

NOV 27 1984

Sec 1

MEMORANDUM FOR: William J. Dircks
Executive Director for Operations

FROM: John G. Davis, Director
Office of Nuclear Material Safety and Safeguards

SUBJECT: COMMISSION INFORMATION PAPER ON CONTAMINATED STEEL
PIPE FITTINGS IMPORTED FROM TAIWAN

There is enclosed for your approval and signature a Commission Information Paper summarizing the events and regulatory responses related to the contaminated pipe fittings discovered among steel castings imported into the United States from Taiwan. No appreciable risk to public health and safety was found, and the matter is considered closed.

John G. Davis, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

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RWilde

Draft of paper sent for review and comments on 10/4/84 to IE and on 10/15/84 to Regional Offices, SP and IP. IE comments received and incorporated. SP and IP suggested changes were accommodated. Regions III and IV comments were accommodated. no comments received from Regions I and II. Region II comment re actions to detect and prevent further distribution of contaminated castings not accommodated, since these actions are still under consideration.

*Reg Page
11-26-84*

B/N

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PDR FOIA
KAWATA93-203 PDR

OFFICE	FCTA <i>WET</i>	FCTA	FCUF	FC	FC	NMSS <i>M</i>	NMSS
SURNAME	WETHompson/rf/as	<i>GATerry</i>	<i>RGPPage</i>	DRChapell	RECunningham	DBMausshardt	<i>JGDavis</i>
DATE	11/13/84	<i>11/14/84</i>	11/14/84	11/14/84	11/14/84	11/20/84	11/27/84

To Cynthia: With the best regards
Who should I send the ^{from China} bill to? ^{Whatever you request, always do first.}

In regard with Red radioactive Contaminated Rebar Steel
Director of Executive Yuan in Taiwan charged to
Handle ⁱⁿ a Serious Manner

This incident should not be considered as an isolated
single incident. The director ordered that this
incident should not be happened again.

(World's News - Taipei) : In regard with radioactive
contaminated rebar steel found in ~~contaminated~~ building
as published in current newspaper, the Director
of the Executive Yuan in Taiwan, ^{Mr.} Hsu Pok Shuen
commented out on September 3, 1992 in a meeting
that this incident should not be treated as an
isolated single incident and should be handled
in a serious manner. He ordered the Taiwan
Atomic Energy Council to conduct inspection and
control to avoid recurrence of this
type of incident.

BH

The secretary of the Atomic Energy Council Mr. Li Kwong-chi reported in the meeting that the first occurrence of this type of incident was in 1983. At that time, the contaminated buildings were demolished.

Mr. Lin indicated that the AEC are actively involved in the control and inspection on the ^{current} steel bar production factories. The next step is to inspect records from these factories for past potential use of contaminated steel bars for other buildings. According to the AEC's ^{current} findings, this incident was an isolated single case, there is no indication of widespread usage of this contaminated bars.

Specialists from several hospitals and Chungking University gathered on September 3, 1952 to discuss and establish criteria for control and inspection. Ma Yueng Yi-Seung pointed out that, according to the AEC, if the radiation dose exceeds 1500 mrem/yr, the residence building has to be inspected and surveyed. Remedial action has to be taken, such as shielded by steel plate and concrete, to reduce radiation dose not to exceed 100 mrem/yr.

contaminated

Radiation survey of the "Manson Mansion" for the AEC shows that in the past 9 years, there are 16 residences exceeding the ^{annual} radiation exposure limit of 500 mrem/yr. The

highest, ^{cumulative} radiation exposure in the 9 years
reaches 120,000 mrem, i.e., about
13,300 mrem/yr, about 27 times the
limit of 500 mrem/yr. This could
result in an increase of 15% of the
normal natural cancer rate of an
individual.

之視聞等能壹

輻射鋼筋 郝柏村促積極處理

指示應避免事件重演 不能視為孤立事件

【本報台北訊】針對最近輻射鋼筋建物發現，行政院郝柏村三日前在行政院院會上指出，政府應當積極檢討處理此一問題，不能將其視為孤立事件，今後原子能委員會應有相當的準備和管制措施，並避免類似事件再發生。

行政院原能會秘書長劉光霽在院會報告，民國七十一年原委會首度發現部分有利用進口廢鋼製作的鋼筋有輻射現象，當時立即將造成污染的房屋拆除。

劉光霽說，對此一問題，原委會的處理方式是先積極處理現在產生的問題，其次再希望工廠配合檢查其他的鋼筋有無類似輻射現象，而根據原委會的了解，目前的現象是孤立現象，不會造成普遍的傷害。

對於受到輻射鋼筋污染的「民生別墅」住宅住戶，原能會三日邀集台大、榮總、三總、清華大學等輻射醫學專家，共同商討出體檢就醫標準，楊義輝指出，原能會決定，如果一年接受的輻射劑量在一千五

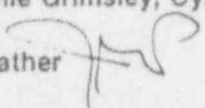
百毫倫目的住戶，都建議接受體檢；住戶在鋼筋之外加上鋼板、水泥等遮蔽物後，輻射劑量也不應超過每年一百毫倫目。原能會近日調查「民生別墅」住戶所接受的輻射劑量，發現在九年之中，共有十六戶累積劑量超過法規所規定的民眾劑量，最高值的住戶接受的輻射劑量達十二萬毫倫目，是法定劑量四千五百毫倫目的二十七倍，這個結果，可能導致住戶一生的致癌率比常人高出百分之一點五。

OCT 23, 1992

MEMORANDUM FOR RECORD

TO: LATA; Reinig, Dunbar, Kingsbury

CAST: LATA; Roger Ray, David Louie
SNL; Jim Metcalf, Jerry Kennedy, Margaret Chu, Ron Ewing
LANL; Tom Buhl
DOE; Harry Pettingill, Jim Magruder, R. Amick
NRC; Donnie Grimsley, Cynthia Jones

FROM: Gordon Prather 

SUBJECT: CCNAA request for information on US response to discovery in 1984 of imported radioactively contaminated steel

The request on the evening of OCT 15 from Dr. Frank Fu for my assistance is Attachment [A]. I told him I would see what I could find out and bring that information to our already scheduled OCT 20 meeting. That meeting was one in a series wherein we [LATA] were attempting to secure the support of the Government of Taiwan for a Grant, to be handled by the European Bank [EBRD], to Ukraine for initiating the Chernobyl Comprehensive Remediation Project.

[I found out later that Fu did ask similar questions of the US NRC, but it seems that the principal reason he asked me to help was because this contamination had been discovered at Los Alamos, and we are, after all, called Los Alamos Technical Associates. In any case, the NRC would not have been able to respond to his deadline.]

The next morning OCT 16 Fu called me again and said that OCT 20 was too late; he needed that information by the close of business that day. He said something about "Senate Hearings in Taiwan" the next day.

In what followed, I contacted lots of old friends and acquaintances, all of whom helped some, but the help that turned out to be most important is described below.

Margaret Chu [SNL] first translated the Chinese article so that we would have some idea of what the problem was in Taiwan. It said that 16 dwellings [multiple?] had been built 8 or 9 years ago in Taiwan with what was now known to be Co-60 contaminated "re-bar" and that some residents had filed a "class action" suit against the Taiwan government. The Atomic Energy Council official responsible for health and safety had already been forced to resign.

Margaret said that it seemed to her that what Fu really needed to know is what the States [e.g. New Mexico] did once they found buildings [e.g. 2 houses in Farmington] or products [outdoor furniture] built with Co-60 contaminated steel.

She said that a friend [once removed] named Tom Buhl [now at LANL] had been the NM State Official responsible when it was discovered that houses had been built with Co-60 contaminated rebar in their foundations.

Tom Buhl [LANL] told me that NM didn't have to do anything [except monitor], because the builder of the as-yet unoccupied houses, jacked up the houses, ripped out the contaminated

6/3

foundation, and poured new ones.

They also had to track down some Co-60 contaminated [mR/hr] outdoor restaurant furniture that turned up in almost every State. David Louie [LATA] put me in touch with the appropriate office in Kentucky, who had found some contaminated tables in a pizza house. Some of these things turned up in Alaska.

Roger Ray had put me in touch with DOE\NauVoo types, but they didn't seem to know much about the incident, other than they had dispatched the DOE\EGG NEST unit down to help the Mexicans. They didn't know anything about what happened in the US.

Harry Pettingill [DOE\EH] told me that his friend in NRC\Region 4, Chuck Cain, had actually run the NRC team that tracked all the contaminated steel and products down, and that there were reports on the subject. Cain and his deputy were out all day Friday, so I called the NRC Reports section here, which turned out to be run by an old friend, Donnie Grimsley. His assistant, Cynthia Jones, provided me with 3 NRC reports and I delivered them to Fu by COB, OCT 16.

It turned out that there had been two other incidents of Co-60 contaminated steel entering the US in 1983-84. The first was from Mexico [JAN 84], the second from Brazil [APR 84] and the third Taiwan!! [AUG 84]. Just coincidence, right? So it may be that the current Taiwan problem is really traceable back to the original Mexican problem and that obviously ought to be of considerable interest to the Taiwanese.

Meanwhile, Jerry Kennedy [SNL] had tracked down at NTS Jim Metcalf [SNL], who had all the reports at home in ABQ of what DOE\NRC had done in Mexico to help the Mexican Government and had an English language version of their Final Report. Jim Xeroxed them all Friday night, gave them to Jerry, who FedExed them to me on Saturday. I gave them to Fu, who air-pouched them on to Taiwan.

Jim had the closest thing to the complete story and Attachment [B] is a Science article that he provided me that does a pretty good job of summarizing all the technical documents he also provided me.

Frank Fu told me he didn't need to know anything more about LATA's capabilities, because my getting him that kind of information on that kind of deadline said it all. I really did try to convince him that the credit lay elsewhere. Really.

So, if we get an EBRD Grant from Taiwan for Chernobyl, I'll buy you all a beer at some outdoor restaurant in Kiev. That is, if their tables weren't Made in Mexico in 1984.

北美事務協調委員會駐美國辦事處科學組

COORDINATION COUNCIL FOR NORTH AMERICAN AFFAIRS
OFFICE IN U.S.A./ SCIENCE DIVISION
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WASHINGTON, D.C. 20016-2137

TEL: (202)895-1932

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REF: DC-

811162

TO: Dr. Gordon Prather

DATE: Oct. 15, 1992

LATA

FROM: Dr. Frank Y. K. Fu 傅應凱博士

FAX NO.: 703-698-0523

NO. OF PAGE: 2 (including cover)

Dear Gordon:

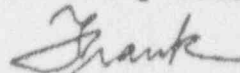
Enclosed please find a page of Chinese article mentioned about the radioactive contaminated Rebar Steel (steel beam) in residence in Taiwan recently. Would you please find some information on the following questions requested by AEC.

constructed

1. Was there any case in U.S. some house incidently were ~~contaminated~~ by radioactive contaminated steel beam.
2. Did any residents suit Govermental Organization for the compensation for the low dose radioactive damage.
3. How did the governmental organization handle and manage these cases. Is there any regulation concerning about the compensation for residents other than radiation workers.
4. The Maximun Permissible dose for the Rebar steel as the construction building material.

We appreciate your help!
With my best regards

Sincerely Yours,



Dr. Frank Fu
Deputy Director

之視聞等能查

輻射鋼筋 郝柏村促積極處理

指示應避免事件重演 不能視為孤立事件

【本報台北訊】針對最近報載建築物發現鋼筋遭列輻射污染一事，國府行政院長郝柏村三日在行政院院會上指出，政府應當積極檢討處理此一問題，不能將其視為孤立事件，今後原于能委員會應有相當的準備和管制措施，並避免類似事件再發生。

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*The incident on Aldama Street
that became North America's
worst radioactive accident.*

HOT

BY SUSAN WEST
PHOTOGRAPHS BY JOSÉ AZEL

Vincente Sotelo lives in Juárez, Mexico, in a neighborhood called Bellavista. On hot afternoons the streets of Bellavista are whitewashed with glare. Only children bother to come outside, lured by a man selling popsicles from a pushcart. On Aldama Street, where Sotelo lives, there is only one tree, angled over the street as if faltering beneath the heat. This is how Bellavista looks every summer afternoon. There is no way to tell, just looking at the low, white houses and the baking streets, that the worst radioactive spill in North America occurred here.

It wasn't the sort of spectacular nuclear accident that we have come to expect, not a reactor ruptured by an unmapped fault line or an unpredicted shifting of winds over a bomb test site. This accident started with a worn-out cancer therapy machine. In the end, all 50 states and much of Mexico had had a brush with the machine's remnants, and at least 200 Mexicans, including Sotelo and his neighbors, had received among the largest doses of radiation on record for the public.

What happened in Juárez a year ago had nothing to do with miscalculations or design error or even human error. It had to do with ordinary actions and extraordinary consequences, with the role of chance and coincidence in the atomic age.

Susan West is a staff writer.



Agustin Villanueva, 17, became sterile from the radiation he received while working in the contaminated scrapyard.

His doctor has told him to rest, but he's bored, so the scrap dealers let him do light work.

S ometime in late November 1983, Sotelo and Ricardo Hernandez, both employees at Centro Médico de Especialidades in Juárez, took the radioactive core of a Picker C-3000 cancer therapy machine from the hospital's warehouse. They heaved the 46-pound metal cylinder into the back of the hospital's white Datsun pickup and tossed in a few other odds and ends. On December 5, they sold the load to a scrapyard for \$10.

The Picker had been in the warehouse six years. It was an old machine, probably made about 1963 and used by the Methodist Hospital in Lubbock, Texas, until the cobalt-60 it contained had lost so much radioactive potency it no longer gave the high doses needed for cancer patients. The Lubbock hospital sold it to the X-Ray Equipment Company in Fort Worth on November 12, 1977. The used-equipment company packaged it up just the way the government says to, made sure all the export paperwork was proper, and sold it to Albelardo Lemus, a doctor at Centro Médico, on November 14. Apparently planning to rejuvenate the Picker, the hospital's doctors had hired a specialist to run it and had gotten a license application from the Mexican nuclear safety commission. But by the time the machine arrived, the technician had decided against the job. The Picker went in the warehouse, and the licensing forms never went back to the Mexican government.

The heart of the Picker is about 6,000 pellets of radioactive cobalt-60, each pellet smaller than the head of a pin. They sit inside a stainless steel cylinder, which is welded shut and nests in another steel cylinder, again welded closed. The double capsule fits into yet a third cylinder, roughly the size of a teacup, two inches wide and two inches high. This cylinder screws into a hole on the rim of a tungsten "wheel," about the size of a tricycle wheel. Inside the helmet-shaped lead head of the machine, the wheel can rotate to aim the cobalt-60 toward the patient.

It was this shiny tungsten wheel containing the cobalt-60 capsule that Sotelo and Hernandez brought to the Yonke Fénix scrapyard in Juárez last December.

Judging from the small rectangular hole later found in the metal capsules holding the cobalt-60, it appears that someone punctured them with a screwdriver, but Sotelo isn't saying. Hundreds of the hot pellets began to dribble from the hole while the wheel bounced around the back of the pickup. After collecting his money, Sotelo drove the Datsun back to Aldama Street and parked it under the single tree, where its battery promptly went dead. The truck stayed on the street seven weeks, radiating enough in one day to kill a mouse enjoying the shade beneath it.

At Yonke Fénix, the wheel was a nuisance. The magnetic crane used to move the scrap couldn't hold on to the non-ferrous tungsten metal, and the wheel was repeatedly lofted momentarily and then dropped, flinging the pellets everywhere. Pedro Torres and Agustin Villanueva, who worked the scales at the yard, kicked the useless wheel out of the way for weeks. The pellets, however, did stick to the magnet, and they became mixed with the scrap leaving the yard. "It was a good salad," Yonke Fénix co-owner Roberto Moya says wryly.

One of the scrapyard's two best customers was Falcón de Juárez, a foundry that melts the scrap to make cast-iron table legs, the pedestal-style bases used by fast-food chains and hotel restaurants. The other was Aceros de Chihuahua, which makes steel rods used to reinforce concrete. About December 10, Falcón sent its first truckload of contaminated table bases to its parent company in St. Louis, and Aceros de Chihuahua began shipping their hot reinforcing rods all over Mexico. In December and January, three distributors in El Paso and one in Arizona bought about 1,000 tons of the rods. The Arizona distributor, Free Market Steel of Phoenix, sold some of the rods to Smith Pipe and Steel in Albuquerque, who in turn began delivering them to customers.

It was then that the accident was discovered. At 2:17 p.m. on January 16, a Smith Pipe and Steel driver made a wrong turn while making a delivery in Los Alamos National Laboratory. As he left the area, a radiation detector under a manhole tripped an alarm that set off a

claxon and a flashing red light and took a picture of the truck. Workers at the laboratory identified the truck, found out the driver's route, and left him messages at each stop. When the driver called about 5:00 p.m., the workers told him he'd best get in touch with the New Mexico state radiation bureau.

Tom Buhl, then director of the bureau, learned all this from the Los Alamos workers just after 5:00. But the driver didn't call the bureau until the next morning, and Buhl spent a good part of the night driving up and down "motel row" in Santa Fe looking for the truck. One of Buhl's coworkers finally met the driver the next morning, waved a radiation detector over the load in the truck, and discovered that it was the reinforcing rods that had tripped the alarm. Buhl learned the rods were contaminated with cobalt-60, traced them back to Free Market Steel in Phoenix, and contacted Arizona's officials. Free Market Steel had bad news: Five more truckloads of reinforcing rods, stamped with AC for the foundry that made them, were on their way from Chihuahua to El Paso. Buhl called customs, the Texas radiation bureau, and the Nuclear Regulatory Commission. "It was kinda like a loose thread on your sweater," he says. "You just keep pulling and you find out it's connected to everything."

By January 19, Texas radiation officials tracked the hot rods from Aceros de Chihuahua back to Yonke Fénix scrapyard and called Roberto Treviño, head of the Mexican nuclear safety commission, who immediately dispatched investigators to Juárez and Chihuahua. They shut down Yonke Fénix and Aceros de Chihuahua and started cleaning up. By January 21, they discovered that Falcón de Juárez, the table legs maker, had also used the tainted scrap, and they closed that foundry as well. But there was still no clue to the source of the cobalt-60, and the Mexican technicians turned their detectors to the streets of Juárez.

The night of January 26, they got lucky. Some of the investigators were driving to a meeting downtown when a detector in their car went berserk. At first they thought the reading was coming from El Paso, but they soon found

out it was from a white Datsun pickup on Aldama Street.

"About midnight or 1:00 A.M., they came and told everyone there was a bomb in the truck and we weren't to leave our houses," says a woman in the Bellavista Tortilleria. "Then a wrecking truck came and took the truck away. After that we were told it was a bomb that emitted radiation."

The pickup had become a fixture in the life of Aldama Street. Sixty-five-year-old Carmen Persabal and her neighbor had rested their arms on it and leaned their backs against it while they passed the time. Sotelo's three children and their friends had tea parties in it. In seven weeks, countless people had walked by it, hung around it, ate and slept in the houses near it.

The truck was emitting 50 roentgens per hour from the driver's side, measured about three feet away. Roentgens are a measure of the energy given off by a radioactive source such as cobalt-60. The biological effect of that radiation is measured in rems, which stands for roentgen equivalent man. A person is exposed to roentgens but gets a dose of rems; one roentgen of cobalt-60 yields about 2 one-rem dose. A chest X ray gives us about .05 rems. American nuclear workers are allowed only five rems in a year; researchers recommend that the rest of the public get no more than a tenth of that. Someone who gets 450 rems in an instant has a 50 percent chance of surviving, but the same dose over a year may cause no immediately detectable harm. A resident of Aldama Street, leaning an outstretched arm against the driver's side of the Datsun, would have gotten about 50 rems in an hour. Except for a handful of victims, the investigators don't know how much radiation the 200 or so people living nearest the truck actually received. So far, all they know is that it wasn't enough to kill anyone but enough to cause official alarm.

In the meantime, the Nuclear Regulatory Commission believed everything was under control on its side of the border. The six states that eventually received the contaminated steel rods are all "agreement" states, meaning that they handle

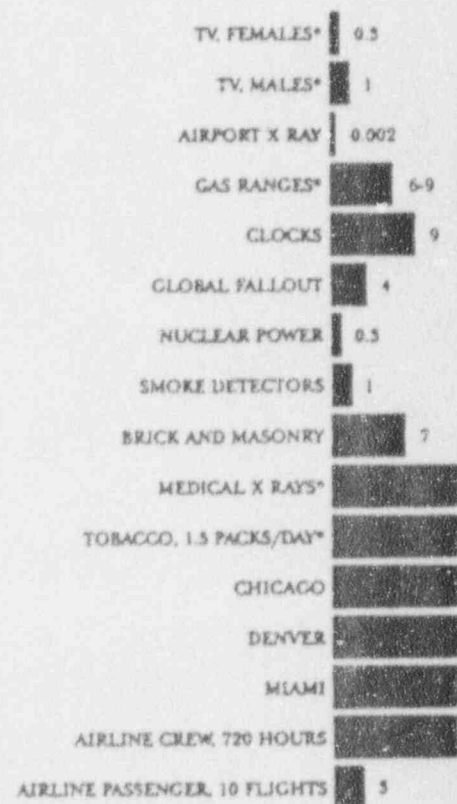
their own nuclear affairs, except for reactors. And they were doing just fine, rounding up the hot steel and sending it back to Mexico. The agency's international relations branch was keeping in touch with their Mexican counterparts, and the regional office in Texas was training customs officials to use radiation monitors in El Paso.

The delusion soon ended. Darrel Wiedeman in the commission's Chicago office got a call that some kind of contaminated metal product had been shipped to a company called Falcon in St. Louis. On January 25, he reached Falcon Products president Frank Jacobs at a business breakfast and sent an inspector from the Missouri public health department to check Falcon's inventory of table bases. They were hot.

By the end of March, health inspectors had checked more than 1,400 of Falcon's customers, mostly restaurants and hotels in all 50 states, Puerto Rico, the Virgin Islands, Singapore, and Canada. Eventually 2,500 table bases were returned from 40 states; the rest of the customers were clean. Few of the pieces had been installed, and Wiedeman estimates the biggest dose anyone could have received was two to four millirems during an hour's meal, about an hour-long chest X ray. The hottest legs, found in a downtown Chicago hotel still under renovation, measured 200 milliroentgens per hour at the metal's surface.

In two months, about 4,000 of the cobalt-60 pellets had been melted into 400,000 pounds of table bases and 6,000 tons of reinforcing rods. At least 60 pellets were pounded into the streets of Juárez and the road to Chihuahua. Almost 1,000 were pulverized into the floors of the two foundries and the dirt of the scrapyard, dusting the piles of car bodies and broken refrigerators. About 900 were rolling around the back of the white pickup when the tow truck hauled it away, each radiating 22 roentgens two inches away.

It's fair to say that nothing like this has ever happened before. Never have so many people been exposed to so much radiation over so long a period of time by such a peaceful instru-



ment of atomic energy. There are, however, a few earlier episodes that have something in common with the Juárez spill.

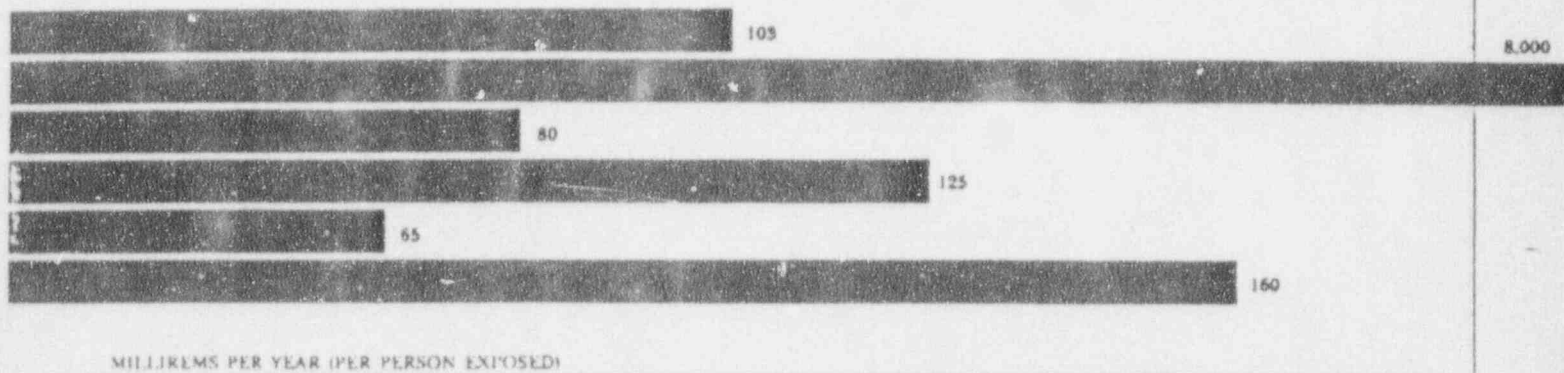
This is not the first time, for instance, that a foundry has accidentally cranked out radioactive products. Like many such plants, the Auburn Steel Company in Auburn, New York, has a radiation gauge to measure the thickness of the steel they produce. The device consists of a small source of radioactivity on one side of the assembly line and a detector on the other; when the steel is too thick, it prevents the radiation from reaching the detector. In February 1983, Auburn Steel's gauge went haywire. The radiation safety officer brought in a radiation detector and discovered the steel itself was radioactive. Somehow, as in Juárez, cobalt-60 had gotten mixed in with the scrap used to make the steel, and the gauge was picking up that radiation. But unlike the Mexico incident, the source was never found.

In 1954, the Marshall Islanders,

Everyday radiation

This year, each person in the United States will receive an average of about 80 millirems of radiation from natural sources and about 100 millirems from man-made sources. But individual doses can vary widely. For example, residents of Denver are exposed to more radiation—from cosmic rays, because of the elevation of the city, and from the high uranium content of the soil—than those of Chicago or Miami. Frequent air travelers also get more cosmic radiation; a flight from Los Angeles to Paris delivers about five millirems. Medical technicians accumulate about three times the dose of an average patient. And many everyday objects contain radioactive substances; there's americium in some smoke detectors, radium or tritium in clocks, polonium in tobacco, and uranium or thorium in brick houses.

*These are doses for specific parts of the body only: For TV, it's the testicles and ovaries (ovaries are shielded inside the body); for cooking gas and tobacco, the lungs; for medical X rays, the bone marrow.



dusted by an unexpectedly long plume of fallout from an atomic test at Bikini Atoll, got about the same dose as that estimated for many of the people in Juárez. In a group of 86 islanders that received an overall dose of 69 to 175 rems, one has since developed leukemia and about 25 percent seem to have malfunctioning thyroid glands, leading to thyroid cancer in four and to stunted growth in others. But the Marshall Islanders' thyroid problems are a result of the radioactive iodine in the fallout, which seeks out that gland. And the islanders received their doses over a period of about 36 hours, not two months.

The accident that the Juárez spill most often calls to mind also occurred in Mexico. In 1962, a Mexican boy picked up a radiographer's slender pencil-shaped tool, which contained the radioactive element iridium-192, and stuck it in his back pocket. Radiographers use such tools to examine pipe welds. They dangle it down a pipe and wrap the pipe with film, and weak places in the welds show

up as dark spots on the film. (These devices still account for up to 70 percent of all reported radiography accidents.)

During the day, the boy and his sister played with the gadget, and at night, it stayed in his jeans that were hung over a chair near their bed. When he developed radiation burns about three weeks later and went to the hospital, his mother found it in his jeans and put it in a glass on the kitchen shelf. He died first, then his mother, his sister, and finally his grandmother, who had moved in to take care of the sick family. But his father, who worked during the day and apparently wasn't home much at night, lived.

When the health officials figured out what happened, they kept track of the father for nine years until he changed his name and moved away. He was exposed to about 1,000 roentgens in 15 weeks, at the rate of nine to 16 roentgens a day. At first his immune system suffered some and he was a bit anemic, but he had no other untoward effects in nine years. Until then, scientists had never thought a

human could absorb so much radiation and live.

It's only from incidents such as these, as well as from the copious studies on the survivors of the atomic bombs dropped on Hiroshima and Nagasaki, that scientists have some idea what happens to a human exposed to nuclear radiation. They know, for example, that when radiation penetrates human tissue, it knocks electrons off some molecules or splices them onto others. Proteins are cleaved when an electron breaks the peptide bonds between their amino acids. Even cellular components that escape a direct hit may later be attacked by the charged molecules created when radiation splits a water molecule. If radiation strikes the twisted ladder-like molecules of a cell's DNA, it can knock out half a rung, cause adjacent rungs to cross-link or cut through both of the long side pieces, chopping the molecule into bits. Cells caught in the act of division are especially vulnerable; the biochemical preparations for division are disrupted and the deli-

Carmen Persabal, who lives on the street where the radioactive truck was parked, got one of the largest doses of radiation.

"The public health officials came to my house. They asked about my nails, and I said they were fine. Then they looked at my nails and they were black, and I hadn't even noticed."

care scaffolding that holds the chromosomes is destroyed.

Death may come to the cell when so many of its vital molecules are rendered useless that it can no longer function or repair itself. But more likely, a heavily irradiated cell will die when it tries to divide, its DNA so mangled that it can't complete the process.

It's the special weakness of dividing cells that causes the symptoms of radiation sickness. White blood cells, for example, are replenished by the constantly dividing cells of the bone marrow. When those vulnerable cells are killed by radiation and the white blood cells in circulation die after their normal lifetime of eight days, the result is the characteristic drop in the white cell count, leaving the victim susceptible to infection. The death of the bone marrow cells also cuts off the resupply of platelets, the short-lived cells that aid in clotting. That causes nosebleeds and bleeding gums. If the bone-marrow destruction is extensive enough, the victim will eventually become anemic as the red blood cells reach the end of their 120-day lives and aren't replenished.

The blood cells are among the most sensitive of any in the body; a dose of 20 rems can cause a drop in the white blood cell count. The cells lining the intestine, which also proliferate rapidly, begin to die in large numbers at a dose of about 200 to 300 rems. Without these specialized cells, the victim can't absorb food or liquids; he vomits and has diarrhea and may hemorrhage or develop intestinal infections. At truly massive doses, however, at about 5,000 rems or more, the central nervous system fails before these other symptoms have time to develop. Some of the nerve cells are just stopped in their tracks.

All of these, of course, are the immediate effects of a large, instantaneous radiation exposure. It's the long-term effects that stump the scientists. And they know the least about the long-term effects of prolonged exposures like those in the Juárez incident.

One long-term effect may be cancer. Twice as many atomic bomb survivors have died from leukemia as in a similar group of unexposed people. Among 571

Massachusetts women who received an average of about 250 rems over a period of days to weeks for inflammation of their breasts, twice as many developed breast cancer as did those in a control group. Their dose was comparable to that received by some of the Juárez women living nearest the truck. The thyroid gland, the lungs, and the colon also seem particularly sensitive to the cancer-causing effects of radiation.

A person who gets repeated low doses of radiation is just as likely to develop cancer as someone receiving the same amount in a single high dose. High doses may kill the cells outright, but cells that incorrectly repair the damage caused by low doses—particularly in their chromosomes—may trigger the process that later leads to cancer. The best the scientists can do is estimate the risk of cancer—for example, in a group of people who each receive a tenth of a rem more than the natural background level every year for life, there will be about three percent more deaths due to cancer.

As for inherited mutations, animal studies clearly show that such mutations can occur when radiation-damaged chromosomes in the eggs or sperm are repaired improperly and passed on. But so far, there's no sign of them in humans, even among children of the atomic bomb survivors.

There are a few other delayed effects that may be associated with radiation exposure. A dose of 600 to 900 rems to the eye sometimes leads to cataracts. In some studies, large doses of radiation appear to cause the walls of the small arteries to thicken. A few scientists believe radiation can cause what they call life-shortening, meaning they don't understand how or why, but in some studies, irradiated animals just die sooner than they ought. To put it callously, not enough people have been exposed to radioactivity and been studied long enough for researchers to know all the problems that can develop.

This means that no one can say anything very definitive about the fate of the people in Juárez. All the scientists can do now is tally what happened to them.

Yonke. Fenix workers Pedro Torres, 29, and Agustín Villanueva, 17, are both

sterile, possibly permanently. They felt a bit nauseous for a while, developed blisters on their feet, and had some trouble with bleeding gums and nosebleeds, but all that went away. Carmen Persabal and her neighbor had black fingernails for a time, the result of radiation-induced overproduction of pigment in their nailbeds. Ricardo Hernandez, Sotelo's companion, had a nasty radiation burn on his palm where he grabbed the wheel. Sotelo, surprisingly, is fine; the Mexican press has called him the Bionic Man. Eight of the scrapyard workers, according to Hector Iturriga, a government doctor in Juárez who treated them in January, had very low numbers of white blood cells, platelets, and red blood cells. Five recovered after one week, he says, but recovery took 45 days for another and 60 days for the other two—Torres and Villanueva.

What happens later on depends on how much radiation these people got and how quickly. For example, a young person who receives a 100-rem dose all at once may have some symptoms of radiation sickness, as well as a one-in-250 chance of later developing leukemia, a risk about 15 times higher than normal. A 100-rem dose spread over a few months might not cause any acute symptoms, but the person would probably have the same risk of developing cancer.

Gayle Littlefield and coworkers at Oak Ridge Associated Universities have analyzed blood samples from 10 of the victims to estimate their doses. Examining the white blood cells, they count the number of abnormal chromosomes called dicentric. These abnormalities are caused only by radioactivity and two relatively rare chemicals. Using data from previous experiments in which cells are exposed to known doses of radiation at known rates, Littlefield can figure out the dose that would produce a given number of dicentrics.

According to Littlefield's analysis, a single dose of 10 to 70 rems would have produced the number of damaged chromosomes found in six of the 10 people. Among the other four, Pedro Torres would have gotten the worst one-time dose, 203 rems; Villanueva 151, Sotelo 123, and Persabal 139.

On the outskirts of Juárez, the hospital's Datsun pickup awaits burial. Its windows are shattered, its doors and hood are covered with radiation warning stickers, and its bed is filled with concrete to block the radioactivity from the cobalt-60 pellets it still holds.

If, however, their exposure was continuous at an extremely low rate for seven weeks, Torres would have accumulated 1,530 rems, Villanueva 880, Sotelo 611, and Persabal 752. Either of these extremes puts those four with the highest doses in the leukemia risk range.

The truth of their exposures probably lies somewhere in between. And that's exactly what the researchers involved with the accident would like to find out. Juan Rauda, who was director of the public health service in Juárez at the time of the accident, located and examined 193 people who lived close enough to the truck to have accumulated a sizeable dose. He also began reconstructing the movements of those people during December and January to get a better idea of how long they were actually exposed. Clarence Lushbaugh, from Oak Ridge Associated Universities, and Zolin Bursin, a radiation consultant from a Las Vegas firm, are proposing a reconstruction of the accident, using a much less potent source of radioactivity, to figure out how much shielding the buildings gave their occupants. It may also be possible to estimate this shielding effect by measuring the radioactivity absorbed by the brick of the houses. The Mexican health officials plan to begin long-term studies on the Juárez victims sometime this fall.

On Aldama Street, you can still pick up a lot of rumors about the accident. "A middle-aged woman down the street died from dehydration. A man on TV said it was from the radiation. Two guys went and got tires from the junkyard where it happened and died from walking around on the dirt," says one man, who nevertheless claims that he's not worried.

Carmen Persabal doesn't seem to be worried either. She rests in the shade of the lone tree and goes to the public health service periodically. "I'm 65. I'm too young to die," she says laughing.

The Centro Médico officials have fired Vicente Sotelo, claiming he broke into the warehouse and stole the tungsten wheel. This summer his neighbors finally began speaking to him again. His friend

Hernandez still has his job because the hospital administrators believe he was Sotelo's dupe.

Roberto Treviño's nuclear safety commission is having a tough time finding a dump site that the public will accept. Officials from the state of Chihuahua, with the commission's help, were supposed to find a suitable location by the end of September.

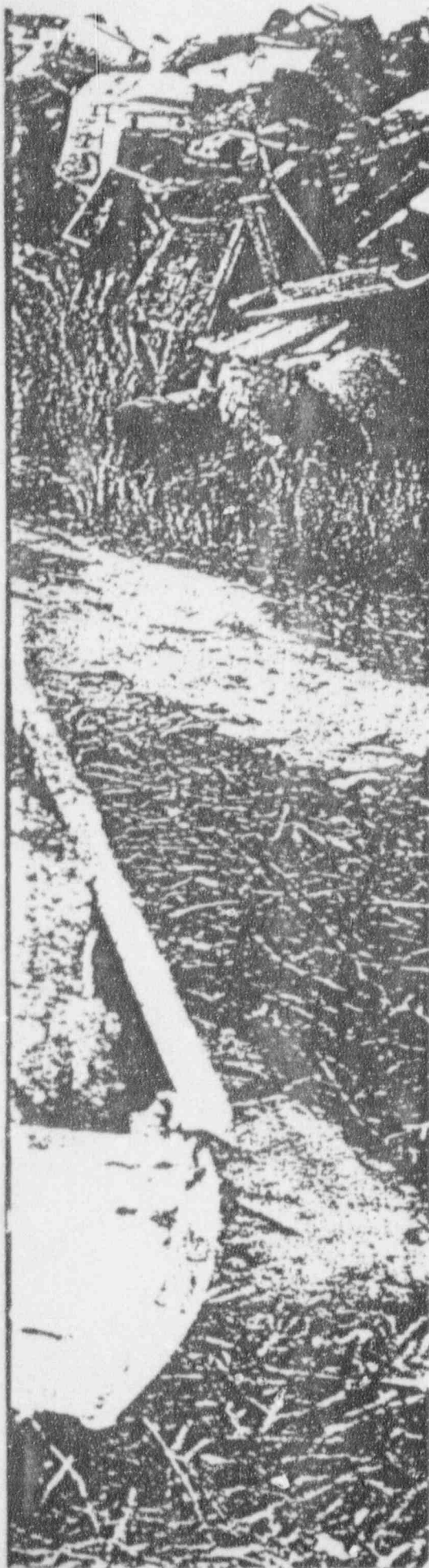
All this time, Falcon Products' table bases, the contaminated scrap from Yonke Fénix, about 600 barrels of radioactive soil, the cobalt-60 wheel returned to its shielding head, and the forlorn Datsun have been sitting in a temporary dump outside the city of Juárez. No one has patrolled it. No signs have denoted the invisible danger. Sections of the barbed-wire fence around it have been pushed down.

The reinforcing rods have been in Chihuahua awaiting burial, and the Aceros foundry has resumed operation. Contaminated rods had to be retrieved from about 20 buildings in Mexico and about 10 structures in the U.S., including two houses in New Mexico that had to be jacked up to have rods ripped from their foundations. The U.S. has now equipped every border entry with a radiation monitor, just in case some of the rods are still loose in Mexico.

Falcon Products has installed radiation detectors, and their workers now check all the scrap they receive and everything that leaves the Juárez foundry. In St. Louis, they monitor every base that comes in and goes out, stamping it "Certified Free of Contamination" before it's shipped.

Falcon's president Frank Jacobs is worried that this accident wasn't just a fluke. "In the last four or five years," he says, "a lot more of this equipment has been exported from the U.S. One day it will come back in another form, and we will have one heck of a problem."

The Nuclear Regulatory Commission is worried, too, and it seems they have reason to be: On August 30, the California regional office of the agency got a strangely familiar call. A plumbing supply company in Valencia had gotten some fittings, made in Taiwan, and contaminated with cobalt-60. ■





POLICY ISSUE (Information)

November 29, 1984

SECY-84-452

For: The Commissioners

From: William J. Dircks
Executive Director for Operations

Subject: CONTAMINATED PIPE FITTINGS DISCOVERED AMONG STEEL
CASTINGS IMPORTED FROM TAIWAN

Purpose: To inform the Commission of the events and regulatory responses related to the contaminated pipe fittings discovered among steel castings imported into the United States from Taiwan.

Summary: GA Technologies at La Jolla, California, detected radioactivity in a pipe tee purchased at a local hardware store. Subsequent checking by Agreement States, NRC Regional Offices, and Headquarters staff showed that shipments of pipe fittings containing small amounts of cobalt-60 originated from a manufacturer in Taiwan. The contaminated fittings were made from a single batch of steel; later batches showed no trace of contamination. Unsold fittings were located at several suppliers in the United States; all had surface radiation levels below 0.08 mr per hour and cobalt-60 content below one nanocurie per gram. The staff concluded that these low levels posed no threat to public health and safety and that no regulatory action was required.

Background: On Wednesday, August 29, 1984, health physicists at GA Technologies (GA), La Jolla, California, detected radioactivity in an unused pipe tee during a routine check to clear the tee for release to unrestricted areas. The radioactivity was tentatively identified as cobalt-60 and the surface radiation level was measured as less than 0.2 mr per hour (later measured more accurately as 0.05-0.07 mr per hour). GA reported the contamination to the California Radiation Control office, which in turn reported it to the Region V office of the Nuclear Regulatory Commission.

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Discussion: California State inspectors found no additional contaminated pipe fittings at the local hardware store where the tee had been purchased, but located and embargoed 23 boxes of contaminated fittings (100 tees and lock nuts per box) at the wholesale supplier in Valencia, California. The fittings were found to have been imported from Taiwan. Samples were sent to the California Department of Health laboratory for analysis. The analysis confirmed that the radioactivity was cobalt-60, with no other radionuclide present, and that the concentration of the contaminant was less than one nanocurie per gram (0.21 nanocuries per gram in the highest reading sample). The highest radiation reading of a sample was 0.08 mr per hour.

The NRC staff notified the U. S. Department of State and the U. S. Customs by telephone concerning the detection of cobalt-60 contamination in pipe fittings imported from Taiwan. They were advised that the level of contamination was very low and did not appear to pose a threat to public health and safety. Both agencies indicated appreciation for being informed but stated that they planned to take no action. The staff also notified the Department of Energy, the Federal Emergency Management Agency, the Environmental Protection Agency and the Department of Health and Human Services of the occurrence of the incident.

Information obtained by telegraph from the Taiwan Atomic Energy Council disclosed that the pipe fittings had been manufactured by the Taiyang Company in Taiwan during the period from January 27 to February 8, 1983. The Taiwan laboratory analysis of contaminated steel pieces showed 0.15 nanocuries per gram in the highest sample, with a surface radiation level of 0.10 mr per hour. Their analysis of the incident led them to estimate that a 10 to 20-millicurie source of cobalt-60 had been melted with 76.8 tons of scrap steel in a single batch and cast into products, including the pipe fittings exported to the United States. The Taiwan Atomic Energy Council reported that the steel melting furnace showed no contamination upon inspection, and fittings manufactured after March 1983 were not contaminated. Sales records showed that export shipments which may have contained some of the contaminated fittings were sent only to two United States distributors, one in Valencia, California, and the other in Sharon, Massachusetts.

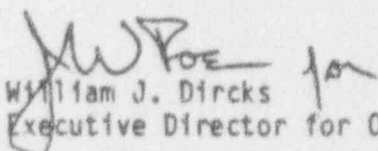
The U. S. distributors identified customers who made purchases of pipe fittings of the type found to have been contaminated with cobalt-60. NRC Regional Offices conducted inspections of these and found contaminated pipe fittings in several locations. All had radiation levels below 0.08 mr per hour at the surface, and the cobalt-60 content of all samples was well below one nanocurie per gram.

The maximum radiation dose that any person would be likely to receive from being in close proximity to a place where the pipe fittings were stored, or installed in a plumbing system, was calculated to be several orders of magnitude below the maximum level of radiation (500 mrem per year) recommended for exposure of the public by the International Commission on Radiological Protection (ICRP) and permitted by 10 CFR Part 20, and also far below the 100 mrem/yr average annual dose recommended by the ICRP.

A second potential source of radiation exposure was that from the leaching of the cobalt-60 into drinking water. This potential source was evaluated by noting that the total quantity of cobalt-60 in a tee was only about one tenth of the occupational maximum permissible body burden. Any leaching of cobalt-60 that occurs in a plumbing system would likely involve only a very small fraction of the cobalt-60 over a long period of time. Even if several fittings were used in a single run of pipe, there would be virtually no risk that the maximum permissible body burden would be exceeded.

The calculated, theoretical, maximum exposure to any individual possessing one or more contaminated pipe fittings is very low and constitutes no significant risk to the general public or to the maximally exposed individual. Accordingly, the staff concluded that there is no threat to public health and safety, and therefore, no regulatory action is required.

Noting that unnecessary exposure to radiation should be avoided, if practicable, unless there is a resulting benefit, the staff suggested to possessors of the contaminated fittings that they arrange to return them to their supplier or to the manufacturer in Taiwan in exchange for new, uncontaminated fittings. The distributor in Valencia, California, has indicated a willingness to make such exchanges for their customers and return the contaminated fittings to Taiwan.


William J. Dircks
Executive Director for Operations