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Dr. Carl Feldman
Chemical Engineering Branch
Office of Nuclear Regulatory Research
U. S. Nuclear Regulatory Commission
5650 Nicholson Lane
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Dear Carl:

Enclosed is a general paper on the risks associated with recycling of decommissioned materials. Our analyses indicate that the risk to individuals and populations from these recycled materials is no greater, and probably smaller, than that associated with a 10 mrem/yr ALARA decommissioning criteria for nuclear facility sites. Therefore, the practice of recycling seems to be acceptable from a health effects standpoint. One could probably make a case for reducing total potential fatalities by recycling due to the energy savings and its associated risks. The study on recycle of enrichment facility scrap metals (NUREG-0518) indicates that 1×10^9 megajoules of energy (equivalent to 170,000 barrels of oil or 30,000 Mg of coal) is saved. Thus, potential health effects from this energy production are avoided.

I hope the enclosed analysis is useful. Please let me know if you have any questions or comments on the material.

Sincerely yours,

John

John P. Witherspoon
Technology Assessments Section
Health and Safety Research Division

JPW:wm

Enclosure

RECYCLE RISK OF DECOMMISSIONED MATERIALS

During decommissioning of nuclear facilities, some contaminated materials may be released for potential recycle to the public sector. The primary technical concern in the recycle of these materials is that the public health and safety must be protected in the manufacture and use of consumer products made from slightly contaminated metals. The magnitude of the recycle problem is believed to be small. For example, the total amount of scrap metal potentially available from a PWR decommissioning (reactors have more recycle metal available than do other nuclear fuel cycle facilities) is about 4000 Mg. This quantity represents a few tenths of one percent of the total metal produced annually in the United States. Nevertheless, it is necessary to estimate the risk associated with recycling scrap metals to determine the acceptability of the practice.

Two studies which give comprehensive analyses of recycle of metals from reactors[1] and DOE diffusion plants[2] are available. Both of these studies estimate the potential radiation doses to individuals and populations from the smelting of scrap metals and from the manufacture and use of consumer products composed of contaminated metals.

The study on recycle of decommissioned reactor metals[1] (NUREG/CR-0134) is general enough in the treatment of residual radioactivity contaminants to encompass a broad spectrum of nuclear facilities. The contaminated levels used in this study are consistent with 10 mrem/yr ALARA levels for surface contaminants prior to recycle considerations. In other words, the metals proposed for recycling and use in consumer products are not contaminated to a degree greater than that proposed to be acceptable for unrestricted use on site following decommissioning.

Radiation dose estimates to individuals and populations were based on integrated doses over a period of manufacture and 30-year life of consumer products made from contaminated metal scrap. No credit was taken for dilution or scavaging processes which would surely reduce contamination levels prior to their incorporation into consumer products. The study estimated a total population dose of 30.7 person-rem for a 30-year recycle of 90 Mg of reactor scrap metal. Since 4000 Mg has been cited as an upper limits of available scrap metal for a PWR, 1365 person-rem (total-body dose) may be considered as an upper limit of potential population dose. At a rate of 100 fatalities (cancers) per 10^6 person-rem,[3] 0.14 fatalities might be associated with recycling metals from one reactor site. The highest estimated dose to an individual using a consumer product from recycled reactor scrap was 14 mrem (over a 30-year period) which represents an individual risk of 1.4×10^{-6} (fatality risk of total body radiation is 10^{-2} per 100 rem as given in ICRP 26).[4]

For comparison, the 10 mrem/yr ALARA criteria for unrestricted use of a decommissioned reactor site represents an individual fatality risk of 10^{-6} per year. For a population of 20,000 persons living on a reactor site for 50 years, about 0.2 fatalities are estimated if decay of ^{60}Co and ^{137}Cs are considered.

The study on recycling of enrichment facility metals[2] assumes that iron, copper and nickel metals are contaminated with 17.5 ppm uranium and 5 ppm ^{99}Tc prior to recycle. No credit is taken for dilution with non-contaminated metals in the manufacture of consumer products. A population dose of 80 person-rem (total-body) per year was estimated for the smelting of metals and manufacture and use of consumer products. The fatality risk associated with this dose is 8×10^{-3} per year or

0.4 fatalities for a 50-year period. The highest individual doses were 440 mrem/yr (22 rem for 50 years) to the bone surface for a steel bone pin containing ^{99}Tc and 290 mrem/yr (14.5 rem for 50 years) to the skin for a copper bracelet containing ^{99}Tc. These estimated doses to extremeties of the body do not represent a high risk of fatality. The risk of fatality from irradiation of the bone surface is 5×10^{-4} per 100 rem and that from irradiation of the skin is 1×10^{-4} per 100 rem (ICRP-26). Thus, the risk of fatality per year is 2.2×10^{-6} and 3×10^{-7} for the bone and skin irradiation, respectively. These risks are similar to the 10^{-6} per year risk to individuals exposed to a 10 mrem/yr ALARA residual radioactivity criteria suggested for use in decommissioning.

It is very probable that radiation doses and fatality risks presented here for recycled materials are overestimates. It is almost certain that contaminated metals would be diluted with non-contaminated materials prior to or during manufacture of consumer products. Moreover, the energy saved by recycling (1×10^{9} megajoules estimated for recycling diffusion facility scraps[2]) represents risks which would be avoided.

Based on these analyses, it appears that recycle of decommissioned materials, even with the potential for affecting larger populations than those at decommissioned sites, results in fatality risks that are no greater and probably lower. Thus, recycle seems to be an acceptable practice that is within the 10 mrem/yr ALARA site decommissioning criteria.

REFERENCES

1. F. R. O'Donnell, et al. Potential Radiation Dose to Man from Recycle of Metals Reclaimed from a Decommissioned Nuclear Power Plant. NUREG/CR-0134. 1978.
2. U. S. Nuclear Regulatory Commission. Draft Environmetal Statement Concerning Proposed Rulemaking Exemption from Licensing Requirements for Smelted Alloys Containing Residual Technetium-99 and Low-Enriched Uranium. NUREG-0518. 1980.
3. NAS/NRC. The Effects on Populations of Exposure to Low-Levels of Ionizing Radiation: 1980. National Academy Press. 1980.
4. ICRP. Recommendations of the International Commission on Radiological Protection. ICRP Publication 26, Pergamon Press. 1977.

7/15/82

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FROM: Carl Feldman

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Effective Rule (RM)		Petition (PRM)	
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		Federal Register Notice	46 FR 11666
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		NUREG Report	0586
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