NUREG–0430
Vol. 15

Licensed Fuel Facility Status Report

Inventory Difference Data
July 1, 1994–June 30, 1995

U.S. Nuclear Regulatory Commission

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Inventory Difference Data
July 1, 1994–June 30, 1995

Manuscript Completed: January 1996
Date Published: May 1996

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U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001

ABSTRACT

The Nuclear Regulatory Commission is committed to an annual publication of licensed fuel facilities' inventory difference (ID) results, after Agency review of the information and completion of any related investigations. Information in this report includes ID results for active fuel fabrication and/or recovery facilities.

Acronyms and/or abbreviations used in this report are identified on page vii.

The various terms and acronyms used in this publication are defined on pages 1 through 4.

SPECIAL NOTE: Combustion Engineering (Windsor, CT --- Docket 70-1100) has been deleted from this report due to its inactive status and limited possession of special nuclear material.

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ABBREVIATIONS/ACRONYMS

C.L.	Confidence level
CFR	Code of Federal Regulations
FKG	Formula Kilogram(s)
HEU	High-enriched uranium
ID	Inventory difference
LEID	Limit of error of an inventory difference
LEU	Low-enriched uranium
NRC	Nuclear Regulatory Commission
Pu	Plutonium
SEID	Standard error of an inventory difference
SM	Source material
SNM	Special nuclear material
SSNM	Strategic special nuclear material
U-233	Uranium-233
U-235	Uranium-235
Pu-238	Plutonium-238
Pu-239	Plutonium-239
Pu-241	Plutonium-241

DEFINITION OF TERMS

1. Isotope: A nuclide of a chemical element (such as uranium or plutonium) whose atoms all have the same number of neutrons, as well as the same number of protons, within their nuclei. That is, all isotopes of a given element must have the same number of protons within the nuclei of their atoms, but the number of neutrons per nucleus varies between isotopes. It is the number of protons plus neutrons within an atom's nucleus that defines its mass number. U-233, U-235, and U-238 are three isotopes of uranium (the latter two being found in naturally occurring uranium ores) having 141, 143, and 146 neutrons, respectively, within the nucleus of each of their atoms.

2. Fissile Isotope: A nuclide species that is capable of giving rise to a self-sustaining chain reaction (of nuclear fission) when present in sufficient mass and concentration. U-233, U-235, Pu-239, and Pu-241 are the only fissile nuclides contained in "special nuclear material" (SNM), which also consists of other uranium and plutonium isotopes.

3. Source Material (SM): (1) Natural uranium or thorium, or depleted uranium, or any combination thereof, in any physical or chemical form, or (2) ores that contain by weight 0.05 percent or more of (i) uranium, (ii) thorium, or (iii) any combination thereof. SM does not include SNM.

4. Special Nuclear Material (SNM): (1) Plutonium, uranium-233, uranium enriched in the isotope uranium-235, and any other material that the U.S. Government, pursuant to the provisions of Section 51 of the Atomic Energy Act of 1954, as amended, determines to be SNM; or (2) any material artificially enriched in any of the foregoing. SNM (of any type) does not include SM.

5. High-Enriched Uranium (HEU): Any uranium-bearing material whose uranium isotope content is 20 percent or more U-235 by weight (relative to total uranium element content).

6. Low-Enriched Uranium (LEU): Any uranium-bearing material whose uranium isotope content is less than 20 percent, but greater than 0.72 percent, U-235 by weight (relative to total uranium element content).

7. Natural Uranium: Any uranium-bearing material whose uranium isotopic distribution has not been altered from its naturally occurring state. Natural uranium is nominally 99.283 percent U-238, 0.711 percent U-235, and 0.006 percent U-234.

8. Depleted Uranium: Any uranium-bearing material whose combined U-233 plus U-235 isotopic content is less than 0.70 percent by weight (relative to total uranium element content).

9. Strategic Special Nuclear Material (SSNM): Uranium-235 contained in HEU, uranium-233, or plutonium. NOTE: All SSNM is SNM, but not all SNM is SSNM.

10. Effective Kilogram of SNM: (1) For plutonium and U-233, their weight in kilograms; (2) for uranium with an enrichment in the isotope U-235 of 1.00 percent (0.01 weight fraction) and above, its element weight in kilograms multiplied by the square of its enrichment expressed as a decimal weight fraction; and (3) for uranium with an enrichment in U-235 below 1.00 percent, but above 0.71 percent, its element weight in kilograms multiplied by .0001.

11. Formula Kilogram (FKG): 1000 formula grams of SSNM computed by the following equation:

$$\text{Grams} = (\text{grams U-235 contained in HEU}) + 2.5\ (\text{grams U-233}) + 2.5\ (\text{grams plutonium})$$

12. Formula Quantity: SSNM in any combination in a quantity of 5000 formula grams or more, as computed by the same equation as given above in definition No. 11. (NOTE: In unirradiated form, this quantity of SSNM is sometimes referred to as a Category I quantity of material.)

13. SNM of Moderate Strategic Significance: (1) Less than a formula quantity of SSNM, but more than 1000 grams of U-235 contained in HEU, or more than 500 grams of U-233 or plutonium, or more than a combined quantity of 1000 formula grams when computed by the equation:

$$\text{Grams} = (\text{grams U-235 in HEU}) + 2.0\ (\text{grams U-233} + \text{grams Pu})$$

or (2) 10,000 grams or more of U-235 contained in LEU enriched to 10 percent or more (but less than 20 percent) in the U-235 isotope. (NOTE: In unirradiated form, either of the forementioned two quantities is sometimes referred to as a Category II quantity.)

14. SNM of Low Strategic Significance: (1) Less than an amount of SNM of moderate strategic significance, but more than 15 grams of (i) U-235 contained in HEU, (ii) U-233, (iii) plutonium, or (iv) any combination thereof; (2) less than 10,000 grams, but more than 1000 grams of U-235 contained in LEU enriched to 10 percent or more (but less than 20 percent) in the U-235 isotope; or (3) 10,000 grams or more of U-235 contained in LEU enriched above natural, but less than 10 percent, in the U-235 isotope. (NOTE: In unirradiated form, any of the above three quantities is sometimes referred to as a Category III quantity.)

15. Inventory Difference (ID): The arithmetic difference between a book inventory and the corresponding physical inventory, calculated by subtracting ending inventory (EI) from the combination of beginning inventory (BI) plus additions to inventory (A) minus removals from inventory (R). Mathematically, this can be expressed as:

$$ID = (BI + A - R) - EI \quad \text{or} \quad ID = BI + A - R - EI$$

16. Limit of Error of the ID (LEID): Twice the standard error of the estimated measurement uncertainty associated with the ID, or in other words, twice the square root of the measurement variance associated with the ID.

17. <u>Standard Error of the ID (SEID)</u>:

(a) For Category III licensees subject to 10 CFR 74.31 or 74.33, SEID is equal to the square root of the sum of both measurement and non-measurement variances associated with an ID.

(b) For Category I licensees subject to 10 CFR 74.59, SEID is equal to the square root of the measurement variance (only) associated with an ID.

18. <u>Detection Quantity (DQ)</u>: A site-specific SNM quantity for Category III licensees whose processing activities are limited to SNM of low strategic significance. The DQ is normally a function of annual throughput, but for low-throughput LEU facilities, the DQ need not be less than 25 kilograms of U-235. The DQ can also be described as a goal quantity, the loss or theft of which must be detected with a 90 percent or better) probability, whenever a physical inventory is taken.

19. <u>Detection Threshold (DT)</u>: An ID alarm limit for Category III licensees that will be exceeded (with 90 percent or higher probability) by an ID (resulting from the taking of a physical inventory) whenever there has been an actual loss of a detection quantity. The DT is a function of both the DQ and SEID, as shown in the following equation:

$$DT = DQ - 1.3 (SEID)$$

20. <u>The ID Was Within Its Expected Range</u>: The ID was less than (i) 200 grams plutonium or U-233, (ii) 300 grams U-235 contained in HEU, or (iii) 9000 grams U-235 contained in LEU, as appropriate, and/or was less than its associated LEID or SEID.

21. <u>The ID Was Within Its Regulatory Limit</u>: The ID exceeded both (1) 200 grams U-233 or plutonium, 300 grams U-235 contained in HEU or 9000 grams U-235 contained in LEU (as appropriate), and (2) its associated LEID or SEID, but was less than 1.5 times the limit for LEID (for 10 CFR 70.51 licensees) or less than the ID limit (for 10 CFR 74.31 and 74.59 licensees). For 10 CFR 74.31 licensees, the ID limit is the site-specific detection threshold quantity, which is considerably larger than SEID. For 10 CFR 74.59 licensees, the ID limit is 3 times SEID.

22. <u>The ID Exceeded Its Regulatory Limit</u>: The ID exceeded its applicable regulatory limit and was thus subject to both licensee and NRC investigations to determine the cause(s) of the excessive value (regardless of whether the ID was negative or positive).

23. <u>Negative ID</u>: A situation that occurs when the amount of SNM on hand, as determined by the physical inventory, exceeds the amount of SNM being carried on the books (records). That is, there appears to be a gain in material. Mathematically, a negative ID is written as "-ID," or shown in parentheses. A negative ID is also referred to as an "ID gain."

24. Positive ID: A situation that occurs when the amount of SNM on hand, as determined by the physical inventory, is less than the amount of SNM being carried on the books (records). That is, there appears to be a loss of material. Mathematically, a positive ID is written as "+ID," or is shown without any designation of sign. A positive ID is also referred to as an "ID loss."

25. Plant: For SNM control and accounting purposes, a plant is defined as a set of processes or operations (on the same site, but not necessarily all in the same building) coordinated into a single manufacturing, R&D, or testing effort. Most licensees have only one plant in this context. A scrap recovery operation serving both onsite and offsite customers, or more than one onsite manufacturing effort (plant), would be treated as a separate plant.

26. SNM Material Type Categories: For inventory and accounting purposes, SNM is classified into six material type categories (not to be confused with Categories I, II, and III quantities). The six categories are uranium in cascades, LEU, HEU, uranium-233, plutonium, and plutonium-238. For each category, SNM is accounted for on both a total element and isotope basis. The element and isotope for each category are as follows:

CATEGORY	ELEMENT	ISOTOPE
Uranium in Cascades	Total Uranium	U-235
LEU	Total Uranium	U-235
HEU	Total Uranium	U-235
Uranium-233	Total Uranium	U-233
Plutonium	Total Plutonium	Pu-239 + Pu-241
Plutonium-238	Total Plutonium	Pu-238

27. Active Inventory (AI): The sum of beginning inventory (BI), additions to inventory (A), removals from inventory (R), and ending inventory (EI), after all common terms have been totally excluded. A common term is any nuclear material value (or item) that appears in both BI and EI, or both BI and R, or both A and R, or both A and EI, with both values dertived from the same measurement (or combination of measurements), and thus does not contribute to the uncertainty associated with the current period inventory difference. The active inventory is used as an indicator of processing throughput and/or measurement activity.

INTRODUCTORY DISCUSSION

LICENSED FUEL FACILITY STATUS REPORT --- INVENTORY DIFFERENCE RESULTS

An inventory difference (ID), also referred to as material unaccounted for (MUF), is the difference between the quantity of special nuclear material (SNM) that should be on hand (as indicated by the licensee's accounting records) and that which a licensee's physical inventory shows is actually on hand. Both quantities (i.e., book and physical) are subject to measurement uncertainties, recording errors, etc.

The ID information presented is for active, licensed facilities that are authorized to possess and use, in an unencapsulated form, at least 1 effective kilogram of SNM. The U.S. Nuclear Regulatory Commission uses a graded approach in applying safeguards requirements for such licensees, depending on the strategic significance of the SNM authorized for possession, and the level and frequency of monitoring programs required for timely detection of losses. Licensees authorized to have significant quantities of strategic SNM --- i.e., high-enriched uranium (HEU), plutonium, or uranium-233 --- and facilities authorized to possess and use 1 or more effective kilograms of SNM of moderate strategic significance are required to conduct physical inventories at least every 6 months, whereas licensees whose holdings are restricted to SNM of low strategic significance perform physical inventories every 12 months.

It is important to understand the distinction between the low strategic significance of low-enriched uranium (LEU) and the higher strategic significance of HEU and plutonium. LEU used to fabricate fuel assemblies for commercial power reactors is enriched to a level of 1 to 5 percent in the U-235 isotope. At this level of enrichment, the uranium is (under certain conditions) capable of sustaining a chain reaction, but is not capable of generating a nuclear explosion (regardless of its quantity and configuration).

NRC safeguards requirements covering LEU are graded to reflect its low strategic significance. They include a formal structured system for material control and accounting and basic industrial security measures. On the other hand, because of the higher strategic significance of HEU and plutonium (which under certain circumstances could be used for the fabrication of a nuclear explosive device), NRC requires licensees to provide substantial physical protection of these materials. Additionally, more rigorous controls and accounting programs are imposed. Physical protection of strategic SNM includes safeguards measures such as barriers, intrusion alarms, armed guards, and offsite police response. Internal systems to control the movement of strategic SNM and to monitor its presence are also required.

Non-zero IDs, both positive and negative, result from a combination of factors such as measurement variability (i.e., measurement uncertainty), measurement errors (i.e., measurement mistakes), changes in the quantity of unmeasured equipment holdup, and recordkeeping errors. An unmeasured loss (either accidental or deliberate) or theft would give rise to a unidirectional (mathematically positive) impact on an ID, so as to make a negative ID less negative (or change it to positive) or a positive ID more positive. Generally speaking, the more complex a facility's process operations are (especially when dealing with chemical operations), the greater the uncertainty associated with an ID value becomes.

Although an ID larger than its overall measurement uncertainty may signal an abnormal situation (requiring determination of the cause), the fact that an ID falls within its associated limit of error --- even a zero ID value --- provides no automatic or conclusive proof that a loss or theft of SNM has not occurred. Hence, NRC relies on information provided not only by the material accounting system, but also by the internal control system, the physical security system, NRC inspections and evaluations, and NRC and licensee investigations.

The concept of the limit of error of the inventory difference (LEID) is a method that licensees subject to 10 CFR 70.51 and NRC use to determine the significance of the ID. LEID is a calculated estimate of the measurement uncertainty (at the 95 percent confidence level [C.L.]) that is associated with the facility's ID. That is, ID should be within the range of zero plus or minus LEID 19 times out of 20, if measurement uncertainty is the only contributor to non-zero IDs.

For 10 CFR 70.51 licensees, an ID that exceeds its associated LEID may be an indication of processing problems, biased or otherwise inaccurate measurements, bookkeeping errors, or a loss or theft of material. NRC accordingly requires licensees to take increasingly stronger investigative actions depending on how much the ID exceeds both LEID and minimum quantities specified in 10 CFR 74.13(b) --- namely, 200 grams of plutonium, 300 grams U-235 contained in HEU, or 9000 grams U-235 contained in LEU. If the ID exceeds its LEID, but does not exceed the minimum quantity, no formal investigation is required.

The concept of the standard error of inventory difference (SEID) is a method that NRC and licensees subject to either 10 CFR 74.31 or 74.59 use to determine the significance of an ID. For 10 CFR 74.31 licensees, SEID is a calculated estimate of the total uncertainty (at the 67 percent C.L.) due to both measurement and non-measurement contributors. Thus, for 10 CFR 74.31 licensees, ID should tend to be less than SEID 2 times out of 3, or less than twice SEID 19 times out of 20. For 10 CFR 74.59 licensees, SEID is the calculated estimate of the measurement uncertainty (at the 67 percent C.L.) that is associated with an ID. Hence, for 10 CFR 74.59 licensees, ID should be less than SEID 2 times out of 3, and less than twice SEID 19 times out of 20, if non-zero IDs result only from measurement uncertainty.

For 10 CFR 74.31 licensees (whose operations are limited to SNM of low strategic significance), ID must exceed its threshold quantity (a site-specific value that is considerably larger than SEID) before investigative actions are required. For 10 CFR 74.59 licensees, investigative actions are required whenever an ID exceeds both (i) 200 grams plutonium or U-233, or 300 grams U-235, and (ii) 3 times SEID.

The IDs for this reporting period (July 1, 1994 through June 30, 1995) are indicated in the "Tabulation of Inventory Differences" that begins on page 7 of this report. An explanation of the significance, and when appropriate, the contributing factor(s) for IDs deemed excessive are included in the last column of the table. Physical inventories are required for each SNM category (LEU, HEU, U-233, plutonium, and Pu-238) within each plant. For those licensees having more than one plant on the same site, the ID value listed, for a given SNM category, is the total site net ID.

Tabulation of Inventory Differences

Licensee	SNM License No.	Docket No.	SNM Category	Inventory Date	Inventory Difference (Grams U-235)	Explanation [See definitions # 20, 21, & 22]
Babcock & Wilcox Naval Nuclear Fuel Div. (Lynchburg, Va.)	42	70-27	HEU	10/31/94	+ 3,386	The SEID for the inventory period was lower than normal (20% of maximum allowable) and thus the ID exceeded its regulatory limit of 3 times SEID. The ID was investigated by the licensee and no anomalous conditions were identified.
			HEU	04/30/95	+ 930	The ID was within its regulatory limit.
			LEU	10/31/94	+ 14	The ID was within its expected range.
			LEU	04/30/95	+ 65	The ID was within its expected range.
B&W Fuel Company (Lynchburg, Va.)	1168	70-1201	LEU	07/11/94	+ 129	The ID was within its expected range.
Combustion Engineering (Hematite, Missouri)	33	70-36	LEU	07/15/94	- 16,025	The ID was within its regulatory limit.

Tabulation of Inventory Differences [Cont.]

Licensee	SNM License No.	Docket No.	SNM Category	Inventory Date	Inventory Difference (Grams U-235)	Explanation [See definitions # 20, 21, & 22]
GA Technologies (La Jolla, Calif.)	696	70-734	HEU	07/11/94	+ 62	The ID was within its expected range.
			HEU	09/12/94	+ 42	The ID was within its expected range.
			HEU	11/14/94	+ 106	The ID was within its expected range.
			HEU	01/16/95	+ 91	The ID was within its expected range.
			HEU	03/13/95	+ 48	The ID was within its expected range.
			HEU	05/15/95	+ 9	The ID was wiyhin its expected range.
			LEU	09/12/94	+ 54	The ID was within its expected range.
			LEU	03/13/95	+ 31	The ID was within its expected range.
General Electric Co. (Wilmington, N.C.)	1097	70-1113	LEU	07/04/94	+ 67,571	The ID was within its regulatory limit.

Tabulation of Inventory Differences [Cont.]

Licensee	SNM License No.	Docket No.	SNM Category	Inventory Date	Inventory Difference (Grams U-235)	Explanation [See definitions # 20, 21, & 22]
Nuclear Fuels Services (Erwin, Tenn.)	124	70-143	HEU	10/25/94	- 433	The ID was within its regulatory limit.
			HEU	04/25/95	- 782	The ID was within its regulatory limit.
			LEU	06/30/95	- 9,002	The ID was within its regulatory limit.
Siemens Power Corp. (Richland, Wash.)	1227	70-1257	LEU	06/07/94	- 17,913	The ID was within its expected range.
			LEU	03/21/95	+ 26,162	The ID was within its expected range.
Westinghouse Elec. Corp. (Columbia, S.C.)	1107	70-1151	LEU	No physical inventory conducted during this July 1, 1994 to June 30, 1995 reporting period.		

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-0430
Vol. 15

2. TITLE AND SUBTITLE

Licensed Fuel Facility Status Report
Inventory Difference Data
July 1, 1994 - June 30, 1995

3. DATE REPORT PUBLISHED

MONTH	YEAR
May	1996

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

D. R. Joy

6. TYPE OF REPORT

7. PERIOD COVERED *(Inclusive Dates)*

July 1994 - June 1995

8. PERFORMING ORGANIZATION — NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

9. SPONSORING ORGANIZATION — NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Same as 8, above

10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

NRC is committed to the periodic publication of licensed fuel facility inventory difference data, following agency review of the information and completion of any related NRC investigations. Information in this report includes inventory difference data for active fuel fabrication facilities possessing more than one effective kilogram of special nuclear material.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

nuclear fuel facilities, inventory difference, physical inventories, special nuclear material accounting

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page)

unclassified

(This Report)

unclassified

15. NUMBER OF PAGES

16. PRICE

NRC FORM 335 (2-89)

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

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