ENCLOSURE 1
ATTACHMENT 2

SHINE MEDICAL TECHNOLOGIES, INC.

SHINE MEDICAL TECHNOLOGIES, INC. APPLICATION FOR CONSTRUCTION PERMIT RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION 11.1-9

PRELIMINARY SAFETY ANALYSIS REPORT CHANGES (MARK-UP)

18 pages follow

List of Tables

Acronyms and Abbreviations

Acronym/Abbreviation	Definition
10 CFR	Title 10 of the Code of Federal Regulations
ALI	annual limit on intake
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
APF	assigned protection factor
ATS	accelerator target systems
Bq/100 cm^2	Becquerel per 100 square centimeters
CAM	continuous air monitors
CEMP	Community Environmental Monitoring Program
CEO	chief executive officer
Ci	curies (unit of measurement of radioactivity)
Ci/yr	curies per year
cm	centimeter
COO	chief operations officer
D/Q	ground level deposition factor
DAC	derived air concentration
DOT	United States Department of Transportation
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQO	data quality objectives
DSSI	Diversified Scientific Services, Inc.
~~ECL~~	~~effluent concentration limits~~
EPA	U.S. Environmental Protection Agency
ES&H	environment, safety, and health
ft^3/yr	cubic feet per year
FSAR	final safety analysis report
GTCC	Greater-than-Class C

Gaseous activity released from the target solution during the production process is collected and sent to the NGRS. This includes any activity that may be released into the hot cells. No activity is released to the general access area of the facility, so no worker exposure to airborne activity is expected during process operations. Activity may be released during maintenance operations that require the opening of process systems. Radiation protection procedures are used to ensure that worker exposure to airborne activity is minimized during maintenance operations. Predicted personnel dose rates (including maintenance activity dose rates) and the associated methodology will be provided in the FSAR.

Gaseous activity from the TSV and process operations is held in noble gas storage tanks until radiodecay has reduced the activity such that releases are below the 10 CFR 20 limits. Annual average airborne radioactivity concentrations are determined per Regulatory Guide 4.20, which uses the stack release rate and annual average relative atmospheric concentrations (χ/Q) values to determine the annual average airborne radionuclide concentration for each radionuclide at the location of the maximally exposed individual (MEI), which is the nearest point on the site boundary, and the nearest full-time resident. The methodology in Regulatory Guide 1.111 is used with the meteorological data in Section 2.3 to calculate the χ/Q values, which are 7.1E-5 sec/m^3 at the MEI and 5.3E-6 sec/m^3 at the nearest resident.Annual off-site doses due to the normal operation of the SHINE facility have been calculated using the computer code GENII2 (PNNL, 2012). The GENII2 computer code was developed for the Environmental Protection Agency (EPA) by Pacific Northwest National Laboratory (PNNL), and is distributed by the Radiation Safety Information Computational Center (RSICC). Annual average relative atmospheric concentration (χ/Q) values were determined using the methodology in Regulatory Guide 1.111 (NRC, 1977) with the meteorological data in Section 2.3. The χ/Q values for the maximally exposed individual (MEI), which is the nearest point on the site boundary, and the nearest full-time resident are 7.1E-5 sec/m^3 and 5.3E-6 sec/m^3, respectively.

Table 11.1-9 contains the estimated gaseous activity production rates for a single TSV. Noble gases are the primary gaseous radionuclides produced in the TSV. Iodine is also volatile and is assumed to become airborne. Iodine is removed in the TOGS and a small fraction is transferred to the NGRS. The minimum holdup time in the NGRS is 960 hours (40 days). As shown in Table 11.1-9, many noble gas and iodine nuclides are short-lived and decay away during this holdup. The resulting annual release, with eight TSVs operating, is limited to a few nuclides as shown in the table.

The limits on calculated radionuclide concentrations are the effluent concentration limits (ECL) in 10 CFR 20, Appendix B, Table 2. To compare the mixture of radionuclides to the limits, the ECL fractions for all radionuclides are calculated and then summed to determine the ECL fraction for the mixture. The sum of the ECL fractions for the total activity released, which includes the releases from the NGRS and argon-41, is less than 10 percent of the acceptance criterion.The dose analysis considered the release of airborne radionuclides and exposure to off-site individuals through direct exposure and potential environmental pathways, such as leafy vegetable ingestion, meat ingestion, and milk ingestion. The analysis considered variations in consumption and other parameters by age group. The estimated annual doses (excluding tritium) at the MEI and the nearest resident are 5.59.0 mrem and 0.400.6 mrem, respectively, which is a small fraction of the 10 CFR 20.1301 limit of 100 mrem. The tritium purification system and neutron driver are designed such that the estimated annual doses to the MEI and the nearest resident are below the regulatory limitsdose constraint specified in 10 CFR 20.1101(d).

Calculational methodologies related to accidental releases of airborne radioactive sources are discussed in Chapter 13.

11.1.6.4 Light Water Pool

The light water pools which provide shielding and cooling to the subcritical assemblies is designed to eliminate unidentified leakage to the facility and the environment.

11.1.6.5 Process Tanks

Process tanks are designed, fabricated and tested in accordance with national codes and standards. The tanks are seismically supported and are located in seismically designed concrete vaults that are designed to eliminate unidentified leakage to the facility and the environment.

11.1.7 ENVIRONMENTAL MONITORING

11.1.7.1 Environmental Monitoring Program

The requirement to have a radiological environmental monitoring program is documented in 10 CFR 20.1302. The radiological environmental monitoring program is used to verify the effectiveness of plant measures which are used to control the release of radioactive material and to verify that measurable concentrations of radioactive materials and levels of radiation are not higher than expected based on effluent measurements and modeling of the environmental exposure pathways. Methods for establishing and conducting environmental monitoring are provided in Regulatory Guide 4.1. Regulatory Guide 4.1 refers to NUREG-1301 for detailed guidance for conducting effluent and environmental monitoring.

SHINE is committed to implementing a radiological environmental monitoring program for the SHINE facility. Regulatory Guide 4.1 and NUREG-1301 are written for nuclear power plants, but, due to the similarities between airborne releases of radioactivity from nuclear power plants and those released from the SHINE facility, guidance provided in Regulatory Guide 4.1 and NUREG-1301 was considered when developing the radiological environmental monitoring plan (REMP) for the SHINE facility. In addition to the guidance provided in Regulatory Guide 4.1 and NUREG-1301, the REMP was developed using the data quality objectives (DQO) process which is a scientific systematic planning method. The DQOs were developed according to the U.S. Environmental Protection Agency (EPA) Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA, 2006).

Environmental monitoring is conducted at potential receptor locations. Details of the REMP are presented in the following sections.

11.1.7.2 Effluent Release Pathways

Effluent releases from the SHINE facility are limited to the airborne pathway. Airborne effluents include noble gases, iodine and other halogens, particulates, tritium, and Ar-41. The DQO process indicates the following radiation exposure pathways represent plausible public exposure scenarios.

- Direct radiation exposure pathway monitored using thermoluminescent dosimeters (TLDs).
- Airborne exposure pathway monitored using continuous air samples.
- Ingestion exposure pathway ~~(monitored only if triggered)~~.

Environmental airborne sampling is performed to identify and quantify particulates and radioiodine in airborne effluents. Regulatory Position C.3.b of Regulatory Guide 4.1 indicates that airborne sampling should always be included in the environmental monitoring programs for nuclear power plants since the airborne effluent pathway exists at all sites. Since the SHINE facility includes airborne effluent releases and radioactivity in the airborne effluent can result in measurable off-site doses and since there is a potential for a portion of the dose to be attributable to radioactive iodine and possibly airborne particulate radioactivity releases, the radiological environmental monitoring program includes airborne sampling.

11.1.7.2.2.1 Air Sampling Locations

The guidance provided in Table 3.12-1 of NUREG-1301 is used to establish locations for airborne sample acquisition, sampling frequency, and type of sample analysis. Continuous air sample locations are specified in accordance with guidance provided in Table 3.12-1 of NUREG-1301. The CAMs that are used to obtain continuous air samples include a radioiodine canister for weekly iodine-131 (I-131) analysis and a particulate sampler which is analyzed for gross beta radioactivity and for quarterly isotopic analysis.

Four CAM locations are near the facility property line in the north, south, east, and west direction sectors to ensure all directions are monitored. The north and east direction sectors (with respect to the SHINE facility vent stack) have the highest calculated annual ground level deposition factor (D/Q) values. There is also a CAM located a sufficient distance from the SHINE facility to provide background information for airborne activity. Table 3.12-1 of NUREG-1301 suggests an additional CAM location in the vicinity of a community having the highest calculated annual average ground-level D/Q. This CAM requirement is combined with the CAM located at the site boundary in the north direction (refer to Table 11.1-8). A description of air sample locations and the rationale for air sample locations are provided in Table 11.1-8. CAM locations are shown on Figure 11.1-3.

11.1.7.2.3 Ingestion Pathway (Biota Monitoring)

NUREG-1301 suggests sampling of various biological media as a means to indirectly assess doses due to particulate and iodine ingestion. This type of monitoring may include sampling of soils, broad leafed plants, fish, meat, or milk. Nuclear power plants have long monitored this pathway and have seen neither appreciable dose nor upward trending. Since the SHINE source term is more modest than that of a nuclear power plant and particulate and iodine radionuclides are not normally expected to be present in ~~measurable~~significant quantities within airborne effluent releases from the SHINE facility, biota monitoring is not routinely included in the REMP. Monitoring of the milk pathway will be performed as part of the CEMP, as described in Subsection 11.1.7.3

~~However, in the event that the results of environmental airborne samples indicate the presence of iodine or particulates in measurable quantities or if the effluent monitor sample results indicate the presence of iodine or particulates in quantities large enough to result in a calculated dose at the property line that exceeds 10 percent of the dose constraint (i.e., 1 millirem per year [mrem/yr] [0.01mSv/yr]) then a sampling campaign is undertaken. The sampling campaign is planned under the DQO process thus ensuring the appropriate types and numbers of samples are collected to best represent potential public doses based on the radionuclides detected in either the air effluent or in air samples.~~In the event that the results of environmental airborne samples, effluent monitor sample results, or milk sampling results indicate iodine or particulates in quantities large enough to result in a calculated dose greater than that predicted for normal releases (e.g., from GENII models used to show compliance with the 10 CFR 20.1101(d) dose constraint), then a more comprehensive sampling campaign is undertaken. The sampling campaign is planned under the DQO process thus ensuring the appropriate types and numbers of samples are collected to best represent potential public doses based on the radionuclides of concern in the environmental airborne, effluent monitor, or milk samples.

~~Milk is one of the most important foods contributing to the radiation dose to people if milk animals are pastured in an area near a facility that releases radioactive material. Dairy production takes place approximately one-half mile (mi.) (0.8 kilometers [km]) to the east of the SHINE facility and goat production takes place at approximately 0.69 mi. (1.1 km) northeast of the facility. If it is determined that biota sampling is required as a result of radioactive iodine and particulate activity measured during effluent monitoring, then milk sampling would be performed consistent with the results of the DQO process noted above.~~

11.1.7.3 Community Environmental Monitoring Program

In addition to the monitoring that is performed to meet regulatory requirements, SHINE has a CEMP. The CEMP initially includes ~~only~~ groundwater monitoring and monitoring of the milk pathway. ~~but a~~Additional initiatives may be undertaken in the future.

Milk is one of the most important foods contributing to the radiation dose to people if milk animals are pastured in an area near a facility that releases radioactive material. Dairy production takes place approximately one-half mile (mi.) (0.8 kilometers [km]) to the east of the SHINE facility and goat production takes place at approximately 0.69 mi. (1.1 km) northeast of the facility. A description of the milk sampling program will be provided with the FSAR.

11.1.7.3.1 Groundwater Monitoring

There is no liquid effluent release pathway from the RCA associated with the SHINE facility and thus, surface waters of the rivers in the vicinity of the plant (e.g., the Rock River and its tributaries) are not expected to accumulate detectable levels of radioactivity. As such, surface water sampling is not included in the radiological environmental monitoring plan. Similarly marine life in the rivers is not expected to accumulate detectable levels of radioactivity and thus sampling of fish or other marine creatures for the ingestion pathway is not included in the radiological environmental monitoring plan.

Measured local water table elevations for the site identify the groundwater gradient and indicate that the groundwater flow is to the west and to the south. The nearest drinking water source is a well located approximately a third of a mile (0.54 km) to the northwest of the facility. There are four test wells within the property boundary for the SHINE facility that were used for monitoring groundwater in support of a hydrological assessment of the site.

One test well is located north, one south, one east, and one west of the SHINE facility building. Although there are no defined liquid effluent release pathways from the RCA and the groundwater is not expected to be contaminated due to operation of the SHINE facility, the test wells to the west and the south are sampled for the presence of radionuclide contaminants. Sampling is in accordance with the recommendations in Table 3.12-1 of NUREG-1301, i.e., quarterly with gamma isotopic and tritium analysis. The rationale for sampling the test wells to the west and south of the SHINE facility is provided in Table 11.1-8.

11.1.7.3.2 Other Potential Special Sampling Initiatives

After SHINE operations are underway, additional sampling initiatives may be undertaken. For example, detectors may be placed within areas of community interest to allow for real-time gamma monitoring that can be observed via the internet. Other initiatives may include collection of high-volume air samples using portable air samplers in areas of community interest.

11.1.7.4 Preoperational Baseline Monitoring

As previously indicated, effluent releases from the SHINE facility are limited to releases via the airborne pathway. Environmental monitoring of the SHINE facility includes the use of TLDs for monitoring direct radiation and CAMs for detecting iodine and particulate activities in airborne effluents. A preoperational baseline survey is performed to obtain TLD readings at the nine TLD locations and to obtain air sample radioactive iodine and particulate surveys at the five air sample locations described in Table 11.1-8. The preoperational baseline TLD readings and the preoperational baseline air sample survey results represent background radiation values that are used with operational surveys to establish the radiological impact of the SHINE facility on the environment.

Since groundwater is sampled via test wells to the west and south of the SHINE facility building as part of the CEMP and since the test wells that are north and east of the SHINE facility building could be sampled in the future, groundwater sampling of the four test wells is included in the preoperational baseline survey. Since milk sampling will be performed as part of the CEMP, milk sampling will be included in the preoperational baseline survey. Additional ~~Biota~~biota sampling (soil, broad leafed plants, ~~milk~~ and meat) will only be conducted if there are ~~measurable~~significant quantities of iodine or particulates in ~~environmental airborne samples or if triggered by the effluent monitor~~other sample results. Since there is a possibility that complete biota sampling could be performed at some future date, biota sampling is included in the preoperational baseline survey.

11.1.7.5 Environmental Monitoring Program Procedures

Environmental surveys conducted in support of the REMP are performed in accordance with written plans documented in facility procedures. Changes to the REMP or to environmental survey plans are reviewed for adequacy and approved prior to implementation in accordance with facility procedures.

11.1.7.6 REMP Reports

A radioactivity effluent discharge summary report, i.e., a “Radioactive Effluent Release Report” and a radiological environmental surveillance program report, i.e., a “Radiological Environmental Operating Report” is provided to the NRC on an annual basis representing a one year monitoring period. The one year monitoring period is in accordance with Section C, Staff Regulatory Guidance, of Regulatory Guide 4.20.

As required by the 1979 NRC Branch Technical Position (included as Appendix A to NUREG-1301), a laboratory inter-comparison program is established to crosscheck sample analysis results. The results of the inter-comparison crosscheck sample analysis are included in the annual Radiological Environmental Operating Report.

Although biota monitoring is not planned, an annual land use census is conducted during the growing season. The location of the nearest milk animal is determined during the annual land use census (as required by the 1979 NRC Branch Technical Position which is included as Appendix A to NUREG-1301). The results of the annual land use census are included in the annual Radiological Environmental Operating Report and are available if it is determined that a biota monitoring sampling campaign is to be undertaken.

Table 11.1-9 TSV Noble Gas and Iodine Production Rates~~,~~ and Annual Releases~~,~~ ~~and ECL Fraction~~ at the Site Boundary After 960 Hours of NGRS Holdup

Radionuclide	Half Life	Production Rate (Ci/sec)	Annual Release (Ci)	~~Site Boundary ECL Fraction~~
Kr-83m	1.86 hours	[Proprietary Information] [Security-Related Information]		
Kr-85	10.76 years	[Proprietary Information] [Security-Related Information]	1.2E+02	~~3.9E-04~~
Kr-85m	4.48 hours	[Proprietary Information] [Security-Related Information]		
Kr-87	1.27 hours	[Proprietary Information] [Security-Related Information]		
Kr-88	2.84 hours	[Proprietary Information] [Security-Related Information]		
Kr-89	3.15 min	[Proprietary Information] [Security-Related Information]		
I-131	8.02 days	[Proprietary Information] [Security-Related Information]	9.5E-01	~~1.1E-02~~
I-132	2.28 hours	[Proprietary Information] [Security-Related Information]		
I-133	20.80 hours	[Proprietary Information] [Security-Related Information]		
I-134	52.60 min	[Proprietary Information] [Security-Related Information]		
I-135	6.57 hours	[Proprietary Information] [Security-Related Information]		
Xe-131m	11.90 days	[Proprietary Information] [Security-Related Information]	5.5E+02	~~6.5E-04~~
Xe-133	5.24 days	[Proprietary Information] [Security-Related Information]	1.1E+04	~~5.0E-02~~
Xe-133m	2.19 days	[Proprietary Information] [Security-Related Information]		
Xe-135	9.10 hours	[Proprietary Information] [Security-Related Information]		
Xe-135m	15.30 min	[Proprietary Information] [Security-Related Information]		
Xe-137	3.82 min	[Proprietary Information] [Security-Related Information]		
Xe-138	14.10 min	[Proprietary Information] [Security-Related Information]		
			~~Total~~	~~6.2E-02~~

11.5 REFERENCES

ANSI, 1978. Radiation Protection Instrumentation Test and Calibration, ANSI N323-1978, American National Standards Institute, 1978.

ASTM, 2008. Radiological Protection Training for Nuclear Facility Workers, ASTM E1168-95, American Society for Testing and Materials, 2008.

CGA, 2011. Commodity Specification for Air, CGA G-7.1, 6th Edition, 2011.

EPA, 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, February 2006.

NRC, 1977. Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Regulatory Guide 1.111, Revision 1, U.S. Nuclear Regulatory Commission, July 1977.

PNNL, 2012. GENII Version 2 Users' Guide, Pacific Northwest National Laboratory, PNNL-14583, Revision 4, September 2012.

WTP, 2002. Preliminary Evaluation of Spent Silver Mordenite Disposal Forms Resulting from Gaseous Radioiodine Control at Hanford's Waste Treatment Plant, WTP-RPT-039, Rev 0, 2002.

List of Tables

Acronyms and Abbreviations (cont'd)

Acronym/Abbreviation	**Definition**
DBA	design basis accident
DOE	U.S. Department of Energy
DOR	Wisconsin Department of Revenue
DOT	U.S. Department of Transportation
DPI	Wisconsin Department of Public Instruction
DSSI	Diversified Scientific Services, Inc.
~~ECL~~	~~effluent concentration limit~~
EDE	effective dose equivalent
EJ	Environmental Justice
ESF	engineered safety feature
F	Fahrenheit
FR	Federal Register
ft.	feet
ft/sec	feet per second
GHG	greenhouse gas
GIS	Geographic Information System
gpd	gallons per day
grams/bhp-hr	grams per brake horsepower-hour
H1H	high, first high
H2H	high, second high
ha	hectare
HAT	Hazard Analysis Team
HAZOPS	Hazard and Operability Study

19.4.8.2.4.1 Gaseous Effluents

Sources of radioactive gaseous effluents are discussed in Subsection 19.4.8.2.2.1. The effluents, which consist of the noble gases krypton and xenon, in addition to iodine and tritium, are released to the environment through the production facility building vent stack. Prior to release to the environment, gaseous effluents are held up to allow for decay.

The methodologies used to calculate the annual average airborne radioactivity concentrations and TEDE at the location of the MEI and the nearest member of the publicTEDE to a maximally exposed member of the public and the nearest full-time resident are discussed here.

Annual average airborne radioactivity concentrations are determined per NRC Regulatory Guide 4.20, which uses the stack release rate and annual average relative atmospheric concentrations (χ/Q) to determine the annual average airborne radionuclide concentration for each radionuclide at the location of the MEI and the nearest full-time resident. The limits on calculated radionuclide concentrations are the effluent concentration limits (ECL) in 10 CFR 20, Appendix B, Table 2. To compare the mixture of radionuclides to the limits, the ECL fractions for all radionuclide are calculated and then summed to determine the ECL fraction for the mixture. The mixture ECL fraction is then compared to 10 percent of the acceptance criterion, or 0.1.Annual off-site doses due to the normal operation of the SHINE facility have been calculated using the computer code GENII2 (PNNL, 2012). The GENII2 computer code was developed for the Environmental Protection Agency (EPA) by Pacific Northwest National Laboratory (PNNL), and is distributed by the Radiation Safety Information Computational Center (RSICC). Annual average relative atmospheric concentration (χ/Q) values were determined using the methodology in Regulatory Guide 1.111 (NRC, 1977) with the meteorological data in Section 2.3. The limit on calculated dose is the annual limit of 0.1 rem in a year to an individual member of the public as specified in 10 CFR 20.1301. Also, a dose constraint of 10 mrem TEDE per year due to air emissions is specified in 10 CFR 20.1101(d). The calculated dose is compared to the acceptance criteria of the 10 CFR 20.1301 dose limit and the 10 CFR 20.1101(d) dose constraint.

Table 19.4.8-4 lists the calculated ECL fraction for the radionuclide mixture at the MEI and at the nearest full-time resident dose receptor locations. These ECL fractions correspond to the effluent releases of the noble gas and iodine radionuclides in Table 19.4.2-1.

The air submersion and the inhalation pathways are the primary contributors to the TEDE due to airborne radiation in the form of gaseous effluents produced by normal operations at the SHINE facility. On a radionuclide-specific basis, the annual average radioactivity concentrations at both the MEI and the nearest full-time resident are multiplied by dose conversion factors from Federal Guidance Reports No. 11 (inhalation pathway) and 12 (air submersion pathway) to yield the committed effective dose equivalent (CEDE) and effective dose equivalent (EDE), respectively. The location-specific CEDE due to inhalation of airborne effluent and EDE due to external exposure to airborne effluent are summed to produce TEDE, which is compared to the As Low As Reasonably Achievable (ALARA) annual dose limits established in 10 CFR 20.1101(d).The dose analysis using the GENII2 code considered the release of airborne radionuclides and exposure to off-site individuals through direct exposure and potential environmental pathways, such as leafy vegetable ingestion, meat ingestion, and milk ingestion. The analysis considered variations in consumption and other parameters by age group, and considered potential doses in each of the 16 meteorological sectors. The doses from each pathway were summed and compared to the acceptance criteria.

Dose due to the deposition and ingestion pathways are ~~negligible compared to~~less than the dose due to airborne sources of radiation.

Annual TEDE due to gaseous effluents released from the SHINE facility at the location of the MEI and nearest full-time resident are listed in Table 19.4.8-5.

As discussed in the following Subsections 19.4.8.2.4.2 and 19.4.8.2.4.3, the doses due to liquid effluents and direct dose from fixed radiation sources are negligible compared to the airborne sources of radiation. The results contained in Table 19.4.8-5 represent the annual TEDE to the MEI and nearest full-time resident for ~~all~~the sources of radiation due to normal operations at the SHINE facility.

Because the results in Table~~s 19.4.8-4 and~~ 19.4.8-5 are within the ~~regulatory limits~~dose constraints explained earlier in this subsection, the radiological impacts to members of the public due to operation of the SHINE facility are SMALL.

19.4.8.2.4.2 Liquid Effluents

As described in Subsection 19.4.8.2.2.2, the SHINE facility does not generate radioactive liquid waste as candidate material for effluent release. As a result, there are no liquid effluent pathways that contribute to waterborne radioactivity concentrations.

Because there are no discharges of radioactive liquid effluent at the SHINE site, the annual averaged waterborne radioactivity concentration is not expected to be greater than the baseline concentration.

19.4.8.2.4.3 Direct Dose

From Subsection 19.4.8.2.2.3, fixed sources of radiation inside the production facility building are due to the radioactive materials used for solution preparation, Mo-99 production operations (e.g., TSV irradiation, holding tanks), and the staging of radioactive waste. The source of radiation inside the waste staging and shipping building is solidified radioactive waste.

Both the production facility and the waste staging and shipping building are designed with appropriate shielding to meet the 10 percent of 10 CFR 20.1301 limits on the outer wall of the RCA in the production facility and at the outer wall of the waste staging and shipping building.

The direct dose to a member of the public at the boundary of the unrestricted area (the site boundary) is due to gamma radiation penetrating the walls of the production facility and the waste staging and shipping facility. The direct dose is small outside of the buildings, due to site shielding design, and the dose will decrease with increasing distance. Because the nearest site boundary is located at an appreciable distance from both fixed sources, the dose is negligible at the site boundary.

19.4.8.2.5 Annual Dose to Maximally Exposed Worker

Administrative dose limits are occupational radiation exposure limits that radiation workers at SHINE shall not exceed without prior management approval. Table 19.4.8-7 gives SHINE administrative dose limits. 10 CFR Part 20 limits are also provided for reference.

are near the facility property line in the north, south, east, and west direction sectors to ensure all directions are monitored. The north and east direction sectors (from the SHINE facility vent stack) have some of the highest calculated annual ground level deposition factor (D/Q) values. There is also a CAM located a sufficient distance from the SHINE facility to provide background information for airborne activity. Table 3.12-1 of NUREG-1301 suggests an additional CAM location in the vicinity of a community having the highest calculated annual average ground-level D/Q. This CAM requirement is combined with the CAM located at the site boundary in the north direction (refer to Table 19.4.8-6). A description of air sample locations and the rationale for air sample locations are provided in Table 19.4.8-6. CAM locations are shown on Figure 19.4.8-1.

19.4.8.3.2.4 Ingestion Exposure Pathway

NUREG-1301 suggests sampling of various biological media (biota monitoring) as a means to indirectly assess doses due to particulate and iodine ingestion. This type of monitoring may include sampling of soils, broad-leafed plants, fish, meat, or milk. Nuclear power plants have long monitored this pathway and have seen neither appreciable dose nor upward tending. Considering the size of the SHINE facility and the low power level of the SHINE irradiation units, in comparison to nuclear power plants, and that particulate and iodine radionuclides are not normally expected to be present in ~~measurable~~significant quantities within airborne effluent releases from the SHINE facility, biota monitoring is ~~not performed~~normally limited to monitoring of the milk pathway, as this pathway is most sensitive for detection of iodine releases.

~~However, in the event that the results of environmental airborne samples indicate the presence of iodine or particulates in measurable quantities or if the effluent monitor sample results indicate the presence of iodine or particulates in quantities large enough to result in a calculated dose at the property line that exceeds 10 percent of the dose constraint (i.e., 1 mrem/yr), then a sampling campaign will be undertaken.~~ In the event that the results of environmental airborne samples, effluent monitor sample results, or milk sampling results indicate iodine or particulates in quantities large enough to result in a calculated dose greater than that predicted for normal releases (e.g., from GENII models used to show compliance with the 10 CFR 20.1101(d) dose constraint), then a more comprehensive sampling campaign is undertaken.

Milk is one of the most important foods contributing to the radiation dose to people if milk animals are pastured in an area near a facility that releases radioactive material. Dairy production takes place approximately one-half mile (0.8 km) to the east of the SHINE facility and goat production takes place at approximately 0.69 mi. (1.1 km) northeast of the facility. ~~If it is determined that biota sampling is required as a result of radioactive iodine and radioactive particulate activity measured during effluent monitoring or air sampling, then m~~Milk sampling will be performed following guidance (i.e., sampling frequency and type of sample analysis) provided in Table 3.12-1 of NUREG-1301. Cow and goat milk samples would be obtained from the dairy production site and the goat production site, respectively, on a semi-monthly basis (when animals are pastured) and on a monthly basis (at other times). An I-131 analysis and a gamma isotopic analysis would be performed on the samples. Since milk samples are considered a better indicator of radioiodine in the environment than vegetation, as long as milk samples are obtained, it is expected that vegetation sampling (e.g., broad leaf vegetables) would not be included in the exposure pathway sampling (in accordance with guidance provided in Table 3.12-1 of NUREG-1301).

Table 19.4.8-4 ~~Annual Average Airborne Radioactivity ECL Fraction at Bounding Dose Receptors[b]~~This table number not used

~~Dose Receptor~~	~~Mixture ECL Fraction~~	~~ECL Fraction Limit[a]~~
~~MEI~~	~~9.3×10^{-2}~~	~~1.0×10^{-1}~~
~~Nearest Full Time Resident~~	~~6.8×10^{-3}~~	

~~a) Limit based on NRC Regulatory Guide 4.20, Regulatory Position C.2.a~~

~~b) Values do not include contributions from tritium~~

Table 19.4.8-5 Annual Total Effective Dose Equivalent to the Public at Bounding Dose Receptors[(b)]

Dose Receptor	Annual TEDE	Annual TEDE ~~Limit~~ Dose Constraint[(a)]
MEI	~~7.9~~9.0 mrem (~~7.9~~9.0 x 10^{-2} mSv)	10 mrem (1.0 x 10^{-1} mSv)
Nearest Full-Time Resident	~~5.7~~6.3 x 10^{-1} mrem (~~5.7~~6.3 x 10^{-3} mSv)	

a) ~~Limit~~Dose constraint based on 10 CFR 20.1101(d)

b) Values do not include contributions from tritium

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