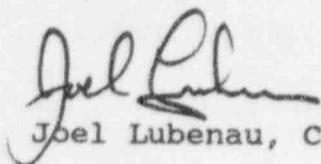


January 5, 1996

Note to Working Group Members

Re: Correspondence and Information

Attached are copies of two letters received following our December, 1995 Working Group meeting. Also attached is a copy of portions of the WWW Home Page for the Steel Manufacturers' Association.



Joel Lubenau, Co-chair

Attachments: As stated

cc w/attachments:

R. Free, TX

WG Liaisons

NRC Public Document Room

## For Release 3-4-96

REVIEW GROUP -  
RADIOACTIVE DEVICES

### Stolen Cameras Pose Serious Health Threat

The Texas Department of Health (TDH) is investigating the theft of three industrial radiography cameras from a site in southeast Houston. Two of the cameras contain cobalt-60 a powerful source of radiation. Exposure could cause death in just a few days.

The two cameras have an oval or irregular-shaped steel shell and may have wheel and lifting mounts on each side. Cameras of this type are usually metallic gray, weigh approximately 600 pounds each and measure about 24" x 20" x 18". Bob Free, with TDH's radiation control bureau, said if the cobalt-60 sources are still properly contained in the cameras, radiation levels present no health hazard to the public.

But if the protective shielding is damaged, the radioactive materials inside could present an extreme health hazard. "Our main concern is if the shielding on these two sources is breached, the exposure could be lethal," he said.

Officials believe that the radioactive material, iridium-192, in the third camera has decayed to an insignificant level and presents no health hazard. This camera has a lunch-box appearance and is steel-shelled with an integrated carrying handle and a round hose connector at each end. It is probably orange and measures about 12" x 8" x 6".

The cameras, used to inspect for welding defects, were marked "Radioactive Material," and labels identifying the radioactive materials contained in the cameras were affixed. However, Free said these labels could have been damaged or removed.

Anyone who sees these cameras or knows of their whereabouts is cautioned not to approach the cameras, and to immediately contact TDH's radiation control bureau at (512) 834-6688 or (512) 458-7460.

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*(For more information, contact Brad Caskey or Tommy Cardwell, TDH Bureau of Radiation Control, at 512-834-6688; or Doug McBride, Public Information Officer, at 512-458-7111, Ext. 2214.)*



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## For Release 3-5-96

### Stolen Cameras Found, Radioactive Source in One Exposed

Acting on a tip from a parolee now in the custody of the Houston Police Department, a team of Texas Department of Health (TDH) radiation control experts today found all three cameras stolen last week from an east Houston industrial site. Two of the cameras were found intact, but the radioactive material in a third camera had been removed from its protective shielding, possibly exposing workers at a Houston scrap metal yard where it was found.

The scrap metal yard was evacuated.

Parts of the cameras were found at three different locations. The radioactive material, cobalt-60, from one of the cameras was found at one site. Its protective shield was found at another. A second camera containing cobalt-60 was found intact, as was a third camera which contained decayed iridium-192 which officials said would not have presented a health hazard even if it had been exposed.

TDH officials said they would not release details about the locations until they were certain radiation levels were safe and the exposed cobalt-60 at one of the sites was safely secured and stored. "We don't want people to be needlessly exposed or to interfere with recovery operations," said Richard Ratliff, chief of TDH's radiation control bureau in Austin.

TDH has begun notifying workers at the location where the exposed source was found and will assist them in being tested to assess the extent of exposure and need for treatment. "We won't know the exposure levels until blood tests are conducted," Ratliff said. Workers exposed to higher levels of radiation might experience nausea, vomiting and diarrhea. Ratliff said these workers should seek immediate medical attention.

Officials said the parolee, who contacted a Houston television station after seeing news coverage about the radioactive dangers of the stolen cameras, apparently was involved in the theft of the heavy-duty cameras which were used to detect flaws in metal welds. Ratliff praised the Houston news media for its work in alerting the public.

TDH was assisted by radiation control personnel from its regional office in Houston and from the City of Houston's Health and Human Services Department and by the Houston Police Department. A Las Vegas-based U.S. Department of Energy radiation response unit, equipped with a radiation-detecting helicopter, was prepared to assist TDH had the cameras and radiation sources not been found today.

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*(For more information, contact Richard Ratliff, Chief, TDH Bureau of Radiation Control, at 512-834-6688; or Doug McBride, Public Information Officer, at 512-458-7111, Ext. 2214.)*



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## For Release 3-6-96

### TDH Says 19 People May Have Been Exposed to Radiation from Camera Part

Texas Department of Health officials have determined that 19 people may have been exposed to potentially dangerous radiation at a northeast Houston scrap metal yard where an unshielded radioactive source, cobalt-60, from a stolen industrial camera was found by a TDH radiation control expert Tuesday afternoon.

Though the extent of physical harm will not be known until medical tests are performed, TDH officials said they are encouraged that none of the people exposed have so far reported having symptoms typically associated with higher levels of radiation exposure.

Richard Ratliff, head of TDH's radiation control program, said that Ben Taub Hospital and the University of Texas Medical Branch in Galveston had offered to perform blood tests and physical examinations of the people exposed. He said Ben Taub's offer was accepted because of its proximity. Tests and examinations were scheduled to begin today.

Officials believe the radiation source had been in the yard since Feb. 26. It was secured and removed from the property late Tuesday. The source was part of a heavy-duty camera stolen with two other cameras from an east Houston industrial site. The other two cameras were found intact and have been secured.

Ratliff stressed that no one exposed to the radiation is radioactive themselves. "The radiation was emitting from a single isolated source," he said. "Once the source was secured and removed, nothing remaining was radioactive. We weren't dealing with radioactive contamination."

Those possibly exposed include 12 employees of Lockwood Scrap Metal where the radioactive source was found, five Houston police officers involved in the search for the stolen cameras, and two children whose parents work at the facility.

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*(For more information, contact Richard Ratliff, Chief, TDH Bureau of Radiation Control, at 512-834-6688; or Doug McBride, Public Information Officer, at 512-458-7111, Ext. 2214.)*

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Return to [TDH Home Page](#)

## SUMMARY OF STOLEN CO-60 CAMERAS IN HOUSTON, TEXAS

On February 27, 1996, two cobalt-60 cameras and an iridium-192 camera was stolen from a location in Houston, Texas. The company, Larpin of Texas, is in bankruptcy and the sources were impounded in place by the Texas Department of Health, Bureau of Radiation Control. The Ir-192 had decayed to minimal activity. The Co-60 cameras, one large, 1665 pounds, and one small, 631 pounds, contained 35.3 curies and 8.6 curies of Co-60 respectively. The three cameras were sold as scrap metal.

While being sold and moved between three scrap metal yards, the lockbox, holding the pigtail and the 35.3 curie source, was torn from the large camera and shielding on February 29, 1996. The source remained in an isolated area until approximately 9:00 AM on March 1, 1996. At that time the camera and the detached lockbox and source was returned to the scrap yard that had initially bought it as scrap. The lockbox and source was thrown and kicked to an area under the corner of an office building. The employees did not recognize the lockbox and source for what it was, and did not know that it was an unshielded source of radiation.

The unshielded source remained at the corner of the office building until March 5, 1996. It was located by Bureau of Radiation Control personnel at 1:30 PM. The scrap yard was evacuated, and the Houston Police Department and Houston Fire Department Hazardous Materials Team were notified that the source had been located. The area was blockaded the source was retrieved and transported to a safe location. The Ir-192 camera was taken at the same time. The second Co-60 camera located at another scrap yard the same day. It was intact and the source was in the shielded position. It was secured and transported to a safe location the next morning.

Nineteen workers and individuals at the scrap yards were exposed to radiation. In addition five Houston policemen and two Bureau of Radiation Control employees were exposed. The 24 individuals, workers, and policemen had blood tests analyzed and all exposures were less than 10 rems. The Bureau of Radiation Control personnel received 520 millirem and 120 millirem exposures respectively.

On March 11, 1996, five suspects were arrested by the Houston Police Department and charged with 2nd degree felony theft. On March 12, 1996, a sixth suspect was arrested and charged with 2nd degree felony theft. Bail was set at \$240,000.00 each for five suspects. A sixth suspect, who was on parole at the time of his arrest, was held without bail.

## THE HISTORY OF THE STOLEN RADIOGRAPHY CAMERAS

7/13/92 the Agency determined that Larpin of Texas was in possession of RAM, that the company did not have an RSO or a radiation safety program, and that no one was in control of the sources.

10/27/92 the Agency issued cease and desist order and impoundment order to the company pertaining to the three Co-60 cameras and the one Ir-192 camera in their possession.

5/20/94 the Agency was notified that Many Diversified Interests, Inc. (MDI) (aka: Larpin of Texas) filed for chapter 7 bankruptcy with an appointed trustee. Once a company has filed for bankruptcy, the control by the Agency of any radioactive material owned by the company is severely limited. Any actions concerning the radioactive material has to go through the bankruptcy court.

6/24 and 7/11/94 the Agency notified the bankruptcy court of our concerns about the radiography cameras at the MDI site.

7/29/94 the Agency formally notified the bankruptcy court, through the Texas Attorney General's Office, that we were a creditor and party of interest in the bankruptcy of MDI.

8/23/94 An Agency region 6, Houston, inspector inspected and photographed the three Co-60 radiography cameras and the Ir-192 camera. One large Co-60 camera was in storage room #1. Two Co-60 cameras, one large and one small, and the Ir-192 camera were in storage room #3. The doors were locked and seals were attached to indicate unauthorized entry. Each door was posted with CRAM and do not enter signs.

9/19/94 the Agency issued an Emergency Impoundment Order of the radiography cameras to the trustee of MDI, and instructed him to properly dispose of the cameras.

12/28/94 the Agency sent a letter to the trustee stating we had turned the matter of disposition of the cameras over to the Texas Attorney General's Office.

3/14/95 The Agency Houston inspector moved the large co-60 camera from storage room #1 to storage room #3. All three Co-60 cameras and the Ir-192 camera are now in storage room #3. The door was again locked and seals were attached to indicate unauthorized entry.

3/95 - 1/15/96 according to a conversation on 3/1/96 with the manager of Gulf Coast Site Work Contractors, they were at the site demolishing the buildings and salvaging equipment and scrap metals. They were aware of the radioactive materials stored in the storage room and avoided the building. They had security at the site until they left on 1/15/96.



1/2/96 the door to the storage building was knocked off one of its top runners by equipment used to clean debris from in front of the building. The door was hanging by one runner. It was taken off the second runner, placed back in place and welded. The building was under constant surveillance and there was never an opportunity for anyone to remove the cameras.

2/26/96 a Texas Natural Resources Conservation Commission (TNRCC) employee observed the door intact on the storage building. The TNRCC employee was working at the site doing hazardous materials work and was at the site almost daily. The work at the site involved the TNRCC and the United States Environmental Protection Agency to determine if the site was contaminated with hazardous materials and if the site should be considered for Super Fund remedial action.

2/28/96 the TNRCC employee noticed the storage building door was off and one of the large Co-60 cameras was sitting outside the building. He notified the Agency. Agency personnel arranged for the transport and storage of the camera to a site authorized to possess the Co-60 camera. One large and one small Co-60 camera and the Ir-192 camera was missing.

2/29/96 - 3/2/96 Austin personnel met with Houston regional personnel and started an investigation of the three stolen cameras.

3/4/96 a news release was issued detailing the stolen cameras.

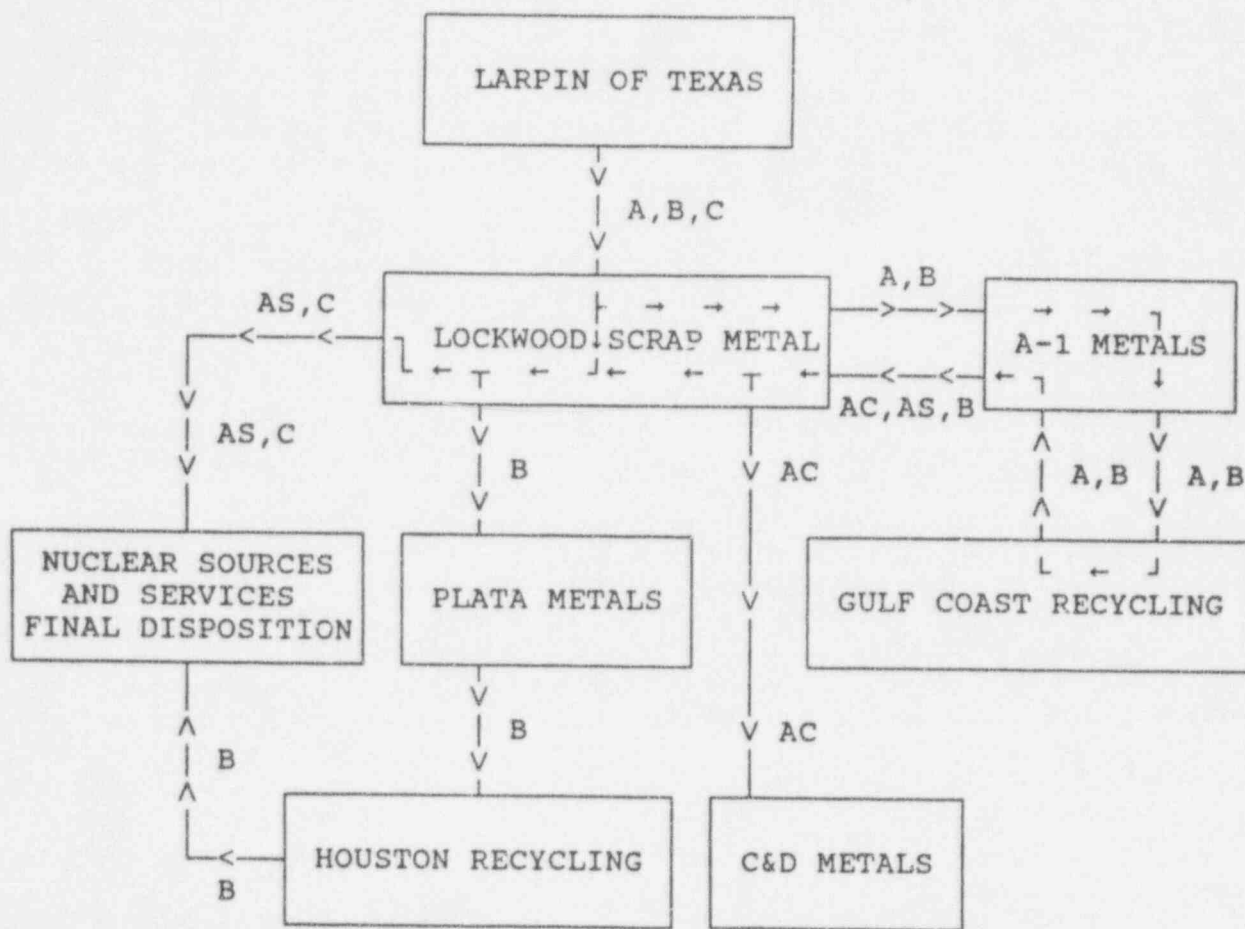
3/5/96 acting on tips received as a result of the news release, Houston regional personnel resumed investigation of the stolen cameras. The larger camera was located at C&D Scrapyard in the morning, but the source was not with the camera. Austin personnel returned to Houston and met with regional personnel and continued the search. The unshielded Co-60 source from the large camera and the Ir-192 camera was located at Lockwood Scrap Metal at 1:30 P.M. The second Co-60 camera was located and verified at Houston Recycling at 4:30 P.M. The camera, with source intact, was secured at Houston Recycling until arrangements could be made to transport it to an authorized company for storage. The unshielded Co-60 source at Lockwood Scrap Metal was retrieved, placed in a shield, and transported, along with the Ir-192 camera, to an authorized company for storage.

3/6/96 the camera, with source intact, at Houston Recycling was transported to an authorized company for storage.

4/96 the bankruptcy court authorized the disposal of the sources owned by MDI. A disposal company authorized to dispose of the sources will take possession of all the sources.

# PATHWAY THE SOURCES TRAVELED

A: LARGE CAMERA CONTAINING 35.5 CURIES OF COBALT-60  
 AC: LARGE CAMERA WITH COBALT-60 SOURCE MISSING  
 AS: COBALT-60 SOURCE FROM LARGE CAMERA  
 B: SMALL CAMERA CONTAINING 8.6 CURIES OF COBALT-60  
 C: THIRD CAMERA CONTAINING DECAYED IRIDIUM-192 SOURCE



NOTE: The lockbox, pigtail, and Co-60 source was torn from the large camera at A-1 Metals after being returned by Gulf Coast Recycling. It was torn loose during moving with a forklift.



## CHRONOLOGY OF THE THEFT OF THE STOLEN CAMERAS

Chronology of the events involving the theft of the cobalt-60 industrial radiography exposure devices (cameras) in Houston:

2/27/96 two Co-60 cameras, one large and one small, and an Ir-192 camera were stolen on February 27th from Larpin of Texas, located at the old TESCO site, in east Houston near IH-10. The cameras were stolen by three individuals, who stripped the cameras of their caution radiation labels, and took the cameras to Lockwood Scrap Metal where they were sold as scrap. A third large Co-60 camera was left at the site. The Agency arranged for this third camera to be transported and secured at a facility authorized to possess the camera.

Lockwood Scrap Metal sold the small Co-60 camera to A-1 Metals the same day.

2/28/96 Lockwood Scrap Metal sold the large Co-60 camera to A-1 Metals. The Ir-192 camera remained at Lockwood Scrap Metal. A-1 Metals determined the cameras were not stainless steel.

2/29/96 A-1 Metals shipped both Co-60 cameras to Gulf Materials Recycling Co. in a large load of scrap. Gulf Materials Recycling Co. has radiation detectors at their plant entry and detected the radiation from the cameras. The manager of Gulf Materials and his two assistants were not at the site when the cameras arrived. A trainee was on duty when the cameras arrived. They segregated the cameras from the rest on the scrap shipment and returned the cameras to A-1 Metals, informing them that the cameras contained radioactive materials.

The large camera's lock box, holding the pigtail and 36 curie cobalt-60 source, was torn loose by a forklift as it was being loaded onto a pallet for loading onto a truck at A-1 Metals for return to Lockwood Scrap Metal on Thursday afternoon, February 29th. The lockbox, with pigtail and source, was loaded on to the pallet with one of the forks of the forklift. The exposed radioactive source and lock box remained on the pallet with the cameras.

A-1 Metals attempted to return the cameras to Lockwood Scrap Metal on the afternoon of February 29th, but the site had closed for the day. The manager of Lockwood Scrap Metals showed up and the A-1 Metals driver informed him that the cameras were radioactive and that A-1 Metals was returning the cameras. The A-1 Metals driver returned to his facility and parked the truck containing the cameras and the exposed source in a remote area at the A-1 Metals facility.

3/1/96 A-1 Metals returned the cameras to Lockwood Scrap Metals. While unloading the cameras from A-1 Metals truck, the lock box and source fell through the pallet and remained on the truck. It was then picked up by the A-1 Metals driver, by the source capsule, and thrown to the side after the cameras were unloaded. It was then kicked under the corner of the office building by a Lockwood Scrap Metal employee. Neither individual was aware that what they were handling and kicking around was an unshielded source.

The owner of Lockwood Scrap Metal was told that the cameras were radioactive. Lockwood Scrap Metal then sold the large camera, without the source inside, to C&D Scrapyard and sold the small camera, with the source inside and shielded, to Plata Metals without advising anyone that the cameras contained radioactive materials. Plata Metals in turn sold the small camera to Houston Recycling. The manager was unaware that the cobalt-60 source was on the ground at his scrapyard. ( Note: The TDH/BRC was never notified by any of these companies that they were in possession of radioactive sources.)

3/5/96 the 36 curie cobalt-60 source remained unshielded at the Lockwood Scrap Metal until Tuesday March 5th where it was located by TDH/BRC Health Physicists at 1:30 PM. The scrapyard was evacuated and secured and the source was recovered and secured later that evening. Eleven adults and two children were exposed to high levels of radiation at the Lockwood Scrap Metal and one adult from A-1 Metals was exposed when he transported and handled the camera and source.

Five Houston Police Officers were slightly exposed when they conducted interviews at Lockwood scrap metal on Tuesday morning, March 5th.

3/7/96 Thirteen individuals went to Ben Taub Hospital, where they were examined and had blood tests run to determine their level of exposure to radiation. In addition, blood was drawn from each individual and sent to the U.S. Department of Energy's Oak Ridge, Tenn. laboratories where they performed a cytogenetic analysis on each person's blood. The police officers were examined by their private physicians.

The Bureau of Radiation Control sent a "Dose Reconstruction Team" to Houston to perform time/exposure dose estimates to determine the estimated exposure to the Lockwood Scrap Metal and A-1 Metals staff.

3/8/96 the A-1 Metals employee went to Ben Taub Hospital for blood tests. None of the exposed individuals experienced any of the medical symptoms associated with large exposures to radiation (i.e. nausea, vomiting or diarrhea). Our initial dose estimates indicated exposures as high as 60 rems. Members of the general public outside the scrapyard should have received less than 0.1 Rem.

Initial analysis of blood samples sent to the DOE REAC/TS (Radiation Emergency Assistance Center / Training Site) in Oak Ridge, Tenn. indicated that all radiation exposures to employees of the scrap metal yards were less than 10 Rem.

The Bureau of Radiation Control will perform a risk assessment analysis on the exposed individuals with assistance from the Bureau of Epidemiology.

3/11/96 The Houston Police Department (HPD) arrested two of the persons that took the radioactive sources from the Larpin of Texas storage site. In addition, the HPD has arrested the owner, manager, and manager's wife of Lockwood Scrap Metal for accepting stolen property.

3/12/96 the HPD and Mr. Tom Nalepa, the E&CH program director had a press conference at 1:00 pm to address the issues of the stolen sources and the arrest of individuals.

3/17/96 the A-1 Metals employee started experiencing symptoms of swelling and pain in the thumb and middle finger of his right hand and small blister appeared on his right thumb. This was the hand used to remove the source from his truck on 3/1/96. Examination by a Houston doctor indicated the symptoms were from radiation exposure, but that damage was minimal and healing should proceed without problems.

NOTE: When it was determined that the lockbox and source had been torn loose from the camera shielding at A-1 Metals, the employee was asked several times, by the investigators and the dose assessment team, if he had touched the source. Each time he replied that he had not. When pain, swelling, and blistering appeared on his right hand, he was asked to describe exactly how he had handled the camera and lockbox and source. He then stated that when he removed the lockbox and source from his truck at Lockwood Metals, he placed a red mechanics rag over the source, grabbed hold of it, and threw it from the truck to the ground. We were asking about contact with the source in terms of distance and he was answering about contact with the source in terms of actually touching the source. His understanding was that using the rag to cover the source meant he had not touched the source.

4/4/96 the A-1 Metals employee is still experiencing pain in his right thumb and middle finger. He had lost feeling in the ends of his right thumb and middle finger and the skin had hardened. The fingernails of his thumb and middle finger are also showing damage.

# TABLE OF DOSE ASSESSMENTS

Owner - Lockwood Scrap Yard		18	rem
Manager - Lockwood Scrap Yard		53	rem
Manager's wife - Lockwood Scrap Yard		55	rem
Two Children at Lockwood Scrap Yard		39	rem
Workers at Lockwood Scrap Yard		15	rem
Customers at Lockwood Scrap Yard		0.16	rem
Worker at A-1 Scrap Metal	wholebody	0.50	rem
	extremity	2500/3000	rem
Police Officers		0.5/3	rem

## DOSE ASSESSMENT

On February 28, 1996, the Texas Department of Health Bureau of Radiation Control was informed that two cobalt-60 radiography sources and an iridium-192 camera was stolen from a storage facility in Houston, Texas. One of the cobalt devices had a source measured at 220 curies on April 19, 1982, and the other cobalt-60 device had a source measured at 110 curies on November 15, 1978. The iridium-192 device and the 110 curie cobalt-60 device were recovered intact. The exposure from these two sources would have been minimal. The larger cobalt source was found at a scrap yard in Houston in an unshielded configuration and recovered on March 5, 1996. The Agency investigation determined that the source was knocked free of its shield on Thursday, February 29, 1996, while at A-1 Scrap Metal and was returned to Lockwood Scrap Metal on Friday, March 1, 1996. Only one individual would have been exposed at A-1 Scrap Metal. The unshielded source remained at Lockwood Scrap Metal from Friday until the following Tuesday at 1:30 PM March 5, 1996. A dose assesment team calculated the worst case exposures for the individuals most likely to have received the highest exposures.

Using the decay equation, the activity of the source was calculated to be 35.3 curies on March 1, 1996. The gamma constant for cobalt-60 is 14.2 roentgens per hour. An exposure rate from the source of 501.5 roentgens per hour (R/hr) at one foot was used to perform the time dose studies. The following is the explanation of the distances and times used for the exposure calculations and the individual exposure calculations. All calculations are worst case and do not take into consideration any shielding from objects or building materials that may have been between the source and the individuals for whom the calculations were made. The following is the equation used for calculations.

$$\frac{I_1}{I_2} = \frac{d_2^2}{d_1^2} \Rightarrow \frac{I_1}{501.5 \frac{R}{hr}} = \frac{(1ft)^2}{d_1^2} \Rightarrow 2I_1 = \frac{501.5 \frac{R}{hr} * (1ft)^2}{d_1^2} \Rightarrow$$

$$I = \frac{501.5 \frac{R}{hr}}{d^2}$$



1. Two children were in the radiation field for 2.5 hours on Saturday, March 2, 1996. Their mother indicated that the children were on the front porch the entire 2.5 hours and spent approximately one hour swinging on the porch rail at 6.5 feet from the source. The rest of the time the children were running on the porch. The front door is 18 feet from the source and the remaining time (1.5 hour) was calculated at nine feet, half way, to the front door.

The first calculation: 6.5 feet for 2.5 hours.

$$I = \frac{501.5 \frac{R}{hr}}{(6.5 ft)^2}$$
$$I = 11.9 \frac{R}{hr} * 2.5 hr = 29.7 R$$

The second calculation: 9.0 feet for 1.5 hours.

$$I = \frac{501.5 \frac{R}{hr}}{(9 ft)^2}$$
$$I = 6.2 \frac{R}{hr} * 1.5 hr = 9.3 R$$

The total calculated exposure for both children was 39.0 rem.

2. The owner indicated that she only spent two hours at the office on Monday, March 4, 1996. Her normal location while in her office is approximately 8.5 feet from the source.

$$I = \frac{501.5 \frac{R}{hr}}{(8.5 ft)^2}$$
$$I = 6.9 \frac{R}{hr} * 2 hr = 13.8 R$$

The total calculated exposure to the owner was 13.8 rem.

3. The yard manager indicated that he was present at the facility for 8 hours on Friday and two hours on Saturday. He did not indicate that he was at the scrap yard on Tuesday morning prior to the evacuation of the yard. However, Mr. Caskey indicated that he was sitting on the porch when he arrived at approximately 1:30 pm. The manager indicated that he spends about one-half of his time on the front porch at 8.5 feet from where the source was located. Of the total time, one hour is spent in the back office at approximately 34 feet from the source location and four hours were spent at the cashier's window 18 feet from the source.

On the porch at 8.5 feet for 5 hours.

$$I = \frac{501.5 \frac{R}{hr}}{(8.5 ft)^2}$$

$$I = 6.9 \frac{R}{hr} * 5 hr = 34.5 R$$

In the back office at 34.0 feet for 1 hour.

$$I = \frac{501.5 \frac{R}{hr}}{(34 ft)^2}$$

$$I = 0.4 \frac{R}{hr} * 1 hr = 0.4 R$$

At cashier's window at 18.0 feet for 4 hours.

$$I = \frac{501.5 \frac{R}{hr}}{(18 ft)^2}$$

$$I = 1.5 \frac{R}{hr} * 4 hr = 6.0 R$$

A total exposure would have been 40.9 rem for this scenario.

The manager was not at work on Monday. He was present on Tuesday from 9:30 am until 1:00 pm. He would have been on the porch at 8.5 feet for another 1.5 hours for a 10.4 rem exposure, one hour in the back office at 34 feet for a 0.4 rem exposure, and one hour at the cashier's window at 18 feet for a 1.5 rem exposure. This scenario would have added another 12.3 rem to his exposure.

The total calculated exposure to the manager was 53.2 rem.

4. The manager's wife was at work 8.5 hours on Friday, and Monday. She indicated that most of her time was spent in the back office area 34 feet from the location of the source. On Saturday she visited the scrap yard with the children for approximately 2.5 hours, spending one hour on the porch at 8.5 feet and 1.5 hours in the back office area at approximately 34 feet. On Sunday she was at work for 2.5 hours, spending 0.5 hours on the porch at 8.5 feet and 2.0 hour in the back office at 34.0 feet. On Tuesday she worked four hours until the source was found. She washed dishes for approximately 10 minutes each of three days at a distance of 4.5 feet from the exposed source. Her exposure at 4.5 feet from the source was assumed to be for 30 minutes. The following is the break down of her exposure:

Friday March 1, 1996

0.5 hours on porch at 8.5 feet	=	6.9 R/hr * 0.5	=	3.5 rem
8.0 hours in office at 34 feet	=	0.4 R/hr * 8.0	=	3.2 rem
				Total = 6.7 rem

Saturday March 2, 1996

1.0 hours on porch at 8.5 feet	=	6.9 R/hr * 1.0	=	6.9 rem
1.5 hours in office at 34 feet	=	0.4 R/hr * 1.5	=	0.6 rem
				Total = 7.5 rem

Sunday March 3, 1996

0.5 hours on porch at 8.5 feet	=	6.9 R/hr * 0.5	=	3.5 rem
2.0 hours in office at 34 feet	=	0.4 R/hr * 2.0	=	0.8 rem
				Total = 4.3 rem

Monday March 4, 1996

2.25 hours on porch at 8.5 feet	=	6.9 R/hr * 2.25	=	15.5 rem
6.25 hours in office at 34 feet	=	0.4 R/hr * 6.25	=	2.5 rem
				Total = 18.0 rem

Tuesday March 5, 1996

0.75 hours on porch at 8.5 feet	=	6.9 R/hr * 0.75	=	5.2 rem
3.25 hours in office at 34 feet	=	0.4 R/hr * 3.25	=	1.3 rem
				Total = 6.5 rem

0.5 hours washing dishes at 4.5 feet	=	24.8 R/hr * 0.50	=	12.4 rem
				Total = 12.4 rem

$$I = \frac{501.5 \frac{R}{hr}}{(4.5 ft)^2}$$

$$I = 24.8 \frac{R}{hr} * 0.5 hr = 12.4 R$$

The total calculated exposure to the manager's wife was 55.4 rem

5. General workers were at a distance of 50 feet for a total of 35 hours for all days and were at a distance of 4.5 feet washing hands for a total of 15 minutes for all days. The workers carry receipts to the cashier's window approximately 15 times per day for an estimated one hour exposure at 18 feet for all five days. This was estimated by review of the receipts between February 28, 1996, and March 4, 1996. The number of receipts were averaged per day and divided by the number of employees (6) to determine the average number of trips to the cashier's window per employee. The assumption was made based on one-half a work day Sunday and until noon Tuesday. The general workers exposure would be as follows:

$$I = \frac{501.5 \frac{R}{hr}}{(50 ft)^2}$$

$$I = 0.2 \frac{R}{hr} * 35 hr = 7 R$$

35 hours working in the scrap yard at 50 feet	=	7.0 rem
0.25 hours washing at 4.5 feet = 24.8 R/hr * 0.25 hr	=	6.2 rem
1.0 hour cashier's window at 18 feet = 1.5 R/hr * 1 hr	=	1.5 rem

Total employee exposure = 14.7 rem

6. Five members of general public visiting scrap yard were timed and averaged for exposures to members of general public visiting the scrap yard. Six individuals were timed at different locations and the times ranged from a high of 460 seconds to a low of 128 seconds at 50 feet for an approximate average time of 300 seconds, which equals 0.08 hrs. The closest a customer was observed to the location where the source was found was approximately 18 feet. Again, the six customers were timed during the period they were within 18 feet of the source. The times ranged from a high of 310 seconds to a low of 101 sec for an approximate average of 200 seconds, which equals 0.06 hours. The average calculated exposure to a customer was as follows:

0.08 hours at 50 feet = 0.2 R/hr * 0.08 hr	=	0.016 rem
0.06 hours at 18 feet = 1.5 R/hr * 0.06 hr	=	0.090 rem

Total exposure to customer per trip to yard = 0.106 rem

The highest exposure would be as follows:

0.13 hours at 50 feet = 0.2 R/hr * 0.13 hr	=	0.026 rem
0.09 hours at 18 feet = 1.5 R/hr * 0.09 hr	=	0.135 rem

Maximum exposure to customer per trip to yard = 0.161 rem

NOTE: SUBSEQUENT CYTOGENETIC STUDIES BY DOE REAC/TS IN OAK RIDGE, TENNESSEE INDICATED ALL EXPOSURES WERE LESS THAN 10 REM.