APS

Angela K. Krainik
Director
Regulatory Affairs
Palo Verde Nuclear
Generating Station

Tel: 623/393-5421
Fax: 623/393-5442

Mail Station 7636
P.O. Box 52034
Phoenix, AZ 85072-2034

102-04432–AKK/SAB/RJR
April 19, 2000

RECEIVED IN
RULES AND DIRS BR.
MAY 4, 2000
9:30 AM

64FR#14952
29 March 99
(12)

Chief, Rules and Directives Branch
Division of Administrative Services
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Comments on "Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities", NUREG-1640 (FR Vol. 64, No. 59, Pg. 14952)

In the March 29, 1999 Federal Register (64 FR 14952), the NRC published for public comment NUREG-1640, "Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities". This draft report documents the technical basis for the NRC to use in developing regulatory standards for clearing equipment and materials with residual radioactivity from nuclear facilities. Since NUREG-1640 may be used to establish clearance levels, it could have a significant impact on PVNGS operations. The enclosed comments provide PVNGS' view of the problems in the design of the models and the assumptions used to determine these limiting clearance values.

In general, the comments focus on the models and assumptions used to determine the dose factors for each scenario presented. Of particular interest to PVNGS is the basis for the clearance values established in NUREG-1640 when compared to the basis used in International Atomic Energy Agency (IAEA) Safety Series No. 89, "Principles for the Exemption of Radiation Sources and Practices from Regulatory Control". IAEA Safety Series 89 recommends using the average dose to a member of a critical group. However, many of the clearance values established by NUREG-1640 represent the dose to a maximally exposed individual within a critical group. As a result, the clearance values proposed by NUREG-1640 are very conservative. This would render standard field instrumentation ineffective in detecting these clearance levels.

Template · ADM-013

E-RIDS= ADM-03
Add · Robert · Meck
(RAM 2)

No commitments are being made to the NRC by this letter.

Please contact Mr. Scott Bauer at (623) 393-5978 if you have any questions.

Sincerely,

Scott Bauer for AKK

AKK/SAB/RJR/ kg

Enclosure

cc: E. W. Merschoff
M. B. Fields
J. H. Moorman
L. Hendricks, NEI

ENCLOSURE

Comments on "Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities", NUREG-1640 (FR Vol. 64, No. 59, Pg. 14952)

Comparison with Other Agencies

<u>Section 2.2.2 Comparison with Environmental Protection Agency</u>
A comparison of NRC and EPA derived clearance values for steel recycling is shown on NUREG-1640, Table 2.4. The NRC value for Co-60 is 0.94 mrem/yr per pCi/g and the EPA value[(1)] 0.90 mrem/yr per pCi/g; hence, a ratio of 1.0 is listed. While this would appear to be in agreement, the values are for two different scenarios. The NRC value is based on a driver transporting scrap, and the EPA value is based on the end user operating a large piece of equipment. The EPA model for a driver transporting scrap yielded a value of 0.018 mrem/y per pCi/g. This produces an EPA/NRC ratio of 0.02 for transporting scrap which indicates the level of agreement stated on NUREG-1640 Table 2.4 does not hold true for specific scenarios.

<u>Section 2.2.4 Comparison with International Atomic Energy Agency</u>
A comparison of derived clearance values with those listed in IAEA-TECDOC-855[(2)], Table 1, "Derived Unconditional Clearance Levels", is shown in NUREG-1640 Table 2.6. The values listed for Co-60 on Table 2.6 are 0.039 Bq/g under the NRC column and 0.3 Bq/g under the IAEA column. The stated NRC/IAEA ratio is 0.1 which implies the NRC and IAEA values agree within one order of magnitude. However, the NRC value is derived from the transportation of scrap (steel, aluminum, or copper) from a licensed facility to a scrap yard or refinery. The IAEA value is derived from the use of a large piece of industrial equipment that weighs 0.5 t where dilution and partitioning were not considered. A scenario based comparison of NRC vs. IAEA clearance levels for a scrap hauler is shown below:

Mass Based Scrap Transportation Clearance Levels (Bq/g to equal 10 μSv/yr)

Product	NUREG	IAEA Value[(1)]	NUREG/IAEA
Steel	3.9E-2[(2)]	2.1E2	0.0002
Aluminum	1.96	1.8E2	0.011
Concrete	4.0E-2	1.7E2	0.0002
Copper	4E-2	Not Evaluated	NA

(1) IAEA Safety Series No. 111-P-1.1 Table III.3 values
(2) Table 2.6 lists 3.9E-2 – this value should be 4.0E-2 based on Table 4.10

Since the NRC values for transporting scrap are significantly below those established

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(1) EPA TSD Appendix J, Normalized Doses And Risks To Maximally Exposed Individuals By Scenario
(2) IAEA-TECDOC-855, Clearance Levels for Radionuclides in Solid Materials, Application of exemption principles. IAEA (1996).

by the IAEA, the NUREG scrap transportation scenario requires investigating.

C.3.4 Geometry Factor Calculation for the Transportation of Material

Load to Driver Distance

The model described in section C.3.4 places the driver only 1-meter (3.3 ft) from the edge of the load. Actual measurements taken on trailers with enclosed semitrailers, flatbed trailers, and tankers showed that the minimum distance from the driver to the trailer's leading edge was 8 ft[3] and the maximum 11 ft. Therefore, a trailer to the driver distance of 9' 6" would be more realistic. Based on various Microshield models, the low load to driver distance overestimates the dose factor for transporting materials by approximately 2.5 times. Since this is a critical parameter, it should be adjusted to reflect a realistic average distance.

For baghouse dust, a Heil Super Jet Aluminum Dry Bunk Trailer is modeled. Based on a scale drawing of the trailer with a tractor, the distance from the leading edge of the load to the driver would be 11.37 ft (the distance described in section C.3.4). However, the tractor modeled has an overall wheelbase of 212 inches. This is typical of tractors that do not have storage or sleeper compartments. Tractors with storage/sleeper compartments have wheelbases that average about 239 inches. This additional 27 inches also adds distance between the driver and the load. The input parameter of 11.37 ft should be reviewed and a value that represents the average driver to load distance developed.

Mass of Load

The model described in section C.3.4 assumes a 57,000-pound steel mass is transported by the modeled truck tractor/semitrailer combination. The mass of 57,000 pounds is not considered realistic because Department of Transportation (DOT) regulations in most states limit the combined gross vehicle weight to 80,000[4] pounds. Since a typical empty truck tractor and semitrailer[5] combination weighs in the neighborhood of 32,000 to 35,000 pounds, the aggregate payload would be limited to about 45,000 to 48,000 pounds. Based on DOT regulations, the 57,000-pound load described in the transportation scenarios could not be hauled on public roadways. Operators also typically maintain their gross vehicle weight at some margin below the stated limit to account for the scale tolerance. Hence, a 40,000 to 44,000 pound maximum load is considered a realistic mass to be used for transporting aggregate scrap.

(3) The EPA used 8 ft for their scrap transportation model

(4) Special permits are available for non-dividable loads which exceed the 80,000 pound limit

(5) Semitrailer – Dump trailer, flatbed, etc

Load Density

The dose factors for the transportation of scrap are not based on independent models. Each model assumes that the semitrailer is full and weighs 57,000 pounds. By producing a volumetrically full trailer each time, the density of the specific waste type is ignored. The waste densities listed in Appendix B "Parameter Value" were not used to determine the external dose factors for waste transportation. Table 1 provides a comparison of material density, waste density listed in Appendix B, the density used to determine the external dose factors, and the density used by the EPA for the transportation of steel scrap.

Table 1 Comparison of Densities (gm/cm^3)

Material	Material Density	Waste Density (ρ_w)	GF-4 Density	EPA Density
Steel	7.86	3.93 (1)	0.236	1.57
Copper	8.94	4.47 (2)	0.236	-
Aluminum	2.7	1.35 (3)	0.236	-
Concrete	2.3	2.3 (4)	0.236	-

(1) Table B.7 Radionuclide independent parameter definitions for exposure scenarios
(2) Table B.9 Radionuclide independent parameter definitions specific to copper scenarios
(3) Table B12 Radionuclide independent parameter definitions specific to aluminum scenarios
(4) Table B.15 Radionuclide independent parameter definitions specific to concrete scenarios

The material density of a volumetrically filled trailer has only a slight impact on the driver's dose because the total activity of the source increases proportionally with density. However, the density impacts the load distribution on the trailer. The scenario ignores this. By assuming each load fills the entire volume of the semi-trailer, the driver is much closer to the load than in real life. The trailer length and type of load will determine actual load distances. For example, a well prepared 40,000 pound load with a density of 3.96 g/cm^3 would have a volume of 4.6E6 cm^3, not 1.1E8 cm^3 described in the model. Since transportation regulations limit the weight on each axle, the load cannot be placed at the front of the trailer. If the load is centered on the trailer, the source to driver distance increases by about 16 feet[6]. Since material density determines the load's dimensions and distance between the driver and the load, a more refined estimate of average load density and distance needs to be produced.

By ignoring the load density and distances, the only variable in the transportation of scrap is produced by a transportation time of 1000 hours (5 hours for aluminum); therefore, the dose factors transporting concrete and copper are the same as transporting steel.

Trailer Dimensions

The trailer described in C.3.4 is not appropriate for the intended task. The trailer described is fine for hauling items that can be stacked, such as boxes, furniture, etc.;

[6] Assuming each dimension decreases equally

however, the trailer is not designed to haul scrap steel. Large volumes of pipe, insulation, cable trays, unistrut, rebar, and small equipment would likely be hauled in a dump trailer with side walls ranging between 4 to 6 ft high. This type of trailer allows the scrap to be removed by dumping or with grappling machinery at the scrap yard. For small volumes that would be accumulated over time, scrap yards often supply 10-ton roll off recycling containers for industrial accounts. Concrete rubble would be hauled in "rock tub" style end dump trailers which have lower sidewalls and heavy steel tubs to withstand the abuse of loading concrete chunks.

Heavy equipment, such as large pipes, concrete blocks, pumps, beams, etc., would be hauled using a flat bed trailer to allow the material to be loaded in a controlled manner. These large objects would be held in place with shoring and hold-downs. These actions are essential to ensure the trailer is not damaged and the load is stable during transport. Since these loads have a higher density, they would be located further from the driver.

Tonnage Hauled by Driver

The scenario for hauling scrap from a facility assumes that a single driver hauls the material for 1000 hours per year. There are several reasons that this is not likely.

1. The scenario does not account for loading/unloading time.
2. The distance to the scrap yard is not specified but an estimate can be calculated. For local hauling, an average 1.5 loads per day is considered reasonable. Based on the assumption the single driver hauls contaminated scrap steel for 250 d/y, at 40,000 lbs/load, the driver would have hauled about 7500 tons of cleared steel. In Section 4, the estimated annual mass of potentially cleared steel from all NRC licensees is estimated at 3.3E+3 ton. As modeled, a single driver would haul more than twice the estimated annual tonnage. The model should consider multiple drivers hauling a fraction of the total steel cleared. For example, the estimated times used by the IAEA for hauling 100 tons of steel are 5 drivers with exposure durations of between 4 and 8 hours.
3. The scenario assumes that a licensee prepares 20 to 40 tons of scrap per day for an extended period of time; a year or more.
4. If local scrap dealers would not accept cleared material, it would be unlikely that a licensee would pay to haul the scrap great distances. Since scrap steel is worth between \$10[7] and \$35[8] per ton, its value would be exceeded by the transportation cost if the hauling exceeds about 500 miles.

Mixing of Scrap

D.3 Mixing Assumptions for Steel Scrap states that the annual average mixing assumption factor of 0.01 to 0.2 was applicable for most scenarios including the

[7] Sheet stock – File cabinets, lockers, etc.
[8] Thicker stock – Beams, etc.

transport of scrap. MicroShield v.5.03 models using the trailer dimensions provided in C.3.4 with a scrap activity of 1 Bq/g produced a geometry factor of 7.3E-4 mrem/hr per pCi/g which is about 40 percent lower than the geometry factor of 1.2E-3 mrem/hr per pCi/g listed on Table G.6. Since the geometry factors produced by both models are fairly close, it is unlikely that the annual mixing factor was applied while generating the geometry factor. Equation 4.55 (or 4.59) is used to calculate the potential external doses to a truck driver. These equations use the geometry factor, original concentration, exposure duration, and an uncertainty factor; however, neither equation includes the annual mixing factor. Without the annual mixing factor, the model assumes that every piece of steel is released at the maximum concentration. By including the mixing factor, the listed FE-SCRP-TRANSPO-W dose factor would be reduced significantly. For example, assuming an annual mixing factor of 0.04, the Co^{60} dose factor of 250 μSv/yr per Bq/g would be reduced to 10 μSv/yr per Bq/g. The inclusion of the annual mixing factor needs to be verified.

Surficial Clearance Values

The XX-SCRP-TRANSPO-W scenarios limit all the surficial clearance values for energetic gamma emitters because the surficial values are dependent on the mass clearance values. Therefore, all of the problems related to C.3.4 geometry are considered transportable to each of the respective surficial values for steel, copper, aluminum, and concrete. Once these values are corrected, surficial clearance values should not be limited by the transportation of scrap.

Section 4.1.2 states, "Rather than attempting to initially define a specific "bounding" scenario, in which potential exposure is maximized even though the combination of circumstances is very improbable, broad scenario categories and a combination of general and specific scenarios within the categories were identified and evaluated. Scenarios were then evaluated so that dose factors calculated in the model would be realistic estimates for potential real-life situations." Contrary to this statement, NUREG-1640 does not provide realistic dose estimates for the average member of the critical group when calculating the scrap transportation scenarios.

C.3.10 – Steel Framed Structure Geometry

The C.3.10 geometry uses a steel sphere with a 200-cm radius and a 2-cm wall thickness. Based upon these dimensions, the volume of the shell would be approximately 1.0E6 cm^3. A density 8.032 g/cm^3 was used instead of the standard 7.86 g/cm^3. No explanation was provided for this deviation; however, for clarity 8.032 g/cm^3 will be used for this comparison. Variations in the outcome will be negligible based on this slight density difference.

Using the density provided and the shell volume of 1.0E6 cm^3, the mass of the steel used in the model would be 8.032E6 grams (17,700 pounds). However, 17,700 pounds is a factor of 10 greater than the mass stated in C.3.10. Since a specific volume is not listed, the mass stated is either understated (10^5 vs. 10^6) or the dimensions provided are inaccurate.

The common thickness for steel construction studs is 20-gauge or 25-gauge steel. Since a 20-gauge stud is thicker and more rigid than a 25-gauge stud, the 20-gauge stud will be used in comparison to the model described in C.3.10. Standard construction techniques utilize studs at 16 inches on center. A 20-gauge stud has a thickness of 0.0396 inch or about 1 mm. Using the dimensions provided in Illustration C.15, the walls have the potential to contain approximately 6.9E4 grams of cleared steel. The ceiling would have the potential to contain approximately 2.6E4 grams of cleared steel. Therefore, the total amount of steel contained it the studs would equal 9.5E4 grams or 210 pounds. This is significantly less than the 8.042E5 grams (1,770 pounds) stated in the geometry section of C.3.10 or the 8.032E6 grams (17,700 pounds) based upon the dimensions listed in the geometry section of C.3.10.

A sensitivity analysis for this model is listed on page C-9. The results of the sensitivity analysis and model are questionable because a realistic room would contain a maximum of 95 kBq and the models used 800 kBq, possibly 8 MBq. This model needs to be evaluated using a realistic source term to establish clearance values that are consistent with the principles defined in IAEA Safety Series 89. IAEA Safety Series 89 establishes clearance (exemption) values based on the average dose to a member of a critical group, not the maximally exposed individual.

C.3.11 Geometry Factor Calculation for a Passenger Vehicle

The geometry of the passenger vehicle is not an accurate representation of a common vehicle. Page C-26 states, "Since it is unlikely that all the components of a vehicle would be made from the same steel source and contain only recycled steel from cleared materials, only the undercarriage slab was used as a source." In addition, the model assumes the mixing factor from a single refinery charge, 0.2 to 1.0. Automobiles are mass-produced; therefore, parts are produced in various locations and assembled to form a vehicle. It would be unlikely that the undercarriage, bracing and stiffeners, doors, hood, trunk, quarter panels, roof, driveshaft, axles, transmission gears, rims, steering column, springs, shocks, pistons, connecting rods, crankshaft, cam shaft, heads, intake and exhaust manifolds, engine block, etc, would be constructed from a single refinery charge of recycled cleared material. Hence, this model uses an undercarriage slab that is over 3/8 inch thick to account for all of the recycled steel that might be used in the automobile. This severely overestimates the dose to the driver and is unrealistic since the basic undercarriage on a common vehicle is constructed using sheet metal with an approximate thickness of 0.0516-inch (18 gauge). This model should evaluate individual components and derive a realistic average dose to a member of the critical group using the annual average mixing assumptions for the critical automobile components. Although the uncertainty in the external exposure factors is discussed in section C.4; a U_{gr} of 0.2 is not realistic. This implies that the average member of the critical group would receive 20 percent of the maximum calculated exposure. This model also assumes that the average automobile will contain about 310 pounds of recycled cleared steel. A mass of 310 pounds would be more representative of an upper bound for a critical component. This model is contrary to IAEA Safety Series 89 which establishes clearance (exemption) values based on the average dose to a member of a critical group, not the maximally exposed individual.

C.3.12 Geometry Factor Calculation for Surface Contamination – Inside a Sphere

The authors model a human inside of a uniformly contaminated sphere. While this model maximizes the dose to the individual, it does not accurately reflect the dose that an individual would receive while occupying a clear truck or other large piece of equipment. The model assumes that the interior surfaces of the cab are uniformly contaminated. To include all the interior surfaces, such as the headliner, windshield, seat back, rear window, and dashboard, is not realistic. There is not a mechanism to contaminate the interior surface of a truck cab as described. Small areas of the floor might become contaminated from cross contamination from foot traffic, or a very localized area on the seat from cross contamination from a tool or miscellaneous material. By no means would the entire floor surface or the seat be uniformly contaminated. In addition, the cab shell is described as being 3 cm (1.2 inches) thick. At this thickness, the shell of the cab alone would weigh 6700 lbs. While the increased thickness does increase the probability of scattered photons, it is not realistic. A shell thickness of 18 or 20 gauge steel would be a better representation of the cab thickness.

This model also lacks good engineering judgment and should be adjusted to conform to real-life situations, not hypothetical worst case models. By assuming the entire surface area of the cab is uniformly contaminated, the model produced surficial contamination levels that are well below the detection capabilities of health physics instrumentation used under normal background situations. This model is considered an example of a bounding condition where the potential exposure is maximized through a combination of improbable and unrealistic situations.

C.3.1 Geometry Factor for Large Pile

Scenario FE-SCRP-HANDLIN-W uses Equation 4.55 (external dose), Equation 4.60 (inhalation dose) and Equation 4.65 (secondary ingestion) to determine the exposure of an individual handling contaminated scrap. The model used to determine the geometry factor assumes a large pile, about 50 percent of the total steel release by all licensees (approximately 1630 tons). This is not considered realistic for several reasons:

1. It would be highly unlikely that 50 percent of all the scrap steel would be sent to a single refinery or scrap recycler.

2. The estimated value of 1630 tons of scrap steel would be worth about $57,000; therefore, it would not make good business sense for a scrap yard to stockpile cleared scrap.

C.3.7 Geometry Factor Calculation for Inside an Object or Structure

For steel, this geometry is not representative of any common residential or common commercial structures. Figure C.12 shows a basement that is constructed using 3-cm (1.2-inch) thick solid steel walls. Basements are not constructed of 3-cm thick steel but with block or solid concrete. At 3.053E6 g, the walls of the 1-meter sphere would weigh 3.4 tons. There are no valid uses for such geometry. If the model is modified to calculate the dose from recycled concrete in a basement, the dose should be calculated from the slab, not the slab, walls and ceiling. Also, the radius of 1 meter is more representative of a pit or sump than a basement.

The geometry section discusses an embedded model for an automobile made from recycled steel. The model assumes a 3-foot sphere with a wall thickness of 1.1 cm or 0.41 inches. This embedded model conflicts with the assumptions for C.3.11 Geometry Factor Calculation for a Passenger Vehicle. No results are presented for this second model. Since neither model provides a realistic geometry, both should be deleted.

C.3.9 Geometry Factor Calculation for Refinery Baghouse Dust Truck Worker

Based on discussion with one of the authors, the semitrailer modeled in C.3.7 is the same as the trailer modeled by the EPA. The semitrailer, a 1040 ft^3 Heil Super Jet Aluminum Dry Bunk Trailer, has dimensions reasonably close to the model; however, the model assumes the trailer is full with dust having a density of 0.51 g/cm^3. This density is not representative of baghouse dust. Since the body of the Super Jet is constructed of aluminum in order to reduce its weight compared to steel bodied trailers, it can hold a maximum payload of about 54,835 pounds. A trailer carrying a load of about 27 tons of EAF dust[9] would only be about 61 percent full. Therefore, the tally point should not be one-half meter above the center of the truck but about 1.2 meters above the surface of the truck. This provides an increased air gap between the baghouse dust and the individual standing atop the truck. This adjusted geometry would provide a more realistic dose estimate to a baghouse dust truck worker.

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[9] p_w = 1.36 g/cm^3 based on Table B.7

Appendix D, Mixing of Cleared Material

The mixing assumptions shown in section D.3.2, Annual Average Mixing for Steel Scrap, uses two examples to determine the high-end and low-end annual average mixing. These estimates are not representative of the average annual mixing of scrap steel. The high-end estimates that 110,000 tons per year of cleared steel are processed by a single refinery within a geographic region. The low-end estimate uses 22,000 tons per year of cleared steel is processed by 4 refineries within a geographic region. EPA TSD (1997) lists five geographic regions: Northeast, Great Lakes, Southeast, Upper Midwest, and West. Section 4.2.2, Sources of Materials, states that approximately 3300 tons[10] of steel are available for recycling each year from all NRC licensed facilities. The annual mixing rate should be derived from the average amount of cleared steel that will be mixed with non-cleared steel, not a hypothetical maximum based on a single charge or a large decommissioning project within one geographical region.

Miscellaneous Comments

The page numbers listed in the table of contents do not match the corresponding text pages in section 4 after page 4-27, section 5 after page 5-11, section 6 after page 6-7, and section 7 after page 7-2. The NUREG-1640's size and cross-referenced format makes obtaining data somewhat unmanageable without an accurate table of contents.

Page 4-98 – last sentence, last paragraph of Work-related Scenarios states, "A range from one-half to a full work day with no most likely value was used." The meaning of this sentence is unclear.

Typographical error on page D-5. EPS's TSD vs. EPAs TSD.

Pages 4-12, 4-13, and 4-44 have incorrect unit conversions or transposed values, for example 50 km (80mi).

Typographical error on page C-25. ho<u>lllo</u>w vs. hollow.

Page C-27, the "Tally" paragraph is incomplete.

The Cm-242 values listed in Tables C.3 – C.10 and C.12 – C.14 are incorrect. For example, in Table C.14 Late Scenarios Single Input is listed as 2.5E+86 mrem/hr per pCi/g.

Page C-30 states, "...composed of smaller parts such as breaks and springs..." The term "breaks" should be "brakes".

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[10] Could reach 7.8E4 tons for a limited number of years because of DOE facility decommisioning

ENCLOSURE

The last sentence of Section 7.6.3, Concrete Surface-to-Mass Ratio, has a typographical error. It should read, "...a 15 cm (6 in) slab with a density of 1.6 g/cm^3 (100 lb/ft^3).