# Preventive Measures for Radioactive Contamination in Iron and Steel Used as Construction Materials.

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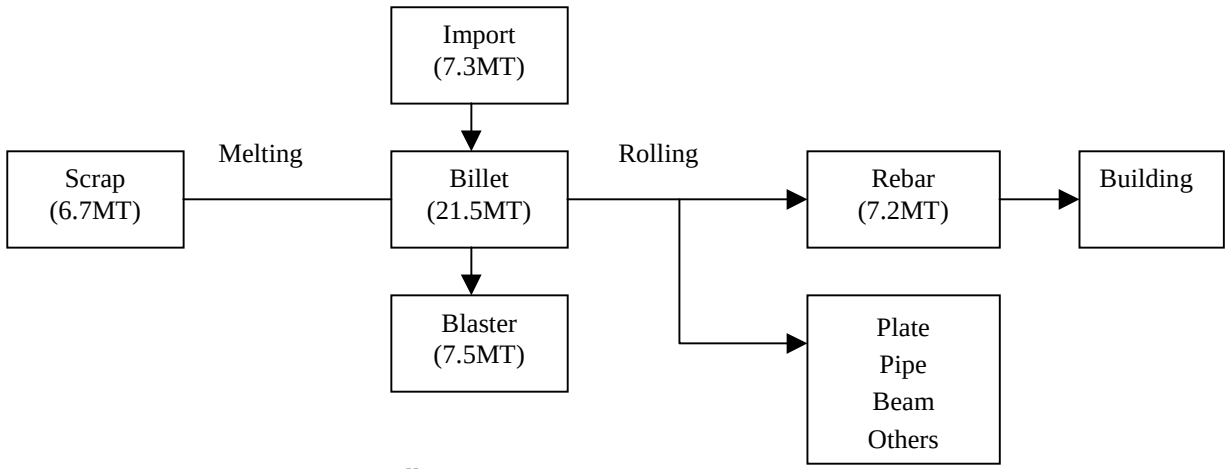
At the end of July 1992, Atomic Energy Council (AEC) received tips-off from Taipei local residents, saying some buildings in Taipei had their rebar been contaminated by radioactive materials. Regarding causes and sources of those radioactively contaminated rebar, views from every aspects were pointing toward that scraps mixed with radioactive source smelting in the steel mill as the most possible reason. After investigating houses and constructors, AEC found that most contaminated buildings were constructed during the period of 1982 and 1984. For protection of public rights, AEC then actively undertook nation-wide survey of more than forty thousand buildings constructed between 1982 and 1984. Thermal Luminescent Dosimeters (TLD) and house by house surveying were major methods to investigate houses contamination. Finally, It was found that radiation contaminated houses are concentrated in Taipei City, Taipei County, Tauoyen County, Keelung County. According to data collected up to December 31 1999, there were 180 cases, with a total of 1601 contaminated housing units. Based on information data of dose assessment, distribution of annual dose are as the following: higher than 15 mSv -143 housing units (9.21%), 5~15 mSv -117 housing units (7.53%), less than 5 mSv -1293 housing units (83.26%)(1).

Except actively conducting remodeling of contaminated houses and granting compensation to house owners, AEC has established following measures to prevent rebars from being radioactively contaminated. (1) Radiation detection training of iron and steel detectors (2) Strengthening controls over radioactive sources (3) Enforcing examination of radioactive levels for imported rebars (4) Requesting domestic steel companies establish radiation detection capability (5) Promoting installation of portal type radiation detectors for steel companies having smelting furnace (6) Enforcing no-radioactive contamination certificate system.

The radiation detection training of iron and steel detectors began in middle January 1995, there were 10,395 people finished training in the end of December 1999. There have been 163 iron and steel companies certified by AEC as having radiation detection capability since AEC assisted them to set up such capability in 1993. There is only one mill which having melting furnace but has not installed portal type detector. As end of December 1999 iron and steel mills had discovered 20 cases of foreign and 33 cases of domestic radioactive sources and radioactive substances in scraps since abnormal radioactive scrap was first found in June 1994, and successfully prevented radioactive substances from going into furnace. Those measures ensure that the rebars used for construction are free from radioactive contamination and protects as well as the safety of living environment for the public.

## INTRODUCTION

There are two major methods producing iron and steel in Taiwan, Electric arch furnace is one of methods, using scrap for melting to produce iron and steel. Another method, blast furnace is using ferrous ore to produce iron and steel. Due to no deposit ferrous ore in Taiwan, all of the ferrous ore need to be imported. Scraps used for melting mostly come from domestic market. Average production and consumption of rebars for the past five years (1994~1998) are shown as figure 1, The imported billet is the average of the past two year (1997~1998). About thirty-four percent billet come from alien countries. About 33% of the billet are rolled into rebars for building construction (2).




*MT: Million tons

Figure 1.Rebars produce and consumption profile

AEC has established measures to prevent rebars from being radioactively contaminated since the disclosure of radiation rebars in 1992, There are six main measures as shown in figure 2. These measures are described in follow paragraphs.

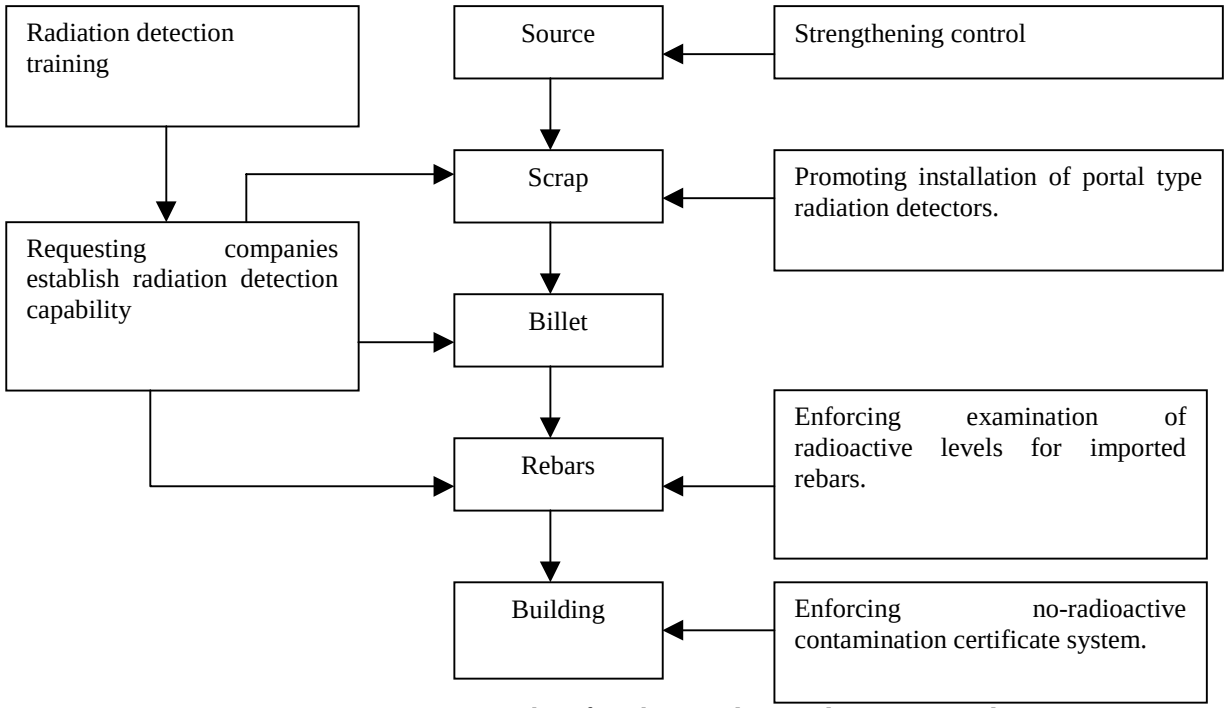



Figure 2. Measures to prevent rebars from being radioactively contaminated.

## RADIATION DETECTION TRAINING OF IRON AND STEEL DETECTORS

Radiation detection of iron and steel requires personnel well trained in the following aspects. They include (A)basis course: (1)introduction of radiation (2)environmental radiation (3)radiation biological effect and radiation protection.(B)radiation measurement: (1)radiation dose and unit (2)radiation detection principle and

instrument (C)introduction of radiation detection related laws and regulations : (1)regulations for prevention and treatment of radiation contaminated buildings (2)guideline for identification of iron and steel products contaminated by radioactive materials (Drafts) (3) no-radioactive contamination certificate system. (D)practice of exercising of radiation detection. The training program began on June 1993. AEC sends senior members as instructor to train government officers and building construction people in iron and steel mill operations etc. About 4000 people had been trained and get qualified certification until end of 1995. AEC has released training work to qualified institute since January 1995, There were 14 training institutions, and 10395 people finished training up to the end of December 1999. As the regulation, The effective period of qualified certification is 5 years. The refreshing training course has been offered since November 1999.

## STRENGTHING CONTROLS OVER RADIOACTIVE SOURCES

To fully implement controls over radioactive sources, AEC, by law, entitled for control of radioactive sources produced or used in domestically, has established computerized system to strengthen management. For all enlisted radioactive sources, AEC requests all radioactive sources utilizing units to submit report to AEC on safety status of each radioactive sources semiannually, and conducts routine and non-routine radiation safety audits. For the implementation of management radioactive sources of military use, AEC and Ministry of National Defense have jointly promulgated “Management regulation over radioactive sources and equipment's capable of producing ionizing radiation in military institutions and their affiliates”. In addition, AEC is now establishing computer link system with customs office and import-export companies to accurately control the status of imported or exported radioactive sources.

## ENFORCING EXAMINATION OF RADIOACTIVE LEVELS FOR IMPORTED REBARS

AEC, in coordination with Commodities Inspection Bureau (CIB) has imposed radiation level checkup for imported rebars from October 1, 1993. CIB added radiation level detection to their inspection list for imported items and sent the checkup result to AEC monthly. The bureau has taken this to be one of their routine works. The major harbors for imported rebars in Taiwan are Keelung Harbor, Taichung Harbor,and Kaoshium Harbor. As of December 1999, a total of 123 lots of rebars had been reportedly imported. Total weight was 203,335.535 tons as shown in table 1, and no signs of radioactively contaminated materials have been found. The imported rebars are mostly used for special purpose, such as resistant to corrosion, high stress etc.

| Year | Lots | Quantities(Ton) |
|---|---|---|
| 1993 | 32 | 99822.35 |
| 1994 | 30 | 81851.95 |
| 1995 | 4 | 553.983 |
| 1996 | 9 | 1059.62 |
| 1997 | 12 | 1410.81 |
| 1998 | 20 | 7233.67 |
| 1999 | 16 | 11403.152 |
| total | 123 | 203,335.535 |

Table 1. Import rebars

## REQUESTING DOMESTIC STEEL COMPANIES ESTABLISH RADIATION DETECTION CAPABILITY

Construction steel materials, such as rebar used in the buildings come from steel companies. To prevent radioactive rebar contaminated buildings from occurring again, AEC has actively requested domestic steel companies to establish radiation detection capability. Each steel company is asked to make radiation level detection for incoming raw materials, outgoing steel products, and during production process in its steel plant. Starting from July 1993, AEC has helped domestic steel companies establish radiation detection capability. There were three stages in enforcement. The first stage was with the help from AEC. Till the bottom of June 1994 there were 66 steel companies having been certified by AEC as having acquired such capability. But due to limited man power resource and tight schedule for AEC personnel, AEC had entrusted Radiation Protection Association (located in Hsin-Chu) to review and help the establishment of such capability for steel companies. Till July 31, 1995, there were 114 steel companies having past the test. Also AEC had drawn up “certification and management guideline for Steel companies' radiation detection operations”, which was promulgated on August 18, 1995. It demands that, in order to establish radiation detection operation system, steel companies should first contact AEC-accredited radiation protection service companies for help. Then those companies should ask AEC for audit and award of a certificate. For those steel companies having awarded certificates, AEC sends person to check if they have fully implemented radiation detection system. The third stage started from August 1995. According to this newly promulgated guideline AEC undertook audits until November 20,1996

when this guideline had been amended. The amended guideline requires that steel companies after having been certified by AEC, should regularly contact AEC-accredited radiation protection service companies for checkup and send up result to AEC for approval. Also, in this amended guideline, AEC requested steel companies having smelting furnace but no portal type radiation detectors should be checked by an AEC-accredited radiation protection service company annually. For those steel companies having no smelting furnace or having smelting furnace and portal type radiation detectors, AEC requested that they be checked by an AEC-accredited radiation protection service company biannually. For those steel companies having their radiation detection operations been integrated into their quality assurance systems as well as accredited by ISO (International Standardization Organization) and, also having sent aforementioned information to AEC for approval, checkup interval could be extended one more year. Up to now, there are 163 steel companies having their radiation detection capabilities have been certified by AEC.

## PROMOTING INSTALLATION OF PORTAL TYPE RADIATION DETECTORS FOR STEEL COMPANIES HAVING SMELTING FURNANCE

Steel industry is one of the most fundamental industries for a country. It has widely related industries accompanying with it and is placed highly in the contribution to economic growth. They use blast furnaces or electric arch furnaces in producing process. At present, Taiwan has China Steel Company using blast furnaces. Their main source materials are ferrous ores. Electric arch furnaces use scraps as their main raw materials. They use electric arches to produce high temperature to melt scraps into steel. Between 1994 and 1998 scrap purchased through imports and domestic market amounted about 6.7 million tons annually in Taiwan, as show in figure 1. Seventy-eight percent scraps came domestically, and twenty-two percent scraps came through imports. 13% of those scraps were used in blast furnaces, the rest eighty-seven percent were used in electric arch furnaces. In recent years there is large increase in steel consumption rate while with low supply rate domestically, which prompts steel companies to expand their production capabilities. Increase in production makes increased demand for the supply of source materials especially the scraps.

Taiwan is a free-trading country. Scraps from all over the world can be exported into Taiwan. Imported of scraps were mainly from countries with long history of steel consumption and large steel consumption rate in the past. Those countries include U.S., South Africa, Australia, Independent States, Eastern Europe, etc. At present, Taiwan has 25 steel mills with electric arch furnaces, which use scraps to produce construction steel materials. In which, twenty-four mills have already installed portal type radiation detectors, which can detect radiation levels of incoming source materials and outgoing steal products to assure the radiation safety of steel products. Since the beginning of establishment radiation detection operational capabilities in steel plants from 1993, there were 53 cases of finding radioactive sources or radioactive materials in scraps as shown in Table 2. These radioactive sources and materials were detected with portal type radiation detectors. In view of this, AEC then actively promoted the installation of portal type radiation detectors in steel plants. To facilitate steel companies, especially those with electric arch furnaces, to installing portal type radiation detectors, AEC promulgated “Encouragement guideline for establishment of portal type radiation detectors in steel companies”, as free tax ,providing citation ,etc.,on March 31,1998.

| Nuclide | Domestic | | Import | | Remark |
|---|---|---|---|---|---|
| | Case | Material | Case | Material | |
| Co-60 | 1 | Grain $4.53\times10^{7}\pm5.17^{4}$Bq/g. | | | |
| Cs-137 | 3 | Source(0.5Ci,1.5Ci,2-50mCi) | 1 | Source (Cs-137 0.75 mCi and Am-241 0.5 mCi) | |
| Kr-85 | | | 1 | Source(0.12Ci) | |
| Ra-226 | 8 | Pipe, switch head, socket connector, fitting, plate, reflection button, | 15 | Iron piece, aluminum rod, graphite casting, fitting, pipe, valve, level gauge,foil | |
| Uranium | | | 1 | Angle metal | |
| Thorium | 1 | Rod | | | |
| NORM | 3 | Pipe, plate, soil | 1 | Pipe | |
| Mixed with Co-60 | 15 | Rebar, rod, plate | | | |
| Contaminated Co-60 | 1 | Circle cast metal | | | |
| Contaminated Cs-137 | 1 | plate | | | |
| unknown | | | 1 | Stainless steel scrap in container | Return |

Table 2. Discoveries of radioactively in scrap

## ENFORCING NO-RADIOACTIVE CONTAMINATION CERTIFICATE SYSTEM

As from July 1, 1995, Taiwan has implemented no-radioactive-materials-contamination certificates system. For all rebar and steel used in construction of buildings, constructors and supervising bodies shall jointly submit no-radioactive-materials-contamination certificates to Buildings Construction Supervisory Institutions for review. There are three formats of no-radioactive-materials-contamination certificates. Format (1) is issued by AEC certified steel companies, Format (2) is issued by AEC-accredited radiation detection companies, Format (3) is issued by constructors, contractors or supervising bodies. Since the start of enforcing no-radioactive contamination certificate system, there has been no cases of radioactive being reported to AEC from Buildings Construction Supervisory Institutions in every counties or cities across Taiwan.

## CONCLUSION:

Regarding handling and mediation of radioactively contaminated buildings, AEC has allocated resources and established “Preventive and Handling Measures for Radioactive-Materials-Contaminated Buildings Incident”. There are many measures undertaken by AEC to prevent construction materials from being contaminated by radioactive materials as the installation of portal type radiation detectors. This can prevent radioactive materials from entering mill process, forestalling production of contaminated steel. In production process, sampling are taking for detection of radiation level in each batch to ensure radiation safety of the products. Building contractors in accompany with constructors and supervising bodies shall submit no-radioactive-materials-contamination certificates to Buildings Construction Supervisory Institutions on their field-inspections of buildings under construction. Buildings Construction Supervisory Institutions are supposed to conduct field-inspections any time. These constitute a tight preventive system for steel materials used in building construction; i.e., from the source materials to finished products. This enables newly constructed buildings no longer being contaminated by radioactive materials.

Article 7 of ROC’s Consumers Protection Law states “Business operators engaging in designing, producing, manufacturing consumers’ products or providing services should ensure the safety, hygiene of their consumer products or services”. Article 4 of consumers Protection Law’s enforcement guideline says, “Consumer products as quoted in Article 7 of this Law, refer to commercial transactions of personal properties, which include finished products, semi-finished products, source materials and spare components.” Therefore, buildings can be regarded as consumer products. So building related businessmen should ensure radiation safety of buildings they constructed, or they will face legal penalties.

## REFERENCE:

1.Communication by private.
2.Taiwan Steel and Iron Industries Association, Steel Statistics Monthly, December 1999.