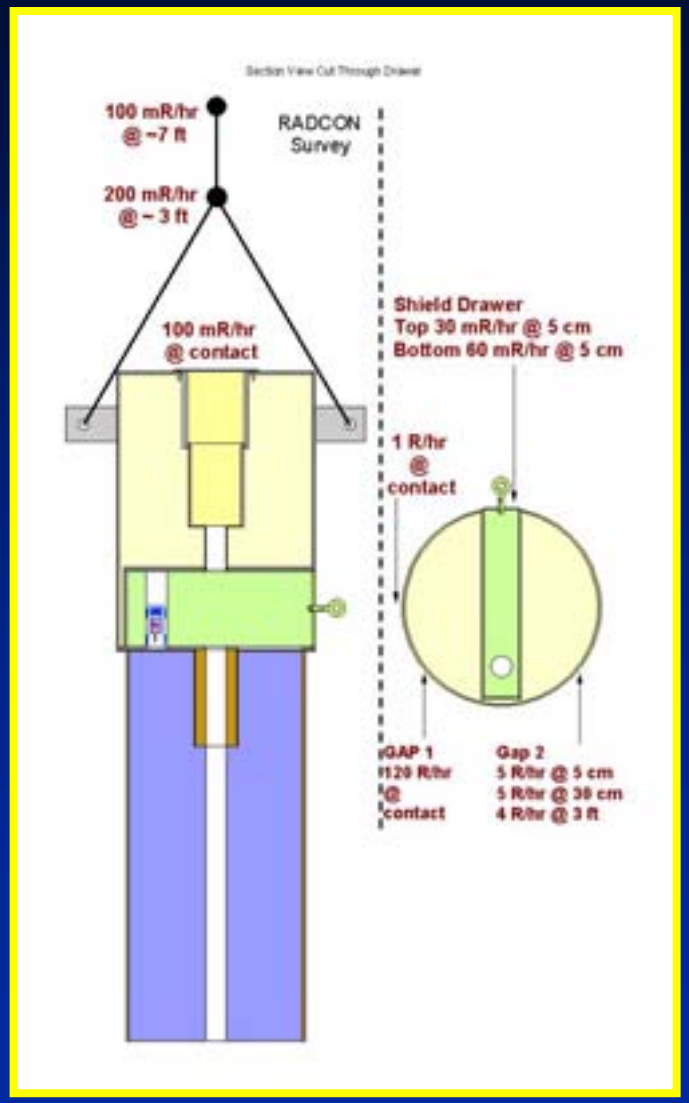
Items to Complete Before Recovering Cobalt Source and Carousel Removed For Repair

- Surveys
  - Remote Robot using EPD's
  - RADCON
- Job Plan (with evaluation of other options)
- Theoretical Calculations of Expected Dose Rates
- Automated Hazard Analysis (AHA)
- Special RWPs
- Reviews and Approvals
  - Facility Radiation Assessment Team Review and Approval (FRAT)
  - Procurement Reviews of Manufacturers Worker Protection Plan
  - Management Reviews and Approvals
  - Safety Reviews and Approvals

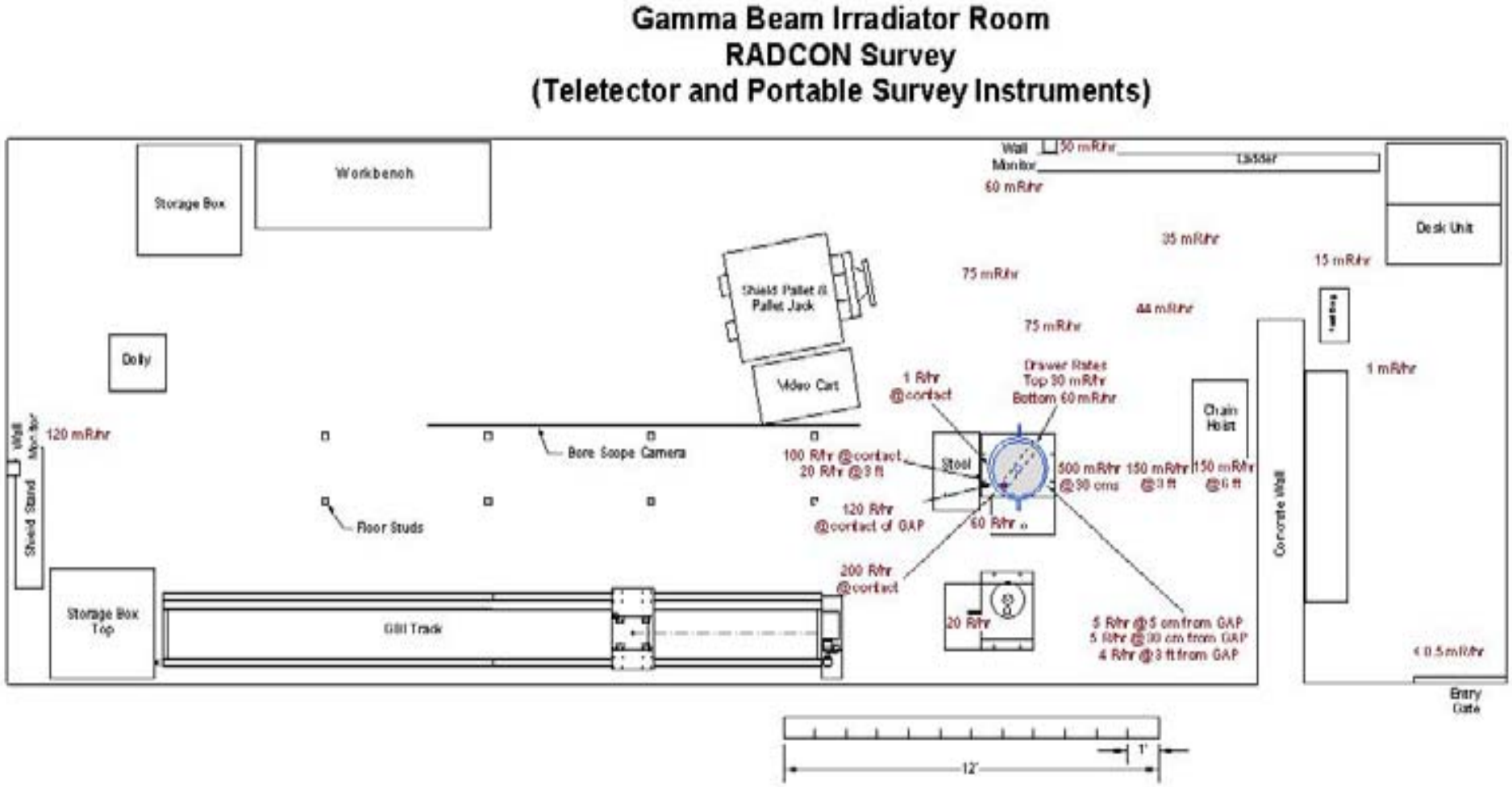
GBI Event – Radiological Surveys

- **Following the GBI event 2 surveys were performed to assess the radiation levels**
  - **The first survey was a cursory survey to assess the radiation levels prior to additional surveys being performed by RADCON personnel**
    - **Performed using a remote robot with electronic pocket dosimeters (EPDs) attached with Teletrac**
    - **Two EPD's were attached to Robot at a height of 51 inches (seam between cask and GBI shield) and 35 inches**
    - **Robot had limited mobility due to various objects in room**
  - **RADCON survey was more extensive focusing on transfer cask and work areas**
    - **There are no contamination or airborne radiological hazards**
    - **Survey instrumentation**
      - **Teletector and RO-20 exposure rate instruments**

RADCON Survey of Transfer Cask



Radcon Survey of the GBI room



GBI Room Layout
Scale 40:1

Job Plan Overview

1. Perform RADCON survey of room and work location
2. Raise transfer cask 1/8 inch from GBI top
   - Note, transfer cask is not raised more than 1/2 inch
3. Perform additional RADCON survey of work location
4. Raise source out of recession and return to transfer cask drawer
   - Requires specialty tools designed and tested by the manufacturer
5. Lower Transfer Cask back to GBI
6. Return source to GBI shielded location using drawer
7. Raise shield and perform survey to verify source has returned to GBI carousel

Other Options

- **Option A**
  - Use Robot to perform Job
  - Robot has limitations
    - Limited mobility and touch
    - Needs platform to perform task
- **Option B**
  - Raise transfer cask a height of 6 inches leaving the source on top of GBI
    - Use ROBOT to retrieve source and place in GBI hole
    - Radiation rates will significantly increase at door of GBI entrance
  - What ifs?
    - If source doesn't drop from Transfer Cask then we can't reposition Cask on GBI
    - Source could drop in a location which the Robot can't access
    - Subsequent entry would result in high exposures

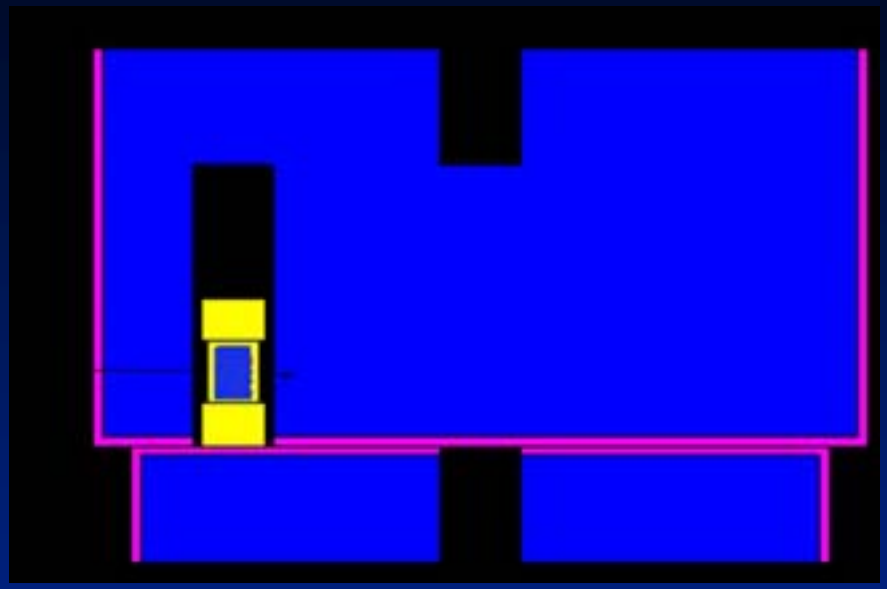
Proposed Two Person Job and Task Items

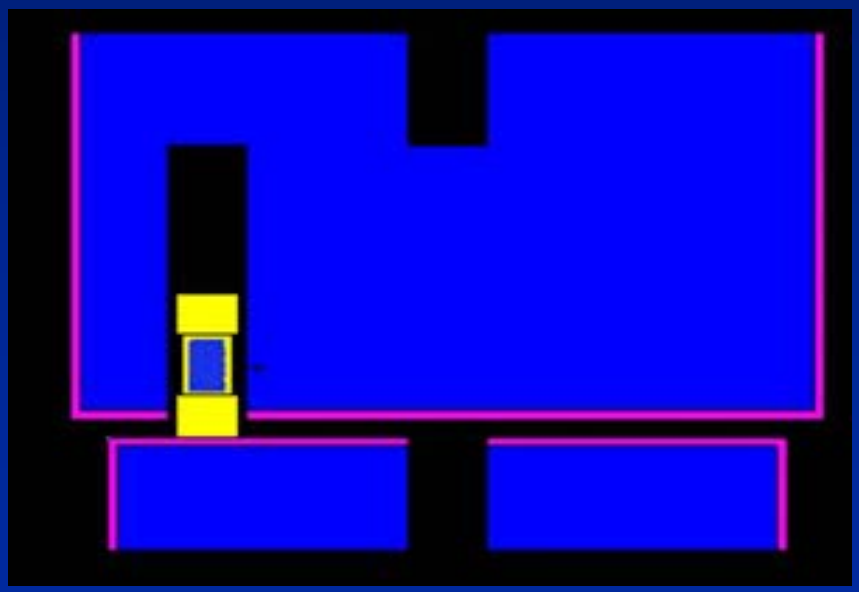
- **Manufacturer**
  - He designed and built the GBI and Transfer cask and has the most knowledge and experience for this situation
  - He also designed the specialty tools for the task and is intimately familiar with manipulating these tools

- **RADCON**
  - Radiological Surveys
  - Work area control

Effects of Lifting the Shield

- **Health Physics Services performed Monte Carlo Calculations to estimate effects of raising the transfer Cask by 1/8 inch**
  - **Will create a very small beam of approx. 2 R/hr between the cask and GBI shield**
  - **Multi-badge with 4 TLDs to account for non-uniform whole body exposure measurements (per 5Q1.2-217)**
  - **Increase Dose Rates by a factor of 2 to 3 at 30 cm from source location (still below 100 mR/hr whole body rate in work area)**





Time, Distance, and Shielding

- **Time was the critical factor for dose control**
  - Practice with special tools using a mock up of the shield and source configuration
- **Distance (Inverse of the Inverse Square Rule)**
  - Lowest dose was actually at the shield
  - Long handle tools places the person in higher exposure
- **Additional shielding was not dose effective**
  - Room return was predominate source of radiation
  - Access to 1/8” gap between shields required
  - Lead jackets will not be used (5 % reduction for Co-60)

Total Personnel Exposures

- **Initial Job (1/19/05)**
  - 9 mRem (Manufacturer)
  - 0 mRem (HPS Staff)
- **RADCON Survey (1/20/05)**
  - 6 mRem
  - 0 mRem
- **Source Recovery (1/25/05)**
  - 7 mRem (Manufacturer)
  - 6 mRem (RADCON)
  - 0 mRem (RADCON)

Total time for source recovery = 6 minutes!