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Title/Desc:

CSER 95-014 CRITICALITY STORAGE CATEGORY FOR K
BASIN SPENT CARTRIDGE FILTERS IN ECOROK CASKS AT
CWC

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ENGINEERING DATA TRANSMITTAL

Page 1 of 2

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1	1	Cog. Mgr. D. S. Leach	<i>D.S. Leach</i>	12/12/95							
		QA									
1	1	Safety R. J. Koll	<i>RJKoll</i>	02JAN96							
		Env.									
1	1	Peer Review J. L. Geiger	<i>J.L. Geiger</i>	12/12/95	AL 34						
1	1	CSR R. M. Irwin	<i>R.M. Irwin</i>	12/12/95	TK03						

18. <i>Edward M. Miller</i> E. M. Miller Signature of EDT Originator Date 12-12-95	19. <i>D.B. Powell</i> D. B. Powell Authorized Representative for Receiving Organization Date 12/12/95	20. <i>D.S. Leach</i> D. S. Leach Cognizant Manager Date 12/12/95	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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UNREVIEWED SAFETY QUESTION CHANGES SCREENING FORM

Document Number: WHC-SD-SQA-CSA-20405
 USQ Screening Number: SWMFE-USQ-95-089

Title: Criticality Storage Category for K Basin Spent Cartridge Filters in ECOROK Casks at Central Waste Complex.

Questions:

Does the referenced item:	N/A	NO	YES/MAYBE
A. Make PROPOSED CHANGES to the facility or procedures which differ from conditions described in the safety basis?	[]	[X]	[]
B. Make PROPOSED CHANGES that represent conditions that have not been analyzed in the safety basis?	[]	[X]	[]
C. Describe tests or experiments which differ from those described in the safety basis?	[]	[X]	[]
D. Is a change in the TSR's involved?	[]	[X]	[]

BASIS (supporting information is required for each question, attach additional pages as necessary):

A. The proposed change does not change container fissile limits and analyzes the ECOROK container to prove that it is within the current criticality limits. The analysis against criticality safety requirements is documented within WHC-SD-SQA-CSA-20405.

B. The ECOROK is analyzed to prove it is an acceptable container and the contents limits are not changed by this CSER. Array restrictions have been shown to be within the safety basis in the criticality evaluation and remain within the conditions analyzed in the safety basis.

C. WHC-SD-SQA-CSA-20405 does not involve any tests or experiments.

D. WHC-SD-SQA-CSA-20405 does not change any TSR related information.

[X] Agree
 [] Disagree (Requires explanation, attach additional pages as necessary)

USQE No. 1

R.M. Irwin

Print

R.M. Irwin 12/13/95
 Signature Date

USQE No. 2

JE Mitchell

Print

JE Mitchell 12/21/95
 Signature Date

RELEASE AUTHORIZATION

Document Number: WHC-SD-SQA-CSA-20405, Rev. 0

Document Title: CSER 95-015: Criticality Storage Category for Spent K Basin Cartridge Filters in ECOROK Casks at Central Waste Complex

Release Date: 01/03/96

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

C. WILLINGHAM

01/03/96

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SUPPORTING DOCUMENT

1. Total Pages 21

2. Title

CSER 95-014: Criticality Storage Category for Spent K Basin Cartridge Filters in ECOROK Casks at Central Waste Complex

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WHC-SD-SQA-CSA-20405

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6. Author

Name: E. M. Miller

Edward M. Miller

Signature

Organization/Charge Code 8M400/LD044

7. Abstract

This CSER justifies storing K Basin spent cartridge filters in ECOROK 25-11 casks with liners under the limits in an existing criticality prevention specification, CPS-SW-149-00002, Rev./Mod. B-1, because the worst case fissionable material inventory is less than 1/2 the CPS limit and the cask is larger than allowed containers, the cask and liner have adequate iron content to meet the CPS requirements, and the cask concrete walls are thick enough to isolate the fissionable contents of each cask from neutron interaction with fissionable material external to each cask.

8. RELEASE STAMP

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CSER 95-014

Title: CRITICALITY STORAGE CATEGORY FOR K BASIN SPENT CARTRIDGE FILTERS IN
ECOROK CASKS AT CENTRAL WASTE COMPLEX

Prepared by: E. M. Miller Date: Dec. 12, 1995
E. M. Miller, Senior Engineer
Criticality Evaluation Team in Consequence Analysis

Reviewed by: J. L. Geiger Date: 1995 Dec 13
J. L. Geiger, Advanced Engineer
Criticality Evaluation Team in Consequence Analysis

Approved by: D. S. Leach Date: 12/13/95
D. S. Leach
Manager, Consequence Analyses

1.0 INTRODUCTION AND SUMMARY

This criticality safety evaluation report establishes that the criticality limits for container type 5 burial boxes may be applied to the ECOROK¹ 25-11 casks with liners that will be used for storage of spent K Basin cartridge filters. The worst-case fissionable material inventory in the spent cartridge filters (excluding uranium) is less than 125 grams per ECOROK cask. The uranium in the filters is enriched to 1.15 wt% at most; at this enrichment, there is no limit on the amount of uranium that can be stored in a

¹ ECOROK is a trademark of Scientific Ecology Group, Inc.

burial box. Therefore, this evaluation concludes that an ECOROK cask with liner containing up to 19 spent K Basin cartridge filter elements or one 88-element cartridge filter assembly may be stored at Central Waste Complex using the limits specified in the *Criticality Prevention Specification for Waste Storage - Central Waste Complex*, CPS-SW-149-00002 (WHC 1994) for the 2.5 ft x 2.5 ft x 2.5 ft burial box, a type 5 container. The criticality limits restrict the fissionable inventory of the smallest burial box to 250 g; the array limits require a 91-cm (3-ft) separation of each container holding an inventory of 250 g or more of fissionable material and between arrays of containers holding inventories of less than 250 g.

Each ECOROK cask has a minimum of 27.9 cm (11 in.) of concrete surrounding the fissionable contents; therefore the interaction would be negligible between the cask's contents and any other fissile material external to the cask. An infinite number of casks, closely packed, could be assembled in a three-dimensional array, and the array would be only as reactive as a single cask, and the entire array would be subcritical. The addition of water to the array and/or to the casks would decrease the reactivity by adding to the reflection, thus further decreasing neutron interaction between casks contents. Consequently, a separation distance is not required and the casks could be stacked with sides touching, in any array, without restrictions. However, the casks are to be stored in a single layer array for stability and because the cask lifting lugs project above the cask's top.

2.0 DESCRIPTION OF FILTERS AND CASKS

Spent K Basin cartridge filters will be shipped to Central Waste Complex for storage. The filters remove solids from K Basin water before the water is pumped to air-cooled chillers. The filter assemblies used until 1995 are composed of 88 elements and are about 81.3 cm (32 in.) in diameter and 86 cm (34 in.) tall, as described in the memorandum of understanding (MOU) attached in Appendix A. Only one of these cartridge filter assemblies will fit in an ECOROK 25-11 cask. The replacement filtering system holds seven cartridge filters. Each filter is about 15.24 cm (6 in.) in diameter and 76.2 (30 in.) long. Nineteen filters will fit in an ECOROK 25-11 cask with a liner, as shown in the source term assumptions development list in Appendix A.

The four drawings in Appendix B show the ECOROK 25-11 cask and liner. The filters are to be put into the 5.1 cm (2 in.) thick steel cylindrical liner. The liner is 78.7 cm (31 in.) inside diameter and 96.5 (38 in.) inside height with exterior dimensions of 88.9 cm (35 in.) outside diameter and 106.7 cm (42 in.) height. The liner is put into the cask that has inside dimensions of 96.5 cm (38 in.) inside diameter and 116.8 cm (46 in) inside height. The exterior dimensions are 152.4 cm (60 in) diameter and 177.8 cm (70 in) height.

The cask is made of steel rebar and concrete. The concrete top and bottom are 30.5 cm (12 in.) thick and the cylindrical sides are 27.9 cm (11 in.) thick. This puts at least 27.9 cm (11 in.) of concrete and 5 cm (2 in.) of iron between the filters and any fissionable material near the cask and twice those thicknesses between any two casks no matter how they are arranged.

CRITICALITY SAFETY EVALUATION REPORT FOR MKIA FUEL PERTAINING TO CONSOLIDATING FUEL STORAGE, WHC-SD-NR-CSER-015, Rev. 0, (Schwinkendorf 1994), specifies that the sludge in the K East Basin has a maximum uranium enrichment of 0.95 wt% and in the K West Basin it is 1.15 wt%. The K West Basin contains fuel enriched to 1.25 wt%, but it is only the outer annular part of the MKIA fuel elements that are enriched to that level. The inner annulus is enriched to 0.947 wt%. When averaged, the result is a maximum uranium enrichment of 1.15 wt% for the corrosion products in the water from the thousands of fuel elements in the basin.

3.0 FISSILE MATERIAL CONTENT

CSAR 95-008: CRITICALITY STORAGE CATEGORY FOR GROUTED K BASIN CARTRIDGE FILTERS AT CWC, WHC-SD-SQA-CSA-20398, Rev. 0, (Miller 1995), found that the maximum plutonium content in any one of the 13 grouted, 88-element, K Basin spent cartridge filter assemblies was 15.5 g of plutonium. The CSER also estimated the uranium content at 2.2 kg with a maximum enrichment of 0.95 wt% in the K East Basin and with a maximum enrichment of 1.15 wt% in K West Basin.

Conservative source term values are given in the MOU for the fissile material content of ECOROK casks loaded with spent K Basin cartridge filters. Table 1 lists the masses of isotopes pertinent to a criticality analysis. The masses were calculated from values specified in Curies in the MOU using constants from Appendix C of *Calculational Methods, Fissile Materials - Equivalents and Conversion Factors*, in WHC-EP-0063-4, (Willis 1995). The total plutonium mass inventory for a cask is 72 g, which is about five times that for an 88-element filter cartridge assembly. About 9% is ^{240}Pu , which makes using 72 g to evaluate the cartridge filter conservative because ^{240}Pu decreases the reactivity of ^{239}Pu by more than its fraction of the mass of plutonium. The source term lists 252 g of ^{235}U and 33.3 kg of ^{238}U per cask. These quantities give an enrichment of 0.75 wt%, which is about that of natural uranium. Uranium of such low enrichment could not be made critical in its form and in the amounts contained in a cask. The fissionable isotopes ^{238}Pu , ^{241}Pu , and ^{241}Am are in such small amounts that they have an insignificant effect on the reactivity of the cartridge filters.

Table 1. Calculated Masses of Plutonium and Uranium from Source Term Data.

ISOTOPE	CURIES	CURIES /GRAMS	GRAMS	WT % of Pu or U
²³⁸ Pu	2.1	17.1	0.12	0.2
²³⁹ Pu	3.7	0.062	59.68	83.2
²⁴⁰ Pu	2.1	0.227	9.25	12.9
²⁴¹ Pu	120.0	103	1.17	1.6
²⁴¹ Am	5.1	3.42	1.49	2.1
TOTAL Pu			71.71	100.0
²³⁵ U	5.45E-04	2.16E-06	252	0.75
²³⁸ U	1.12E-02	3.36E-07	33333	99.25
TOTAL U			33585	100.0

Appendix A contains a worst-case fissile loading analysis for an ECOROK cask and liner filled with 19 spent filter elements. The worst-case analysis uses six times the maximum plutonium concentration and three times the maximum uranium concentration found in the basin sludge times the weight of the dirt that an 88-element assembly could hold increased by the ratio of the surface area of 19 filter elements to that of the 88-element cartridge filter assembly. The weight of the dirt was found to be 120 kg (264 lb), which is five times that in an 88-element cartridge filter assemblies. K Basin data on plutonium and uranium concentrations were increased by a factor six for plutonium and three for uranium to 0.4 g Pu/lb of sludge and 66 g U/lb of sludge. The resulting worst-case loading for the ECOROK cask is conservatively estimated to be 106 g of plutonium and 17 kg of uranium. The plutonium value is about 50% higher than the source term value, and the uranium value is about half that of the source term value. In all cases, the limiting loading resulted from 19 cartridge filters rather than an 88-element cartridge filter assembly.

CSER 95-008 (Miller 1995) found that K Basin reports on fissionable isotopes present in filters included isotope 237 of neptunium. The largest amount on any 88-element assembly was 3.74 g. Estimating the amount on 19 filter elements as five times that on an 88-element assembly, the ²³⁷Np loading of an ECOROK cask would be less than 19 g. The factor of five was based on the larger amount of dirt that the 19 elements can hold compared to that an 88-element filter assembly can hold per the worst-case analysis in Appendix A.

4.0 ANALYSIS

The K Basin spent cartridge filters in ECOROK casks are subcritical in all circumstances because there is so little fissionable material in them and because the cask and liner isolate the fissionable material in the cask from neutron interaction with any other fissionable material outside the cask. The sections below demonstrate that the containers are less reactive than burial boxes or 55-gallon drums containing the allowable limits of fissile material (WHC 1994). CSAR 80-021: *Packaging, Storage, and Disposal of Solid Waste (55-Gallon Drums, Unrestricted H/Pu Only)*, SD-SQA-CSA-20121, Rev. 0, (Carter 1981), established the adequate subcriticality of the limits for arrays of drums. The limit for drums was used to establish the limits for burial boxes in CSAR 82-001: *Transportation and Burial of PUREX Burial Box*, SD-SQA-CSA-20129, Rev. 0, (Carter 1982). The sections below show that the ECOROK 25-11 casks with liners containing K Basin spent cartridge filters are significantly less reactive than the smallest burial box or a 55 gallon drum containing the limiting quantity of fissionable material.

4.1 TOTAL FISSILE MATERIAL

The cartridge filter elements in the ECOROK cask are expected to hold plutonium and uranium in the amounts specified in the MOU and neptunium in the amount specified in CSER 95-008 (Miller 1995). Only the plutonium would contribute to the reactivity of the casks. The uranium is less than 1.15 wt% enriched (Schwinkendorf 1994), and at that enrichment, the uranium effect on reactivity is negligible. Less than 19 g of neptunium will be present in the 19 cartridge filter elements that can fit in the ECOROK cask liner. If only a little hydrogen is present ($H/Np > 5$), then ^{237}Np will not contribute to the reactivity (Carter 1968). The cartridge filter elements are wet when bagged in plastic and put in the casks, so the water of hydration and that retained in the dirt would maintain an H/Np ratio greater than 5, and therefore the neptunium can be considered exempt from criticality consideration. Even if dried in a fire, a total of 19 g of ^{237}Np would be no more reactive than an equal mass of plutonium (Carter 1968). The 19 g of ^{237}Np added to the 72 g of plutonium estimated to be in a cask by the MOU source term would still be less than 100 g of fissionable material per ECOROK cask. Even if all the fissionable material from a cask were concentrated in less than 20% of the area of a 55-gallon drum, the total equivalent plutonium inventory would be less than the 100 g limit for a single 55-gallon drum.

For the worst-case estimate of 106 g of plutonium, the combined plutonium and neptunium inventory would be less than 125 g of fissionable material. The cask system would still be safe at 125 g because this amount is less than one quarter of the minimum critical mass of ^{239}Pu ; 531 grams (Carter 1968). Therefore, even if all the fissionable material from 19 spent filter elements in an ECOROK cask were collected, optimally water moderated, and fully reflected, a criticality would not be possible.

The dirt and fissionable material are spread over 19 cartridge elements, so the fissionable material is spread over more than 20% of the volume, and the 100 g limit for 55-gallon drums would not be applicable.

4.2 BURIAL BOX FISSILE MATERIAL LIMITS

CPS-SW-149-00002 (WHC 1994) specifies limits for burial boxes (container type 5). The criticality limit for the smallest type 5 container (2.5 ft x 2.5 ft x 2.5 ft burial box) is 250 g of fissile material; the limit allows an unrestricted amount of uranium when the maximum enrichment is no more than 1.15 wt%. The amount of fissionable material (plutonium and neptunium) and uranium are well within these limits for the smallest type 5 container.

In addition, the ECOROK cask is larger than the smallest burial box. The burial box's volume is 442 l and the ECOROK 25-11 cask liner inside volume is 460 l and the outside cask volume is 3,000 l. The greater volume decreases the reactivity of a cask when compared to a burial box because the fissile material is at a lower density. Therefore, applying the array limits for the burial boxes to the casks will mean greater subcriticality.

4.3 ACCIDENT CONDITION

A possible off-normal contingency is the placement of an ECOROK cask in an array of 55-gallon drums. CPS-SW-149-00002 (WHC 1994) specifies limits for 55-gallon drums (container type 1) based on CSAR 80-021 (Carter 1981). The Criticality Prevention Specification allows 200 g of fissile material in a 55-gallon drum when the material occupies more than 20% of the drum volume and 100 g if the material occupies less than 20% of the drum volume. In the worst-case loading, the cask is estimated to contain less than 125 g of fissionable material divided equally between 19 filter elements. The cask's fissionable loading of less than 200 g spread out in 19 filter elements meets the limits for 55-gallon drum.

The ECOROK 25-11 cask (3,000 l) is about 15 times larger than a drum (217 l) and if substituted for drums in an array would decrease the array's reactivity. The reactivities of two arrays are roughly inversely proportional to the ratio of the two fissile densities raised to about the 1.5 power. As the volume of items in an array increases and the amount of fissile material per item remains constant without the addition of moderation or reflection, the reactivity of the array decreases (Carter 1968).

CSAR 80-021 (Carter 1981) shows that the reactivity of an array of 55-gallon drums is strongly dependent on the mass of iron in the drums. The more iron in a drum, the lower the reactivity of the array. An allowable 55-gallon drum has a minimum iron content of 23 kg. The drum (22.5 in. I.D., 33.25 usable inside height) has a volume of about 217 liters. The ECOROK 25-11 cask liner is made of steel (98 % iron) and is 5.08 cm (2 in) thick, top, bottom,

and sides. The liner contains more than 6,000 kg of iron plus the rebar in the cask. The cask's volume is 3,000 ℓ . Therefore the density of iron in a cask is 2.0 kg/ ℓ (that in a drum is 0.106 kg/ ℓ). The cask's iron content is adequate to substitute for that in displaced drums to maintain subcriticality in an array of waste drums:

4.4 CONTAINER ISOLATION

The drawings in Appendix B show that there is at least 27.9 cm (11 in.) of concrete in the wall of the cask around the 19 filter elements. When two casks are adjacent, at least 55.8 cm (22 in.) of concrete separate the fissionable material. The 27.9 cm (11 in.) of concrete is enough to isolate the fissionable material in one cask from neutron interaction with the fissionable material in another cask (Carter 1968), so the casks would not act as an array but as separate units even when stacked as close together as possible. Additional water would act as an absorber and a reflector and add to the neutron isolation of adjacent casks. No limits are needed on the arrangement of the ECOROK 25-11 casks with liners containing spent filter cartridges from K Basins. However, CPS-SW-149-00002 (WHC 1994) at Central Waste Complex requires a 91-cm (3-ft) separation between each container holding 250 g or more of fissile material and between arrays of containers holding less than 250 g.

5.0 TECHNICAL PEER REVIEWER

J. L. Geiger of the Criticality Evaluation Team of Consequence Analysis performed the independent technical review of *CSEER 95-015: Criticality Storage Category for K Basin Cartridge Filters in ECOROK Casks at the Central Waste Complex*. The reviewer provided the following comments.

The analyst's comparison of the ECOROK 25-11 cask to a DOT 17H drum is instructive. CSAR 80-021 (Carter 1981) showed that the DOT 17H drum or equivalent container is safe so long as each container contains no more than 200 g total mass of fissile material (not counting ^{235}U at no more than natural enrichment), and so long as the container array does not include more than five layers.

Source Term data, combined with further information on neptunium, leads to a total fissile loading (excluding ^{235}U at no more than natural enrichment) of less than 200 g per cask.

Equivalence to the DOT 17H drum consists of two requirements: one dimensional and the other compositional.

- o The dimensional requirement is that two dimensions must be no less than two feet (61 cm) and the third no less than three feet

(91 cm). The horizontal dimensions of the ECOROK 25-11 cask with liner are specified by the drawings in Appendix B as 2.6 feet (79 cm), and the vertical dimension as 3.2 feet (97 cm).

- o The compositional requirement is that the container include steel walls with a mass of at least 23.5 kg. This mass was derived by assuming the surface of the container was covered with 18 gauge steel. The ECOROK 25-11 cask steel liner with both a larger surface area, and a 5 cm (2 in.) thickness, is much more massive. Furthermore, the greater thickness of steel in the ECOROK 25-11 liner provides greater absorption of neutrons even without scattering than the DOT 17H drum.

The design of the ECOROK 25-11 cask shows that it is not intended to be stacked. The requirement that the casks not be stacked (more than 5 high) completes the demonstration that storage of filter elements in the ECOROK 25-11 complies with the results of CSER 80-021 (Carter 1981).

6.0 REFERENCES

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- Willis 1995, *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-4, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

BASIS DOCUMENTS FOR FISSIONABLE MATERIAL SOURCE TERM

Memorandum of Understanding	10
Source Term for ECOROK Cask	13
Worst-Case Fissile Loading for ECOROK Cask	14

MEMORANDUM OF UNDERSTANDING
ACTIVITY A-1 CARTRIDGE FILTER REPLACEMENT,
SOURCE TERM

Prepared by:

Carol C Pitkoff
Project Engineer

Richard G Cowan
Systems Engineering

Dennis L Sherrell
Systems Engineering

Concurrence:

Frank J Muller
Project Lead Engineer

Dennis S Takasumi
K Basins Projects

Steven P Burke
Cognizant Engineer-Water

Michael S Mercado
Shipping and Packaging

Robert M Irwin
SWM Cognizant Engineer

Mark A Jensen
Standards and Requirements

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MEMORANDUM OF UNDERSTANDING
ACTIVITY A-1 CARTRIDGE FILTER REPLACEMENT,
SOURCE TERM

This memorandum of understanding (MOU) has been prepared to document the source term to be used for shipping and storing spent cartridge filters for K East and West Basin.

Beginning in 1973, KE Basin was reactivated for the purpose of storing spent fuel from N Reactor. At that time, the basin was provided with a recirculated water treatment loop that included two cartridge filters and a heat exchanger.

The cartridge filters are presently out of service in both KE and KW Basins. Their operation became untenable due to high dose rates (ALARA considerations) and the fact that they typically exceed the limit that defines transuranic waste. KE and KW Basins each have 2 filters located in the current filter housing.

The filter assembly now installed in the cartridge filter system are approximately 32 inches in diameter and 34 inches tall. The assembly has 88 filter elements spring loaded in-between two carbon steel disc. The filter system has an outside in flow path for the basin water which captures the particulate on the outside of the filters. Removal of these filters results in some of the caking dropping into the filter housing.

The cartridge filter system is being upgraded. The housing for the existing system will be retro-fitted with an internal adaptor that will hold seven(7) filter cartridges. Each filter will be constructed out of a perforated stainless steel can with a polypropylene pleated filter inside. The flow will be directed from the inside out to retain the filter cake within the individual filter elements during filter change outs. This filter upgrade will increase the dirt loading capacity of the filter elements and the source term for used filters.

The source term was determined using information from previous spent filters and sludge characterization data.

Assumptions:

- 800 sq ft of filter area vs. 150 sq ft for the old filters
- 264 pounds maximum dirt loading (approximately 5 X the maximum loading of the old string filters)
- 5 X the quantity of Cs, Sr, and TRU in SD-SNF-TA-005 Safety Evaluation - Spent Water Treatment System Components Inventory Release. This has the source term for the old string filters
- The TRU constituents were estimated based on the mean percent abundances for the overall basin fuel inventory.
- 21 Ci of Ba 137m associated with 22 Ci of CS 137

- 22 Ci of Y 90 associated with 22 Ci of Sr 90
- Non TRU constituents were estimated by comparison of the ratios of those constituents to Cs 137 in the overall basin fuel inventory

Source Term for cartridge filters in K Basin

TRU - 13 Ci total

²³⁸Pu - 2.1 Ci

²³⁹Pu - 3.7 Ci

²⁴⁰Pu - 2.1 Ci

²⁴¹Am - 5.1 Ci

Non TRU

¹³⁷Cs - 22 Ci

^{137m}Ba - 21 Ci

⁹⁰Sr - 22 Ci

⁹⁰Y - 22 Ci

⁶⁰Co - .5 Ci

¹⁴⁷Pm - 18 Ci

¹⁵¹Sm - 2.8 Ci

¹⁵⁴Eu - 2.1 Ci

²³⁴U - 0.0141 Ci

²³⁵U - 0.000545 Ci -- ~~0.75% enriched~~ *dep*

²³⁶U - 0.00204 Ci

²³⁸U - 0.0112 Ci

²⁴¹Pu - 120 Ci

All other 4.6 Ci

SOURCE TERM FOR ECO-ROK CASK/LINER SPENT FILTER ELEMENT LOADING

- The worst case is based on a "tight-fit" (6.1" triangular pitch) arrangement of 19 each, 6" diameter by 30 long, 43 sq ft, pleated media, filter housings from the filter pumps
- Total filter area = 43 sq ft X 19 ea = 800 sq ft vs ~150 sq ft for the old filters
- The generally accepted dirt capacity for the old filter set (confirmed verbally by that vendor) is "around 50 lbs" of dirt (~150 g/sq ft) under our conditions -- this is roughly three times the limit (50 g/sq ft) for string wound filters under a different vendor's (probably prejudiced) test conditions -- the other vendor apparently doesn't sell string wound filters
- The other vendor's catalog claims that pleated filters are limited to less than 20 g/sq ft (they apparently don't sell conventional pleated filters either) -- i.e., we should give the pleated filters credit for at least 60 g/sq ft (instead of 20) -- on the other hand, if we just use the same per-sq ft loading we have historically seen with the old string wound filters, then we should have a very conservative source term (at least factor of 3 conservative)
- 800 sq ft X 150 g/sq ft = 120 kg = 264 pounds worst case maximum dirt loading, i.e. roughly five times the maximum total loading historically experienced with the old string wound cartridge filters (note this is per shipment, not per filter housing -- 600 sq ft/max capacity)
- From SD-SNF-TA-005, the worst case string wound filter assembly was estimated to contain less than 4.3 Ci of Cs, an assumed equal amount of Sr (very conservative assumption -- the analyses summarized by the document indicate that the Sr/Y content of the filter cake will be about 10% of the Cs/Ba content), and less than 2.6 Ci of TRU (obtained by means of an estimate of the Cs/Ba content from gamma dose rate measurements on the grouted filter assemblies, coupled with the worst case TRU/Cs/Ba ratio from the available analytical data)
- If we take five times the SD-SNF-TA-005 values as our worst case, that gives us less than 22 Ci of Cs, less than 22 Ci of Sr, and less than 13 Ci of TRU
- Because the above values already represent a very conservative, rough estimate of the worst case curie content, it should be possible to use these aggregate values as a basis to estimate worst case values for individual isotopes without losing validity
- The following TRU constituents were estimated by allocation of the 13 Ci total, based on the mean percent abundances for the overall basin fuel inventory: 2.0 Ci of Pu-238; 3.7 Ci of Pu-239; 2.1 Ci of Pu-240; 5.2 Ci of Am-241
- About 2.1 Ci of Ba-137m would be associated with the 22 Ci of Cs-137 -- 22 Ci of Y-90 would be associated with the 22 Ci of Sr-90 (the Sr/Y estimate is probably a factor of ten too high)
- The remaining non-TRU constituents were estimated by comparison of the ratios of those constituents to Cs-137 in the overall basin fuel inventory, in light of the fact that the Cs-137 to TRU ratio indicated by the filter cake analyses listed in SD-SNF-TA-005 is a factor of ten lower than that ratio in the overall basin fuel inventory
- As an example, the ratio of Cs-137 to Co-60 is about 90 to 1 in the fuel inventory, such that 22 Ci of Cs-137 would indicate around 1/4 Ci of Co-60, whereas in the filter cake 22 Ci of Cs-137 indicate 2.4 Ci of Co-60
- The following additional non-TRU constituents were estimated by the above method: 120.3 Ci of Pu-241; 17.6 Ci of Pm-147; 2.8 Ci of Sm-151; 2.1 Ci of Eu-154; and 4.6 Ci of "other"

WORST CASE FISSILE LOADING FOR ECO-ROK CASK/LINER SPENT FILTER ELEMENTS

- The worst case is based on a "tight-fit" (6.1" triangular pitch) arrangement of 19 each, 6" diameter by 30 long, 43 sq ft, pleated media, filter housings from the filter pumps
- Total filter area = 43 sq ft X 19 ea = 800 sq ft vs ~150 sq ft for the old filters
- The generally accepted dirt capacity for the old filter set (confirmed verbally by that vendor) is "around 50 lbs" of dirt (~150 g/sq ft) under our conditions -- this is roughly three times the limit (50 g/sq ft) for string wound filters under a different vendor's (probably prejudiced) test conditions -- the other vendor apparently doesn't sell string wound filters
- The other vendor's catalog claims that pleated filters are limited to less than 20 g/sq ft (they apparently don't sell conventional pleated filters either) -- i.e., we should give the pleated filters credit for at least 60 g/sq ft (instead of 20) -- on the other hand, if we just use the same per-sq ft loading we have historically seen with the old string wound filters, then we should have a very conservative source term
- $800 \text{ sq ft} \times 150 \text{ g/sq ft} = 120 \text{ kg} = \underline{264 \text{ pounds}}$ worst case maximum dirt loading, i.e. roughly five times the maximum total loading historically experienced with the old string wound cartridge filters
- From Table 4 of the Internal Memo, RB Baker to Rp Omberg, "Summary Status of 105-K East Sludge Characterization", dated Sept 28, 1994, the weasel pit sludge has the worst case concentration of Pu and U per drum of sludge -- 43 g Pu/drum and 15 Kg U/drum = 0.06 g Pu/lb and 22 g U/lb
- Table 4 also indicates that the highest Pu/U ratio, which occurs in the sandfilter backwash pit, instead of the weasel pit, is around 200 U to 1 Pu, as opposed to the usual 400 U to 1 Pu
- For a conservative estimate of the typical Pu concentration within the ECOROK, combine the apparent Pu/U ratio from the backwash pit with the average uranium concentrations from the weasel pit -- 0.12 g Pu/lb sludge (doubled) and 22 g U/lb sludge (unchanged)
- Finally, for worst case fissile concentrations, triple both of these "typical" concentrations -- this would yield 0.4 g Pu per pound of sludge and 66 g U per pound of sludge
- Combining the above worst case fissile concentrations with the above worst case sludge weight (264 lbs) yields a worst case fissile inventory of $264 \times 0.4 = 106 \text{ g Pu}$ and $264 \times 66 = 17 \text{ Kg U}$
- Assume worst case distribution of the fissile material, along with worst case isotopic content for the U (unirradiated MK1A fuel)
- For the ECOROKS that will contain the existing cartridge filters, assume approximately one half of these amounts as a worst case quantity (over twice the generally accepted dirt loading for those filters)

APPENDIX B

PICTURES AND DRAWINGS OF ECOROK 25-11 CASK AND LINER

Pictures of ECOROK Casks and Liners	16
ECOROK 25-11 Assembly	17
Optional 2" Thick Steel Liner for ECOROK 25-11	20

ECOROK 25-11 & STEEL LINERS

liner

*Packaging
(water)*

FIG. 2
100-15-001
OCT 15 1991

PLAN VIEW

ELEVATION

ITEM	PART NO.	DESCRIPTION
1	100-15-001	ECOROK 25-11 ASSEMBLY
2	100-15-002	BODY ASSEMBLY
3	100-15-003	LO ASSEMBLY
4	100-15-004	LO BLADE ASSEMBLY
5	100-15-005	LO BLADE ASSEMBLY
6	100-15-006	LO BLADE ASSEMBLY
7	100-15-007	LO BLADE ASSEMBLY
8	100-15-008	LO BLADE ASSEMBLY
9	100-15-009	LO BLADE ASSEMBLY
10	100-15-010	LO BLADE ASSEMBLY
11	100-15-011	LO BLADE ASSEMBLY
12	100-15-012	LO BLADE ASSEMBLY
13	100-15-013	LO BLADE ASSEMBLY
14	100-15-014	LO BLADE ASSEMBLY
15	100-15-015	LO BLADE ASSEMBLY
16	100-15-016	LO BLADE ASSEMBLY
17	100-15-017	LO BLADE ASSEMBLY
18	100-15-018	LO BLADE ASSEMBLY
19	100-15-019	LO BLADE ASSEMBLY
20	100-15-020	LO BLADE ASSEMBLY
21	100-15-021	LO BLADE ASSEMBLY
22	100-15-022	LO BLADE ASSEMBLY
23	100-15-023	LO BLADE ASSEMBLY
24	100-15-024	LO BLADE ASSEMBLY
25	100-15-025	LO BLADE ASSEMBLY
26	100-15-026	LO BLADE ASSEMBLY
27	100-15-027	LO BLADE ASSEMBLY
28	100-15-028	LO BLADE ASSEMBLY
29	100-15-029	LO BLADE ASSEMBLY
30	100-15-030	LO BLADE ASSEMBLY
31	100-15-031	LO BLADE ASSEMBLY
32	100-15-032	LO BLADE ASSEMBLY
33	100-15-033	LO BLADE ASSEMBLY
34	100-15-034	LO BLADE ASSEMBLY
35	100-15-035	LO BLADE ASSEMBLY
36	100-15-036	LO BLADE ASSEMBLY
37	100-15-037	LO BLADE ASSEMBLY
38	100-15-038	LO BLADE ASSEMBLY
39	100-15-039	LO BLADE ASSEMBLY
40	100-15-040	LO BLADE ASSEMBLY
41	100-15-041	LO BLADE ASSEMBLY
42	100-15-042	LO BLADE ASSEMBLY
43	100-15-043	LO BLADE ASSEMBLY
44	100-15-044	LO BLADE ASSEMBLY
45	100-15-045	LO BLADE ASSEMBLY
46	100-15-046	LO BLADE ASSEMBLY
47	100-15-047	LO BLADE ASSEMBLY
48	100-15-048	LO BLADE ASSEMBLY
49	100-15-049	LO BLADE ASSEMBLY
50	100-15-050	LO BLADE ASSEMBLY
51	100-15-051	LO BLADE ASSEMBLY
52	100-15-052	LO BLADE ASSEMBLY
53	100-15-053	LO BLADE ASSEMBLY
54	100-15-054	LO BLADE ASSEMBLY
55	100-15-055	LO BLADE ASSEMBLY
56	100-15-056	LO BLADE ASSEMBLY
57	100-15-057	LO BLADE ASSEMBLY
58	100-15-058	LO BLADE ASSEMBLY
59	100-15-059	LO BLADE ASSEMBLY
60	100-15-060	LO BLADE ASSEMBLY
61	100-15-061	LO BLADE ASSEMBLY
62	100-15-062	LO BLADE ASSEMBLY
63	100-15-063	LO BLADE ASSEMBLY
64	100-15-064	LO BLADE ASSEMBLY
65	100-15-065	LO BLADE ASSEMBLY
66	100-15-066	LO BLADE ASSEMBLY
67	100-15-067	LO BLADE ASSEMBLY
68	100-15-068	LO BLADE ASSEMBLY
69	100-15-069	LO BLADE ASSEMBLY
70	100-15-070	LO BLADE ASSEMBLY
71	100-15-071	LO BLADE ASSEMBLY
72	100-15-072	LO BLADE ASSEMBLY
73	100-15-073	LO BLADE ASSEMBLY
74	100-15-074	LO BLADE ASSEMBLY
75	100-15-075	LO BLADE ASSEMBLY
76	100-15-076	LO BLADE ASSEMBLY
77	100-15-077	LO BLADE ASSEMBLY
78	100-15-078	LO BLADE ASSEMBLY
79	100-15-079	LO BLADE ASSEMBLY
80	100-15-080	LO BLADE ASSEMBLY
81	100-15-081	LO BLADE ASSEMBLY
82	100-15-082	LO BLADE ASSEMBLY
83	100-15-083	LO BLADE ASSEMBLY
84	100-15-084	LO BLADE ASSEMBLY
85	100-15-085	LO BLADE ASSEMBLY
86	100-15-086	LO BLADE ASSEMBLY
87	100-15-087	LO BLADE ASSEMBLY
88	100-15-088	LO BLADE ASSEMBLY
89	100-15-089	LO BLADE ASSEMBLY
90	100-15-090	LO BLADE ASSEMBLY
91	100-15-091	LO BLADE ASSEMBLY
92	100-15-092	LO BLADE ASSEMBLY
93	100-15-093	LO BLADE ASSEMBLY
94	100-15-094	LO BLADE ASSEMBLY
95	100-15-095	LO BLADE ASSEMBLY
96	100-15-096	LO BLADE ASSEMBLY
97	100-15-097	LO BLADE ASSEMBLY
98	100-15-098	LO BLADE ASSEMBLY
99	100-15-099	LO BLADE ASSEMBLY
100	100-15-100	LO BLADE ASSEMBLY

NOTES:

- SEE SPECIFICATION STD-11-001.
- CAUTION (ITEM 3) TO BE PLACED TO THE UNDERSIDE OF LO (ITEM 1). ENSURE THAT CABLE IS IN LINE WITH LO AT HOLES AND HOLES ARE PLACED.
- STAPLE AT 2" HOLE + 1/2" DIA. HOLE NO LETTERS LOCATE APPROXIMATELY AS SHOWN.
- CAUTION TO REMEMBER THAT ALL DOT SLITTING SHEETS (ITEM 4) AND WELDING HOLES IN LO (ITEM 3) ARE IN LINE WITH LIFTING TUBES (ITEM 8) AND WELDING HOLES IN BODY (ITEM 2) AT FINAL ASSEMBLY.
- CUT AWAY WELDING WIRE FACING (ITEM 3) AS NECESSARY TO ACCOMMODATE ALL POINTS.

ITEM	DESCRIPTION	REVISION
1	ECOROK 25-11 ASSEMBLY	1
2	ECOROK 25-11 ASSEMBLY	1
3	ECOROK 25-11 ASSEMBLY	1
4	ECOROK 25-11 ASSEMBLY	1
5	ECOROK 25-11 ASSEMBLY	1
6	ECOROK 25-11 ASSEMBLY	1
7	ECOROK 25-11 ASSEMBLY	1
8	ECOROK 25-11 ASSEMBLY	1
9	ECOROK 25-11 ASSEMBLY	1
10	ECOROK 25-11 ASSEMBLY	1
11	ECOROK 25-11 ASSEMBLY	1
12	ECOROK 25-11 ASSEMBLY	1
13	ECOROK 25-11 ASSEMBLY	1
14	ECOROK 25-11 ASSEMBLY	1
15	ECOROK 25-11 ASSEMBLY	1
16	ECOROK 25-11 ASSEMBLY	1
17	ECOROK 25-11 ASSEMBLY	1
18	ECOROK 25-11 ASSEMBLY	1
19	ECOROK 25-11 ASSEMBLY	1
20	ECOROK 25-11 ASSEMBLY	1
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22	ECOROK 25-11 ASSEMBLY	1
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31	ECOROK 25-11 ASSEMBLY	1
32	ECOROK 25-11 ASSEMBLY	1
33	ECOROK 25-11 ASSEMBLY	1
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36	ECOROK 25-11 ASSEMBLY	1
37	ECOROK 25-11 ASSEMBLY	1
38	ECOROK 25-11 ASSEMBLY	1
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42	ECOROK 25-11 ASSEMBLY	1
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90	ECOROK 25-11 ASSEMBLY	1
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92	ECOROK 25-11 ASSEMBLY	1
93	ECOROK 25-11 ASSEMBLY	1
94	ECOROK 25-11 ASSEMBLY	1
95	ECOROK 25-11 ASSEMBLY	1
96	ECOROK 25-11 ASSEMBLY	1
97	ECOROK 25-11 ASSEMBLY	1
98	ECOROK 25-11 ASSEMBLY	1
99	ECOROK 25-11 ASSEMBLY	1
100	ECOROK 25-11 ASSEMBLY	1

INFORMATION ONLY

OCT 15 1991

BEST AVAILABLE COPY

ECOROK 25-11 ASSEMBLY

DETAIL D
WELDING NOTCH IN LIP

DETAIL F
SAME VIEW

③ UD ASSEMBLY

GASKET DETAIL

DETAIL G
SCALE 3/16"=1"

④ BOLT SLEEVE INSERT ASSY.
SCALE 1/8"=1'

⑤ VENT FILTER INSERT
SCALE 1/2" = 1'

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100-11-015

△ ⑥ BODY REBAR CAGE ASSEMBLY

△ ⑦ LID REBAR CAGE ASSEMBLY

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OCT 15 1993

REV.	DESCRIPTION	APPROVED	DATE
REVISIONS

ECOROK			
ECOROK 25-11 ASSEMBLY			
REV. 1	1.0	1.0	1.0
REV. 2	1.0	1.0	1.0
REV. 3	1.0	1.0	1.0
REV. 4	1.0	1.0	1.0
REV. 5	1.0	1.0	1.0
REV. 6	1.0	1.0	1.0
REV. 7	1.0	1.0	1.0
REV. 8	1.0	1.0	1.0
REV. 9	1.0	1.0	1.0
REV. 10	1.0	1.0	1.0
REV. 11	1.0	1.0	1.0
REV. 12	1.0	1.0	1.0
REV. 13	1.0	1.0	1.0
REV. 14	1.0	1.0	1.0
REV. 15	1.0	1.0	1.0
REV. 16	1.0	1.0	1.0
REV. 17	1.0	1.0	1.0
REV. 18	1.0	1.0	1.0
REV. 19	1.0	1.0	1.0
REV. 20	1.0	1.0	1.0
REV. 21	1.0	1.0	1.0
REV. 22	1.0	1.0	1.0
REV. 23	1.0	1.0	1.0
REV. 24	1.0	1.0	1.0
REV. 25	1.0	1.0	1.0
REV. 26	1.0	1.0	1.0
REV. 27	1.0	1.0	1.0
REV. 28	1.0	1.0	1.0
REV. 29	1.0	1.0	1.0
REV. 30	1.0	1.0	1.0
REV. 31	1.0	1.0	1.0
REV. 32	1.0	1.0	1.0
REV. 33	1.0	1.0	1.0
REV. 34	1.0	1.0	1.0
REV. 35	1.0	1.0	1.0
REV. 36	1.0	1.0	1.0
REV. 37	1.0	1.0	1.0
REV. 38	1.0	1.0	1.0
REV. 39	1.0	1.0	1.0
REV. 40	1.0	1.0	1.0
REV. 41	1.0	1.0	1.0
REV. 42	1.0	1.0	1.0
REV. 43	1.0	1.0	1.0
REV. 44	1.0	1.0	1.0
REV. 45	1.0	1.0	1.0
REV. 46	1.0	1.0	1.0
REV. 47	1.0	1.0	1.0
REV. 48	1.0	1.0	1.0
REV. 49	1.0	1.0	1.0
REV. 50	1.0	1.0	1.0
REV. 51	1.0	1.0	1.0
REV. 52	1.0	1.0	1.0
REV. 53	1.0	1.0	1.0
REV. 54	1.0	1.0	1.0
REV. 55	1.0	1.0	1.0
REV. 56	1.0	1.0	1.0
REV. 57	1.0	1.0	1.0
REV. 58	1.0	1.0	1.0
REV. 59	1.0	1.0	1.0
REV. 60	1.0	1.0	1.0
REV. 61	1.0	1.0	1.0
REV. 62	1.0	1.0	1.0
REV. 63	1.0	1.0	1.0
REV. 64	1.0	1.0	1.0
REV. 65	1.0	1.0	1.0
REV. 66	1.0	1.0	1.0
REV. 67	1.0	1.0	1.0
REV. 68	1.0	1.0	1.0
REV. 69	1.0	1.0	1.0
REV. 70	1.0	1.0	1.0
REV. 71	1.0	1.0	1.0
REV. 72	1.0	1.0	1.0
REV. 73	1.0	1.0	1.0
REV. 74	1.0	1.0	1.0
REV. 75	1.0	1.0	1.0
REV. 76	1.0	1.0	1.0
REV. 77	1.0	1.0	1.0
REV. 78	1.0	1.0	1.0
REV. 79	1.0	1.0	1.0
REV. 80	1.0	1.0	1.0
REV. 81	1.0	1.0	1.0
REV. 82	1.0	1.0	1.0
REV. 83	1.0	1.0	1.0
REV. 84	1.0	1.0	1.0
REV. 85	1.0	1.0	1.0
REV. 86	1.0	1.0	1.0
REV. 87	1.0	1.0	1.0
REV. 88	1.0	1.0	1.0
REV. 89	1.0	1.0	1.0
REV. 90	1.0	1.0	1.0
REV. 91	1.0	1.0	1.0
REV. 92	1.0	1.0	1.0
REV. 93	1.0	1.0	1.0
REV. 94	1.0	1.0	1.0
REV. 95	1.0	1.0	1.0
REV. 96	1.0	1.0	1.0
REV. 97	1.0	1.0	1.0
REV. 98	1.0	1.0	1.0
REV. 99	1.0	1.0	1.0
REV. 100	1.0	1.0	1.0

STD-27-008

① LID ASSEMBLY

② BODY ASSEMBLY

REV	DESCRIPTION	DATE
1	OPTIONAL 2" THK STEEL LINER FOR ECOROK	11
2	BODY ASSEMBLY	
3	LID ASSEMBLY	
4	PLATE 18 11/16 x 18 x 1/2 THK ROLLED TO ± 33 0.6.	ASTM A-18
5	PLATE 18 11/16 x 18 x 1/2 THK.	ASTM A-18
6	PLATE 8 x 3 x 1/2 THK.	ASTM A-18
7	PLATE 18 11/16 x 18 x 1/2 THK.	ASTM A-18
8	PLATE 3 x 3 x 1/2 THK.	ASTM A-18

NOTES:

1. FABRICATOR TO ENSURE ALL PLATES ARE THICK SQUARE AND FREE FROM BARS, WELD SPATTER ETC.

DETAIL A
SCALE 1/8"=1"

DETAIL B
SCALE 3/8"=1"

INFORMATION ONLY
OCT 15 1993

BEST AVAILABLE

REV	DESCRIPTION	DATE
1	OPTIONAL 2" THK STEEL LINER FOR ECOROK 25-11	0
2	BODY ASSEMBLY	
3	LID ASSEMBLY	
4	PLATE 18 11/16 x 18 x 1/2 THK ROLLED TO ± 33 0.6.	ASTM A-18
5	PLATE 18 11/16 x 18 x 1/2 THK.	ASTM A-18
6	PLATE 8 x 3 x 1/2 THK.	ASTM A-18
7	PLATE 18 11/16 x 18 x 1/2 THK.	ASTM A-18
8	PLATE 3 x 3 x 1/2 THK.	ASTM A-18

① OPTIONAL 2" THK STEEL LINER FOR ECOROK 25-11

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Consequence Analysis	Date 12/15/95
Project Title/Work Order		EDT No. 142228
CSER 95-014: Criticality Storage Category for Spent K Basin Cartridge Filters in ECOROK Casks at Central Waste Complex		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
R. B. Bendixsen	T3-01	X			
T. Chiao	A3-34	X			
J. P. Estrellado	T3-01	X			
D. E. Friar	A3-34	X			
J. L. Geiger	A3-34	X			
B. H. Gilbert	A3-34	X			
R. J. Giroir	T4-05	X			
A. J. Green	H4-64	X			
J. R. Green	G2-02	X			
A. L. Hess	A3-34	X			
R. J. Koll	T3-01	X			
R. M. Irwin	T4-03	X			
D. S. Leach	A3-34	X			
K. M. McDonald	T4-03	X			
E. M. Miller	A3-34	X			
D. B. Powell	T4-03	X			
A. L. Ramble	A3-38	X			
C. A. Rogers	A3-34	X			
Central Files	A3-86 T3-01	Original + 2			
ESTI	T3-07	2			