UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 28, 2015

Mr. Michael Griffin
Vice President of Permitting, Regulatory
and Environmental Compliance
Strata Energy, Inc.
PO Box 2318
Gillette, WY 82717-2318

SUBJECT: AMENDMENT 4, SOURCE AND BYPRODUCT MATERIALS LICENSE SUA-1601, ROSS IN-SITU RECOVERY (ISR) PROJECT, CROOK COUNTY, WYOMING, REMOVAL OF LICENSE CONDITION 12.8, DOCKET NO. 040-09091, TAC J00735

Dear Mr. Griffin:

Enclosed, please find the U.S. Nuclear Regulatory Commission (NRC) staff's "*Safety Evaluation Report, Materials License SUA-1601, Amendment 4, Removal of License Condition 12.8, Ross ISR Project*" and License SUA-1601, Amendment 4.

By letter dated March 1, 2015, Strata Energy, Inc. (Strata) submitted a license amendment request that addressed preoperational license conditions (LCs) 12.6, 12.7 and 12.8 of its Materials License SUA-1601 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15103A045). By letter dated July 23, 2015, NRC staff provided comments and requested additional information (ADAMS Accession No. ML15190A156). By letter dated July 27, 2015, Strata responded to the NRC staff's request for additional information on LC 12.8 only. Strata's responses to comments on other LCs is addressed in separate correspondence. By letter dated October 15, 2015, NRC staff issued an additional request for additional information and draft safety evaluation report with open items (ADAMS Accession No. ML15278A115) on LC 12.8. By letter dated October 20, 2015, Strata Energy, Inc. (Strata) submitted its responses to NRC staff's additional request for additional information (ADAMS Accession No. ML15294A228).

The NRC staff reviewed the submitted documents and approves the amendment request to remove license condition 12.8. Staff documents the justification for its actions in the attached Safety Evaluation Report (Enclosure 1). Amendment 4 to Source and Byproduct Materials License SUA-1601 is attached as Enclosure 2.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure" a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's ADAMS. ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

If you have any questions regarding this action, please contact Mr. John Saxton, the Project Manager for the Ross ISR Project, at 301-415-0697 or by e-mail at John.Saxton@nrc.gov.

Sincerely,

/RA/

Andrew Persinko, Acting Director
Division of Decommissioning, Uranium Recovery
and Waste Programs
Office of Nuclear Material Safety
and Safeguards

Docket No.: 040-09091
License No.: SUA-1601

Enclosures:
1. Safety Evaluation Report
for Amendment 4, License SUA-1601
2. Amendment No. 4, Source
and Byproduct Materials License SUA-1601

cc: D. Schellinger WDEQ

If you have any questions regarding this action, please contact Mr. John Saxton, the Project Manager for the Ross ISR Project, at 301-415-0697 or by e-mail at John.Saxton@nrc.gov.

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Andrew Persinko, Deputy Director
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**Safety Evaluation Report, Materials License SUA-1601,
Amendment 4, Removal of License Condition 12.8, Ross ISR Project**

DATE:	October 22, 2015
DOCKET:	04009091
LICENSE NO.:	SUA-1601
LICENSEE:	Strata Energy, Inc.
SITE:	Ross ISR Project
PROJECT MANAGER:	John L. Saxton
TECHNICAL REVIEWER:	David Brown

This is a U.S. Nuclear Regulatory Commission (NRC) staff safety evaluation report for a license amendment request by Strata Energy, Inc. (Strata) to remove pre-operational license condition (LC) 12.8 from NRC Materials License SUA-1601 (Strata 2015a, b, c).

<u>Background</u>

In Section 5.7.6.2.1 of its 2011 Technical Report (TR), Strata stated, with regard to personnel contamination, "[s]ince any beta-gamma contamination at an ISR [in-situ recovery] (or uranium mill) must be associated with alpha emitting nuclides, no special monitoring or survey for beta-gamma emitters are required." (Strata 2011). In Section 5.7.6.3.1.1 of the NRC staff's January 2014 safety evaluation report (2014 SER), NRC staff stated that Strata's description of personnel contamination surveys is acceptable to the staff, except with respect to beta-gamma contamination surveys (NRC 2014b). The NRC staff made a similar finding in Section 5.7.6.3.1.2 of its 2014 SER that the plant contamination survey program does not address the potential for beta-gamma contamination. As a result of these deficiencies, NRC staff included preoperational LC 12.8 requiring Strata to develop, prior to the NRC preoperational inspection, a survey program for beta-gamma contamination for personnel contamination from restricted areas and plant area contamination that will meet the requirements of 10 CFR Part 20, Subpart F.

LC 12.8 of Materials License SUA-1601 (NRC 2015c) states:

> Prior to the preoperational inspection, the licensee shall develop a survey program that will meet the requirements of 10 CFR Part 20, Subpart F to detect beta-gamma contamination on personnel exiting restricted areas and to detect beta-gamma contamination in unrestricted and restricted areas. The licensee shall provide, for NRC staff review and approval, the surface contamination detection capability (scan MDC) of the radiation survey meters used in surveys for releasing equipment and materials to unrestricted use or personnel

> contamination. In the scanning mode, the detection capability for any expected alpha and beta radiation shall be provided in terms of dpm per 100 cm^2.

In Attachment 2 to its March 1, 2015, letter, Strata provided information in response to LC 12.8 (Strata 2015a). Specifically, in Section 4.0, "License Condition 12.8," of its March 1, 2015, letter, Strata described its approach and commitments as described in Section 5.7 of its TR and provided additional information to address the issues identified in LC 12.8.

Strata's response in its March 1, 2015, letter, was deficient by not describing the detection capability of equipment used to both release equipment and materials to unrestricted use and assess personnel contamination before personnel exit restricted areas in terms of disintegrations per minute (dpm) per 100 cm^2, as required by LC 12.8. The specific item that NRC required for staff review and approval is the surface contamination detection capability (scan MDC) of radiation survey meters used in surveys for releasing equipment and materials to unrestricted use or personnel contamination. In accordance with the license condition, this information was to be provided in terms of dpm per 100 cm^2. Strata described several aspects of its survey program, such as personnel dosimetry, surface contamination limits, and technical parameters of survey equipment, but did not describe the detection capability of equipment used to release equipment and survey personnel in terms of dpm per 100 cm^2.

By letter dated July 23, 2015, NRC staff requested additional information (RAI-1) regarding Strata's March 1, 2015, letter and the deficiency described above (NRC 2015a). In that request for additional information (RAI), staff explained that 2014 SER Section 5.7.6.3.2 (NRC 2014a) documented the basis for and purpose of LC 12.8. The purpose of LC 12.8 is that the licensee demonstrate, using specific information about surface equipment and procedures proposed for use at the Ross ISR Project, that the scan minimum detectable concentration will be sufficiently low to meet or exceed the guidance in the Guidelines (NRC 1993a) and Regulatory Guide 8.30, Table 2 (NRC 2002) for both alpha contamination and beta-gamma contamination. The NRC staff explained that factors which should be considered in estimating scan MDCs are addressed in Section 6.7.2 of NUREG-1575 (NRC 2000) and NUREG-1507 (NRC 1998). The NRC staff noted that it has previously approved a program description which included consideration of scan MDCs (NRC 2014b).

By letter dated July 27, 2015, Strata responded that NRC staff did not address the main point of Strata's March 1, 2015, letter:

> "…namely that only those beta-gamma surveys which were committed to in the Strata Technical Report (TR) (Strata 2011) would be conducted until characterization studies demonstrated that additional beta-gamma surveys for contamination control were required. Of particular interest, Strata's TR only committed to doing contamination surveys for alpha radiation for personnel exiting restricted areas." (Strata 2015b).

Strata's July 27, 2015, statement did not address the deficiencies with the approach described by NRC staff in its 2014 SER, which were the basis for license condition 12.8. However, Strata included additional information in two attachments to its July 27, 2015, letter: Attachment 3, "Instrument Specifications and Additional Considerations," and Attachment 4, "Beta-Gamma Contamination Control Survey Programs." By letter dated October 15, 2015, NRC staff issued an additional request for additional information (NRC 2015b). By letter dated October 20, 2015, Strata provided its responses to the NRC staff's additional request for additional information (Strata 2015c). A summary of this information and the staff's evaluation is provided below.

Evaluation

With regard to surveys for beta-gamma absorbed dose rates, the applicable release limits are the average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters of 0.2 millirad per hour (mrad per hr) at 1 centimeter (cm) and 1.0 mrad per hr at 1 cm, respectively. These limits are stated in Policy and Guidance Directive FC 83-23, Enclosure 2, Table 1, footnote f (NRC 1993a). The levels contained in Policy and Guidance Directive FC 83-23, Enclosure 2, Table 1, footnote f are limits imposed by license condition in LC 9.6 of Materials License SUA-1601. In Attachment 3 to its July 27, 2015, letter, Strata stated that it would use a Ludlum Model 19 or Ludlum Model 9-3 to detect potential contamination from radionuclides emitting gamma radiation. In Attachment 4 of its July 27, 2015, letter, Strata stated that contamination surveys for equipment and material which are to be released to unrestricted areas will be performed with the Ludlum Model 2360 ratemeter/scalemeter/data logger with a Ludlum Model 43-93 alpha/beta probe and a Ludlum Model 19 or Ludlum Model 9-3, or equivalent survey instrumentation. Strata also stated that its applicable limits for beta-gamma contamination include the additional stipulation in footnote f of Table 1 of Enclosure 2 to NRC's FC 83-23 (NRC 1993a).

In its July 27, 2015, letter, Strata described the detection capability of the Model 19 by stating that it is a highly sensitive microRoentgen (μR) meter with a measuring range of background to 5 milliRoentgen (mR) per hr. However, the Model 19 only measures gamma radiation, and could not be used to measure beta-emitting contamination on surfaces. The Model 9-3 proposed by Strata is an air ionization chamber for areas with elevated gamma radiation with a range up to 50 R per hr. The Model 9-3 has a retractable beta shield which allows for measurement of beta-emitting contamination on surfaces using a 7 mg per cm^2 shield. The lowest indicated range of the Model 9-3 is 0.2 mR per hr, which is about the same as the applicable release limits for average radiation levels associated with surface contamination resulting from beta-gamma emitters of 0.2 millirad per hour (mrad per hr) at 1 cm.

Therefore, by letter dated October 15, 2015 (NRC 2015b), NRC staff asked Strata to identify a beta-gamma detector with sufficient sensitivity below the release level in Policy and Guidance Directive FC 83-23, Enclosure 2, Table 1, footnote f (NRC 1993a). By letter dated October 20, 2015, Strata provided calculations which show that the surface contamination limits in Table 1 are more restrictive than the beta-gamma absorbed dose rate limits in footnote f. Therefore, Strata showed that meeting the surface contamination limits ensures the limits in footnote f will be met, and that a separate detector to measure beta-gamma absorbed dose rate was not needed to show that the limits in footnote f are met (Strata 2015c).

The following is the NRC staff's independent evaluation of Strata's rationale. As stated above, footnote f to Table 1 of Enclosure 2 of Policy and Guidance Directive FC 83-23 establishes separate radiation absorbed dose rate limits for beta-gamma contamination which must be met in addition to the beta-gamma surface activity limits in Table 1. As described in detail below, for beta-emitting progeny of natural uranium present at an average surface activity level of 5,000 disintegrations per minute per 100 square centimeters (dpm per 100 cm^2) or a maximum surface activity level of 15,000 dpm per 100 cm^2, the contamination will have associated absorbed dose rates through not more than 7 milligrams per square centimeter of total absorber of less than 0.2 mrad per hour and 1.0 mrad per hr, respectively. Therefore, the surface activity limits (in dpm per 100 cm^2) are the more restrictive limits, and dose rate limits in footnote f will be met if the beta-gamma emitter surface activity limits ir Table 1 are met.

Using Equation 6.33b of Cember (2009), the dose rate, $\dot{D}_b$, (in milliGray per hour, or mGy per hr) to the basal cells of the skin at a depth of 0.007 grams per square centimeter (g per cm^2) is approximated by:

$$\dot{D}_b = 3.6\ x\ 10^{-4} \times C_a \times \overline{E} \times e^{-(\mu_{\beta,a} \times d)} \times e^{-(\mu_{\beta,t} \times 0.007)} \times \mu_{\beta,t}$$

where $\overline{E}$ = average energy of emission of the beta particle in megaelectronvolts (MeV)
C_a = surface contamination in Becquerel per square centimeter (Bq/cm^2)
$\mu_{\beta,a}$ = beta particle absorption coefficient for air = $16(E_m - 0.036)^{-1.4}$, cm^2/g
$\mu_{\beta,t}$ = beta particle absorption coefficient for tissue = $18.6(E_m - 0.036)^{-1.37}$, cm^2/g
E_m = maximum beta particle energy in MeV
d = density thickness of air between a planar source and dose point in g per cm^2

The conversion factor 3.6 x 10^{-4} includes multiple factors, including a factor of 0.5 to account for the fraction of beta particles that leave the surface; an assumption that 25% of the beta particles that go into the surface are backscattered (or a factor of 1.25); an energy conversion factor of 1.6 x 10^{-13} joules per MeV; a time conversion factor of 3600 seconds per hour; and an energy absorption conversion factor of 10^6 gram-milliGray per joule. Protactinium-234m (E_m = 2.29 MeV, E = 0.82 MeV) is a short-lived progeny of natural uranium with the most energetic beta particle, and would result in the most conservative dose rate if all of the surface contamination were attributed to this radionuclide. If one assumes surface contamination levels of protactinium-234m equal to the average allowable level of 5,000 dpm per 100 cm^2 (0.83 Bq per cm^2), then the absorbed dose rate at a distance of 1 cm would be 0.0014 mGy per hr (0.14 mrad per hr). This conservative calculated rate is well below the 0.2 mrad per hr at 1 cm limit in footnote f of Table 1 for the average radiation level associated with surface contamination resulting from beta-gamma emitters. Similarly, surface contamination comprised entirely of protactium-234m at a level equal to the maximum allowable level of 15,000 dpm per 100 cm^2 (2.5 Bq per cm^2) would cause a dose rate at 1 cm of 0.0043 mGy per hr (0.4 mrad per hr), which is less than the 1.0 mrad per hr at 1 cm limit in footnote f of Table 1 for the maximum radiation level.

Therefore, NRC staff agrees that beta-gamma emitting contamination from natural uranium at the average and maximum limits allowed in Table 1 will have associated surface dose rates of less than 0.2 mrad per hr and 1.0 mrad per hr, respectively. The surface activity levels are thus the more restrictive limit, and compliance with the dose rate levels in footnote f is demonstrated by meeting the surface activity guideline values.

With regard to other surveys, in Attachments 3 and 4 of its July 27, 2015, letter, Strata explained that removable contamination levels would be measured using a Ludlum Model 3030, or equivalent instrumentation, and that fixed and removable contamination for personnel exit surveys and equipment and material released from restricted areas would be measured using a Ludlum Model 2360 ratemeter / scalemeter / data logger coupled with a Ludlum Model 43-93 alpha / beta probe, or equivalent instrumentation (Strata 2015b). In its July 27, 2015, letter, Strata did not describe the detection capability of the instruments specified, as required by LC 12.8, but rather provided additional information which can be used to calculate detection capability in terms of dpm per 100 cm^2. By letter dated October 15, 2015, NRC staff asked Strata to describe the methodology by which Strata will determine the detection capability for fixed and removable alpha and beta contamination, as required by LC 12.8 (NRC 2015b). By letter dated October 20, 2015, Strata provided a detailed description of the methodology by which it will determine the detection capability for alpha and beta contamination (Strata 2015c). In its letter dated October 20, 2015, Strata included the following attachments: Attachment 1, "Responses to the Requests for Additional Information"; Attachment 2, "Revised Beta-Gamma Contamination Control Program"; and Attachment 3, "Revised 'Instrument Specifications and Additional Considerations.'"

The NRC staff's evaluation of the information provided by Strata in its letters dated July 27, 2015, and October 20, 2015, is provided below. This evaluation focuses on four factors that are important to ensuring that radiation survey equipment and methods for uranium contamination are sufficiently sensitive to detect contamination at acceptably low levels. These factors are: (1) accounting for mixtures of radionuclides; (2) estimating counting efficiencies of survey equipment; (3) the energy of radiation emitted from calibration sources; and (4) the use of both scans (i.e., sweeping the detector across a contaminated surface) and static (i.e., fixed) surveys to detect contamination.

Mixtures of radionuclides

In Section 5.7.3.1.1 of its TR (Strata 2011), Strata committed to confirm that natural uranium is the primary radioactive material of concern in both airborne particulate samples and yellowcake processed at the Ross ISR Project. This assumption regarding airborne contamination will be verified by air sampling and analysis in accordance with LC 10.16 (NRC 2014a) and commitments in Section 5.7.3 of Strata's TR regarding characterization of yellowcake (Strata 2011). However, natural uranium and its short-lived progeny are not the only potential contaminants on surfaces, equipment, and personnel at an ISR facility. Lixiviant solutions will also contain radium-226 and potentially long-lived isotopes of thorium (e.g., thorium-230). Therefore, by letter dated October 15, 2015, NRC staff asked Strata to account for at least two mixtures of radionuclides likely to be present in contamination at its Ross ISR Project – lixiviant and yellowcake (NRC 2015c). As described further below, by letter dated October 20, 2015, Strata revised its beta-gamma contamination control program to account for lixiviant and yellowcake mixtures at the Ross ISR Project (Strata 2015c).

Counting efficiencies of Ludlum Model 3030 and 43-93

In its July 27, 2015, letter Strata cited only the so-called "4π" instrument efficiencies cited by the manufacturer for the instruments it proposed, which accounts for the intrinsic efficiency of the instrument to detect radiation emitted into all directions from an ideal source (e.g., a flat and polished calibration source). These are idealized counting efficiencies which do not take into account source effects, such as the absorption or scattering of radiation in the paper filter being surveyed. As noted in the NRC staff's letter to Strata dated October 15, 2015, an appropriate consideration of the counting efficiencies of the Ludlum Model 3030 and Model 43-93 would take into account a number of factors, including absorption or scattering of radiation on the surface of the item being surveyed, the distance between the surveyed item and the detector, and the intrinsic efficiency of the detector to detect radiation incident upon it (i.e., instrument efficiency) (NRC 2015b).

In its October 20, 2015 (Strata 2015c), response to NRC staff's October 15, 2015, RAI, Strata accounted for source effects using the methodology the NRC staff has previously endorsed (NRC 1998, 2006). This approach to calculating counting efficiency for alpha and beta particles is described in the International Organization for Standardization's (ISO) Guide 7503–1, "Evaluation of Surface Contamination" (ISO 1988a). The ISO approach defines the counting efficiency for alpha and beta particles as the product of the instrument efficiency, ε_i, and the source efficiency, ε_s. In the ISO approach, the instrument efficiency (ε_i) is the ratio of the instrument's net reading (in counts per minute, or cpm) to the surface (2π) emission rate of a source for radiation of a given energy under given geometric conditions. The source efficiency (ε_s) is the ratio of the surface emission rate of a source to the radiation production rate in the source. Specifically, the ISO 7503-1 recommendation is to use a source efficiency of 0.5 for maximum beta energies exceeding 0.4 MeV, and to use a source efficiency of 0.25 for maximum beta energies between 0.15 and 0.4 MeV and for alpha-emitters (ISO 1988a). Source efficiencies may be determined experimentally or simply selected from the guidance contained in ISO 7503-1 (NRC 1998). The product of the instrument efficiency and the source efficiency ($\varepsilon_i \times \varepsilon_s$) describes the counting efficiency of the instrument.

As stated above, the NRC staff has previously endorsed the ISO 7503-1 (ISO 1988a) approach for assigning default surface efficiencies based on particle type (alpha or beta) and energy (beta only) (NRC 2006, 1998). Therefore, NRC staff finds acceptable Strata's proposed methodology for calculating counting efficiencies for use in estimating MDC.

Weighted counting efficiencies for radionuclide mixtures

By letter dated October 15, 2015, NRC staff asked Strata to describe a methodology to calculate MDCs which correctly considers radionuclide-weighted counting efficiencies for the major radionuclide mixtures likely to be encountered at the Ross ISR Project (NRC 2015b). The staff's draft SER with open items, which was included with its October 15, 2015, request for additional information, provided an example of accounting for a mixture of radionuclides, including an example calculation in Tables 1 and 2 of the overall weighted counting efficiency of the Ludlum 43-93 for alpha and beta particles in aged yellowcake. By letter dated October 20, 2015, Strata revised its methodology for calculating MDCs to include mixtures of radionuclides present in lixiviant and yellowcake. Therefore, NRC staff finds acceptable Strata's proposed methodology for calculating weighted counting efficiencies for radionuclide mixtures.

Calibration sources

In its letter dated July 27, 2015, Strata stated that it has purchased a thorium-230 alpha calibration source which emits alpha particles with energies of 4.68 MeV (76%) and 4.62 MeV (24%) and a strontium-90 beta calibration source with a maximum beta energy associated with its short-lived yttrium-90 progeny of 2,270 keV. The thorium-230 emission energies are between the major emission energies for uranium-234 (4.77 MeV) and uranium-238 (4.20 MeV). The strontium-90 / yttrium-90 maximum beta energy is nearly the same as the maximum beta energy for protactinium-234m, the predominant (i.e., largest contributor to detector response) short-lived beta-emitting progeny of uranium-238.

The NRC staff previously recommended that calibration sources should be selected that emit alpha or beta radiation with energies similar to those expected of the contaminant in the field (NRC 1998). In addition, the most representative calibration source would be one prepared from the radioactive material being assessed in the field (NRC 1998). ISO-8769, "Reference Sources for the Calibration of Surface Contamination Monitors," provides recommendations on calibration source characteristics (ISO 1988b).

The NRC staff endorsed (NRC 2006, 1993b) previous versions of the American National Standards Institute (ANSI) standard N323AB–2013, “Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments.” (ANSI 2013). ANSI standard N323AB–2013 recommends that single point calibrations are only valid for applications to field measurement energies that are greater than the calibration energy (ANSI 2013).

By letter dated October 15, 2015, NRC staff noted that the radiation emission energy of the thorium-230 and strontium-90 calibration sources selected by Strata are close to the emission energies of isotopes of uranium and its short-lived progeny to calibrate the Ludlum Model 3030 and Ludlum Model 43-93 for use at an ISR facility (NRC 2015b). However, the NRC staff stated that the strontium-90 source is not appropriate for calibrating the Ludlum Model 3030 and Ludlum 43-93 to detect beta particles with lower maximum emission energies than that of protactinium-234m, such as the beta particles from decay of thorium-234 and thorium-231. Therefore, the NRC stated that unless Strata uses either an alternative source or an appropriate additional source (e.g., carbon-14 with a maximum beta energy of 156 keV) to calibrate the Ludlum 43-93 at those energies, it should not credit the instrument’s response to those energies when estimating minimum detectable concentrations and surface contamination levels. By letter dated October 20, 2015, Strata responded that it calculated the MDC for its instruments using a weighted counting efficiency for only high energy beta particles because it did not have a lower energy calibration source with which to calibrate its Ludlum Model 3030 and Ludlum Model 43-93. Strata also committed to obtaining a carbon-14 calibration source, conducting an analysis of the radionuclide composition of its pregnant lixiviant, and recalculating its MDCs within 3 months of the beginning of operations at the Ross ISR Project. The NRC staff finds it acceptable that Strata has correctly estimated its MDCs while it has only a strontium-90 calibration source, until it can obtain a carbon-14 calibration source and analyze its pregnant lixiviant. A summary of Strata’s results for the Ludlum Model 43-93 and aged yellowcake is provided for illustrative purposes in Tables 1 and 2 below.

As a result of these weighted counting efficiencies, Strata revised its beta-gamma contamination survey program to use slower scan speeds (i.e., 0.5 cm per s) and longer static survey times (1.5 minutes, instead of 1 minute) to ensure MDCs will be below applicable regulatory limits. Strata also revised its action limit from 750 dpm per 100 cm^2 to 900 dpm per 100 cm^2.

In addition to evaluating the radionuclides chosen by Strata for its calibration sources, the NRC staff also evaluated the size and shape (i.e., geometry) of the calibration sources proposed by Strata. Strata proposed to use disk type sources, which have a relatively small active area as compared to the area of the detector face. The NRC staff is aware that one recommendation in ISO-7503-1 (ISO 1988a) is that the dimensions of the calibration source be sufficient to cover the active area of the detector. However, ANSI standard N323AB–2013 (ANSI 2013) provides guidance on using an array of small sources, or a single source, to develop an effective area source in the size and shape of the detector probe. As noted in Table 4.11 of NUREG-1507 (NRC 1998), the difference in instrument efficiency between a disc source and a distributed source is relatively small for zinc-sulfide (ZnS) detectors like the Ludlum 43-93, at least in the case of detecting alpha particles.

Table 1. Strata's Ludlum 43-93 alpha counting efficiency for aged yellowcake

Isotope	Energy[2] (MeV)	Uranium Fraction	Branching Ratio	Instrument Efficiency	Surface Efficiency	Weighted Efficiency
U-238	4.15	0.485	.21	0.36	0.25	0.0092
U-238	4.20	0.485	.79	0.36	0.25	0.0345
U-234	4.72	0.493	.28	0.36	0.25	0.0124
U-234	4.77	0.493	.72	0.36	0.25	0.0319
U-235	4.21	0.022	.06	0.36	0.25	0.0001
U-235	4.37	0.022	.17	0.36	0.25	0.0003
U-235	4.40	0.022	.55	0.36	0.25	0.0011
U-235	4.60	0.022	.05	0.36	0.25	0.0001
	Alpha counting efficiency =					0.090

Table 2. Strata's Ludlum 43-93 beta counting efficiency for aged yellowcake

Isotope	Energy[2] (keV)	Activity Fraction	Branching Ratio[2]	Instrument Efficiency	Surface Efficiency	Weighted Efficiency
Th-234	103	0.489	0.21	0	0[1]	0
Th-234	193	0.489	0.79	0	0.25	0
Pa-234m	**2290**	**0.489**	**0.98**	**0.37**	**0.5**	**0.0887**
Th-231	206	0.022	0.13	0	0.25	0
Th-231	287	0.022	0.12	0	0.25	0
Th-231	288	0.022	0.37	0	0.25	0
Th-231	305	0.022	0.35	0	0.25	0
	Beta counting efficiency =					0.089

[1] The surface efficiency is assigned a value of zero because this maximum beta energy is less than the 150 keV threshold described in ISO (1998a).

Strata stated that its procedures for scanning potential contamination describe that the probe face should be held 0.3 cm (1/8-inch) from the material being scanned. To evaluate whether Strata's proposed calibration sources and scan height would be adequate, the NRC staff considered Tables 4.5 and 4.6 of NUREG-1507 (NRC 1998), which indicate that there should be minimal difference in detector response to a distributed or disc source for both alpha and beta particles at Strata's proposed scanning distance. The NRC staff also reviewed work by Goles (1991), who found that, assuming a 100 square centimeter contamination zone, the instrument minimum detectable concentrations for contamination distributed across an area would be nominally the same as if all surface contamination was concentrated at a single point. Goles stated that this is because the increased residence time of the detector over a distributed source during a scan compensates for the lower surface contamination of the distributed activity.

Therefore, the NRC staff has reasonable assurance that the licensee can implement an adequate on-site calibration program for its contamination detection instruments using its thorium-230 and strontium-90 sources when the calibration is performed in accordance with accepted standards (e.g., ANSI standard N323AB–2013) using the scanning methodology proposed by the licensee.

Alpha Scans and Static Surveys

By letter dated October 20, 2015, Strata provided an assessment of the MDC for the Ludlum Model 3030 to detect removable alpha contamination for both aged yellowcake and pregnant lixiviant using the formula for calculating the MDC for static surveys by Strom and Stansbury, as presented in Table 3.1 of NUREG-1507 (NRC 1998). This formula is as follows:

$$MDC = \frac{3 + 3.29\sqrt{\mathrm{R}_b t_g (1 + t_g/t_b)}}{(\text{counting efficiency})(t_g)}$$

where R_b is the background counting rate; t_g is the gross counting time; and t_b is the background counting time. For aged yellowcake, Strata assumed a Ludlum Model 3030 alpha background count rate of 3 cpm, an alpha counting efficiency of 15.7%, and a background and survey count time of 1 minute and 1.5 minute, respectively to estimate an MDC of about 80 dpm per 100 cm^2. Strata's value for pregnant lixiviant was 100 dpm per 100 cm^2. The NRC staff finds these values acceptable because they are both less than the 500 per 100 cm^2 value for the lower limit of detection specified in Table 3, "Summary of Survey Frequencies," of NRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities." (NRC 2002). These values are also below Strata's revised proposed action level of 90% of the regulatory limit (e.g., < 90% of the removable alpha contamination limit of 1,000 dpm per 100 cm^2, or 900 dpm per 100 cm^2). The NRC staff finds Strata's proposed action level is acceptable because it is consistent with guidance contained in Regulatory Position 4 of Regulatory Guide 8.30 (NRC 2002) that licensees set administrative levels to protect workers.

In its October 20, 2015, letter Strata also described its methodology for calculating scan MDCs for alpha surveys using the approach outlined in NUREG-1507 (NRC 1998) and Abelquist (2014).

For alpha-emitting radionuclides, the scan MDC takes into account that the background response of most alpha detectors is very close to zero. At these low count rates, the probability of detecting alpha-emitting surface contamination is calculated using Poisson summation statistics. Equation 6-12 of NUREG-1575 describes the probability of observing a single count while passing the detector over a contaminated area (NRC 2009). Abelquist (2014) defined the minimum alpha activity that can be detected by solving Equation 6-12 for "G", resulting in:

$$Alpha\ scan\ MDC = \frac{\left[-\ln\left(1 - P(n \geq 1)\right)\right] * 60}{\varepsilon_i \varepsilon_s t}$$

Where $P(n \geq 1)$ is the probability of detecting a single count; ε_i is the instrument efficiency; ε_s is the surface efficiency; and t is the scan time (also referred to as residence time) in seconds. For aged yellowcake, Strata assumed a $P(n \geq 1) = 90\%$ probability of detecting 1 count; a counting efficiency ($\varepsilon_i \times \varepsilon_s$) of 0.09 (9%); and a residence time (i.e., t) of 14 seconds to estimate an alpha scan MDC of just over 110 dpm per 100 cm^2. Strata's value for pregnant lixiviant was 137 dpm per 100 cm^2. Strata's estimate of residence time was based on a scan rate of 0.5 cm per second over the smallest dimension of the detector, which is its approximate width of 7 cm.

The NRC staff finds these values acceptable because they are lower than the 500 dpm per 100 cm^2 value for the lower limit of detection specified in Table 3, "Summary of Survey Frequencies," of NRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities" (NRC 2002). This value is also below Strata's proposed action level of 90% of the regulatory limit (e.g., < 90% of the removable alpha contamination limit of 1,000 dpm per 100 cm^2, or 900 dpm per 100 cm^2). By letter dated October 15, 2015, NRC staff asked Strata to quantify the scan speed for purposes of ensuring that this scan speed is controlled by procedures and staff are correctly trained on the importance of this parameter. By letter dated October 20, 2015, Strata explained its proposed scan speed (as described above) and committed to incorporate this scan speed requirement into appropriate procedures and training personnel to conduct the scans at the specified scan rate.

NRC staff also evaluated Strata's October 20, 2015, estimate of MDC for static surveys using the same formula by Strom and Stansbury (1992) cited above, except that consideration of the probe area is added:

$$MDC = \frac{3 + 3.29\sqrt{\mathrm{R}_b t_g (1 + t_g/t_b)}}{(\text{counting efficiency})(t_g)\,\frac{probe\ area,\, cm^2}{100\ cm^2}}$$

The active probe area of the Ludlum 43-93 is 100 cm^2. Strata assumed a Ludlum Model 43-93 alpha background count rate of 1 cpm, a counting efficiency of 9% (see Table 1 above), and a background and survey count time of 1 minute and 1.5 minutes, respectively, to estimate an MDC of about 64 dpm per 100 cm^2. Strata's value for pregnant lixiviant was 81 dpm per 100 cm^2. The NRC staff finds these values are acceptable because they are less than the 500 dpm per 100 cm^2 value for the lower limit of detection specified in Table 3, "Summary of Survey Frequencies," of NRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities" (NRC 2002). These values are also below Strata's proposed action level of 90% of the regulatory limit for release of equipment and materials (e.g., < 90% of the removable alpha contamination limit of 1,000 dpm per 100 cm^2, or 900 dpm per 100 cm^2). NRC staff also finds that the typical alarm setting of 20 cpm for personnel contamination surveys using a Ludlum 43-93 corresponds to a contamination level of about 200 dpm per 100 cm^2, which is below acceptable contamination levels.

Beta Scans and Static Surveys

NRC staff also evaluated Strata's methodology for determining MDCs for surveys of beta-emitting contamination. For aged yellowcake, Strata assumed the Ludlum Model 3030 beta background count rate of 50 cpm, a beta counting efficiency of 15.3%, and a background and survey count time of 1 minute and 1.5 minutes, respectively, to estimate an MDC of about 374 dpm per 100 cm^2. Strata's value for pregnant lixiviant was 418 dpm per 100 cm^2. NRC guidance (e.g., Regulatory Guide 8.30) does not specify an acceptable MDC for beta-emitting contamination. However, these values are below Strata's proposed action level of 90% of the regulatory limit (e.g., < 90% of the removable beta contamination limit of 1,000 dpm per 100 cm^2, or 900 dpm per 100 cm^2).

Strata used the methodology for calculating MDC for beta scan surveys that is outlined in NUREG-1575 (NRC 2009) and Abelquist (2014). Equation 6-10 of NUREG-1575 provides a formula for estimating the scan MDC for beta-gamma-emitting radionuclides on structure surfaces:

$$Beta - Gamma\ Scan\ MDC = \frac{MDCR}{\sqrt{p}\varepsilon_i \varepsilon_s \frac{probe\ area, cm^2}{100\ cm^2}}$$

Where MDCR (minimum detectable count rate) is determined using equations 6-8 and 6-9 of NUREG-1575 (NRC 2009); p is the surveyor efficiency; ε_i is the instrument efficiency; ε_s is the surface efficiency; and the probe area is characteristic of the instrument. The active probe area of the Ludlum 43-93 is 100 cm^2. For aged yellowcake Strata assumed a false positive rate of 0.60 (60%); true positive proportion of 0.95 (95%); a surveyor efficiency of 0.5; a counting efficiency ($\varepsilon_i \times \varepsilon_s$) for protactinium-234m of 0.089 (8.9% - see Table 2 above); a 14 second residence time; and 300 cpm background count rate, to estimate a beta scan MDC of about 790 dpm per 100 cm^2. Strata's value for pregnant lixiviant was 879 dpm per 100 cm^2. NRC guidance (e.g., Regulatory Guide 8.30) does not specify an acceptable MDC for beta-emitting contamination. However, these estimated MDCs are below Strata's internal action level of 90% of the applicable removable surface contamination limit of 1,000 dpm per 100 cm^2 in Table 1 of Policy and Guidance Directive FC 83-23 (NRC 1993a).

Strata's estimate of the beta static survey MDC for aged yellowcake using a Ludlum Model 43-93 beta background count rate of 300 cpm, a counting efficiency of 8.9%, and a background and survey count time of 1 minute and 1.5 minute, respectively, is about 762 dpm per 100 cm^2. Strata's value for pregnant lixiviant was about 848 dpm per 100 cm^2. These values are acceptable because they are below Strata's proposed action level of 90% of the regulatory limit for release of equipment and materials (e.g., < 90% of the removable alpha contamination limit of 1,000 dpm per 100 cm^2, or 900 dpm per 100 cm^2).

Conclusion

The NRC staff finds that Strata has adequately described its monitoring equipment sensitivity, calibration methods and frequency, and planned use, in accordance with LC 12.8. Therefore, NRC staff proposes to remove LC 12.8 from Materials License SUA-1601. NRC staff will include Strata's letter dated October 20, 2015, to the "tie-down" license condition 9.2, which states that the licensee shall conduct operations in accordance with the commitments, representations, and statements contained therein.

Categorical Exclusion and Consultations

In accordance with 10 CFR 51.22(b), the NRC staff has determined that an environmental assessment or an environmental impact statement is not required for this action because it is an amendment which is procedural in nature, which is included in the list of categorical exclusions in 10 CFR 51.22(c). Specifically, 10 CFR 51.22(c)(11) describes the following category of action which is categorically excluded: "Issuance of amendments to licenses for fuel cycle plants and radioactive waste disposal sites and amendments to materials licenses identified in 10 CFR 51.60(b)(1) which are administrative, organizational, or procedural in nature, or which result in a change in process operations or equipment, provided that (i) there is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, (ii) there is no significant increase in individual or cumulative occupational radiation exposure, (iii) there is no significant construction impact, and (iv) there is no significant increase in the potential for or consequences from radiological accidents."

The staff evaluated the four conditions contained in 10 CFR 51.22(c)(11)(i) through 10 CFR 51.22(c)(11)(iv). This administrative and procedural amendment removes pre-operational license condition 12.8 from NRC Materials License SUA-1601 as a result of the NRC staff's approval of the survey program and information provided by Strata in satisfaction of the license condition. As an administrative and procedural amendment, this action is categorically excluded from the requirement to prepare an environmental assessment or environmental impact statement.

In addition, the review and approval of the information submitted by Strata which enables the staff to remove LC 12.8 allows Strata to implement a beta-gamma contamination control program in accordance with regulatory requirements. This program has no bearing on plant operations, air effluents, or liquid waste processing activities. Therefore, there can be no significant changes in the types or amounts of effluent released offsite. A beta-gamma contamination control program ensures that there will be no significant increase in individual or cumulative occupational radiation exposure. Finally, since the beta-gamma contamination control program involves only portable radiation detection equipment, training and procedures, there will be no significant construction impact resulting from implementation of the program and no significant increase in the potential for, or consequences of, radiological accidents.

The NRC staff has determined that a Section 7 consultation is not required because the proposed action is administrative/procedural in nature and will not affect listed species or critical habitat. The NRC staff has also determined that the proposed action is not a type of activity that has potential to cause effects on historic properties because it is an administrative/procedural action. Therefore, no further consultation is required under Section 106 of the National Historic Preservation Act.

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Enclosure 2

Amendment No. 4, Source and Byproduct Materials License SUA-1601