U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

# PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

# SUBJECT: WASTE CHARACTERISTICS DATA BASE


**PRESENTER:** KARL J. NOTZ

**PRESENTER'S TITLE AND ORGANIZATION:** TASK MANAGER
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE

**PRESENTER'S TELEPHONE NUMBER:** (615) 574-6632


AUGUST 28-29, 1990

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# CHARACTERISTICS DATA BASE (CDB)

## OBJECTIVE

- PROVIDE A UNIFIED SOURCE OF DATA FOR THE FEDERAL WASTE MANAGEMENT SYSTEM

- PROVIDE DETAILED CHARACTERISTICS OF WASTES THAT WILL, OR MAY REQUIRE GEOLOGIC DISPOSAL

# CHARACTERISTICS DATA BASE (CDB)

(CONTINUED)

## SCOPE

- MAJOR PHYSICAL CATEGORIES
  - LWR SPENT FUEL
  - IMMOBILIZED HLW
  - NON-LWR SPENT FUEL
  - MISCELLANEOUS WASTE (e.g., GTCC HARDWARE)

# CHARACTERISTICS DATA BASE (CDB)

(CONTINUED)

- PROVIDES DATA IN THESE CATEGORIES
  - PHYSICAL DESCRIPTIONS
  - CHEMICAL COMPOSITIONS
  - RADIOLOGICAL PROPERTIES
    - * THERMAL SOURCE STRENGTH
    - * GAMMA RADIATION
    - * NEUTRON SOURCE STRENGTH
    - * INDIVIDUAL NUCLIDES
    - * INTEGRAL HEATS
  - INVENTORIES
  - PROJECTED QUANTITIES

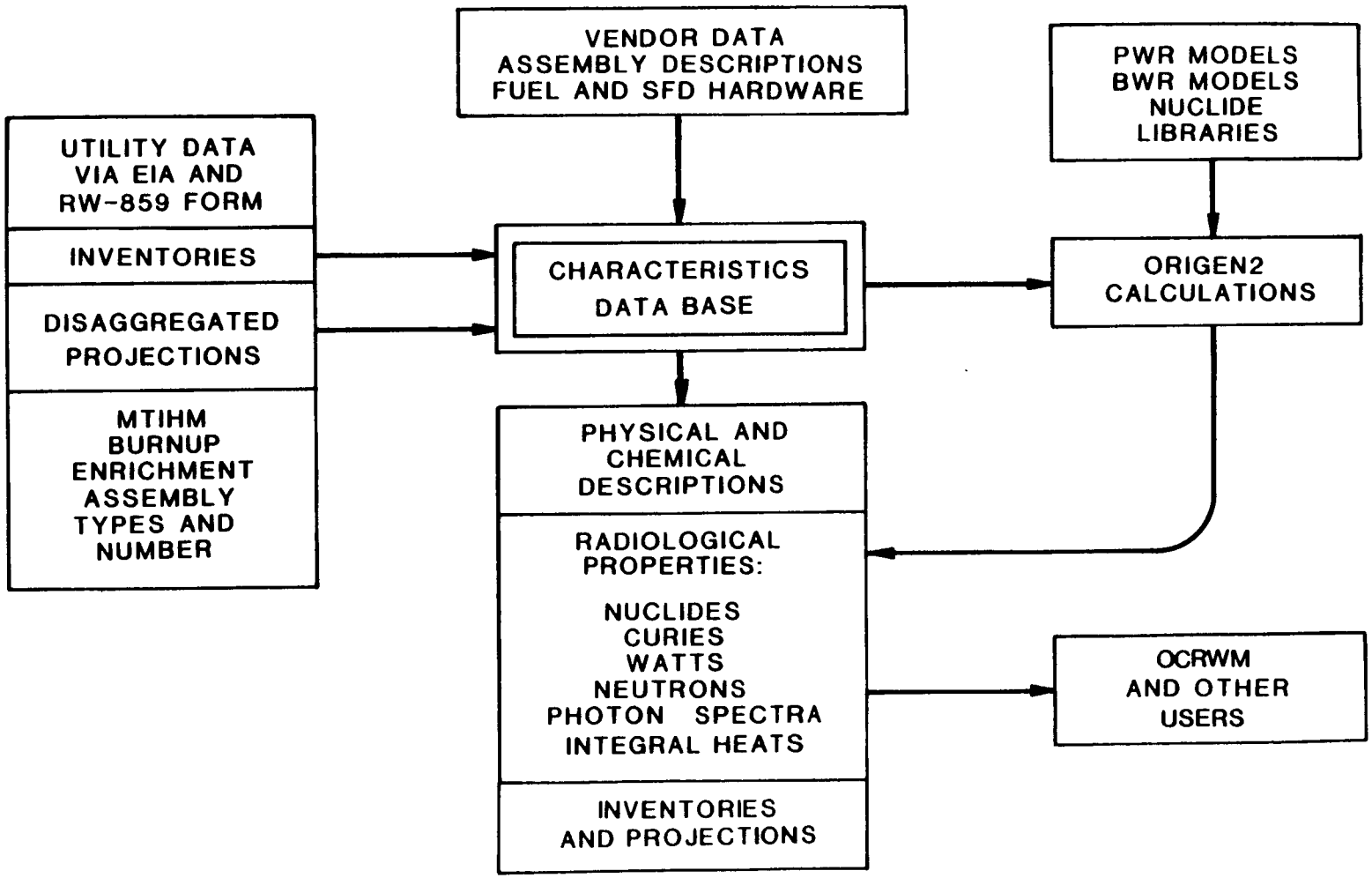
# OVERALL SUMMARY OF POTENTIAL REPOSITORY WASTES PROJECTED TO 2020

| | NUMBER OF CANISTERS | WATTS PER CANISTER |
|---|---|---|
| LWR SPENT FUEL | 40,000 | 2,500 |
| IMMOBILIZED HLW | 16,000 | 110 - 1200 |
| NON-LWR/SPECIAL CASE | 1,400 | 50 - 100 |
| GTCC HARDWARE | 10,000 | 10 - 200 |

# SUMMARY OF SPENT FUEL CHARACTERISTICS PROVIDED

- EXTENSIVE PROPERTIES
  - INVENTORIES
  - PROJECTED QUANTITIES
- INTENSIVE PROPERTIES
  - PHYSICAL DESCRIPTIONS
  - CHEMICAL COMPOSITIONS
  - RADIOLOGICAL PROPERTIES
- "EXCEPTION" PROPERTIES OF LWR SPENT FUEL
  - DEFECTIVE FUEL
  - SPECIAL FUELS
- NON-LWR SPENT FUELS

# CHARACTERISTICS DATA FOR LWR SPENT FUEL

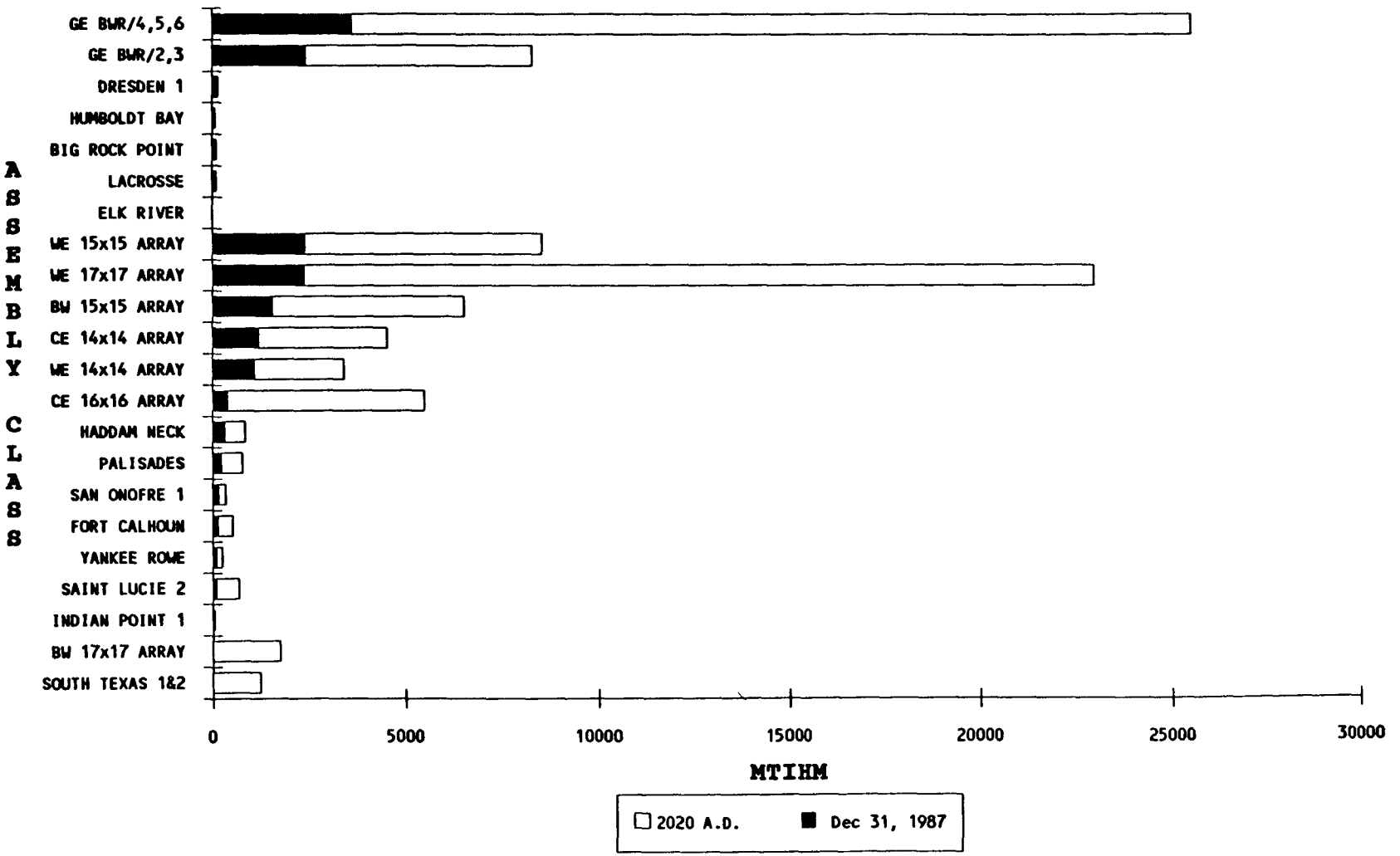


# ASSEMBLY CLASSIFICATION SCHEME*

- NEEDED TO SIMPLIFY DATA ORGANIZATION
- BASIS: REACTOR CORE CONFIGURATION
  - 23 CLASSES
  - 7 BWR
    - * 2 GENERIC
    - * 5 ONE-OF-A-KIND
  - 16 PWR
    - * 9 GENERIC
    - * 7 ONE-OF-A-KIND
- FURTHER BREAK-DOWN BY MODEL TYPE

*REPORT ISSUED ORNL/TM-10901, NOVEMBER 1988

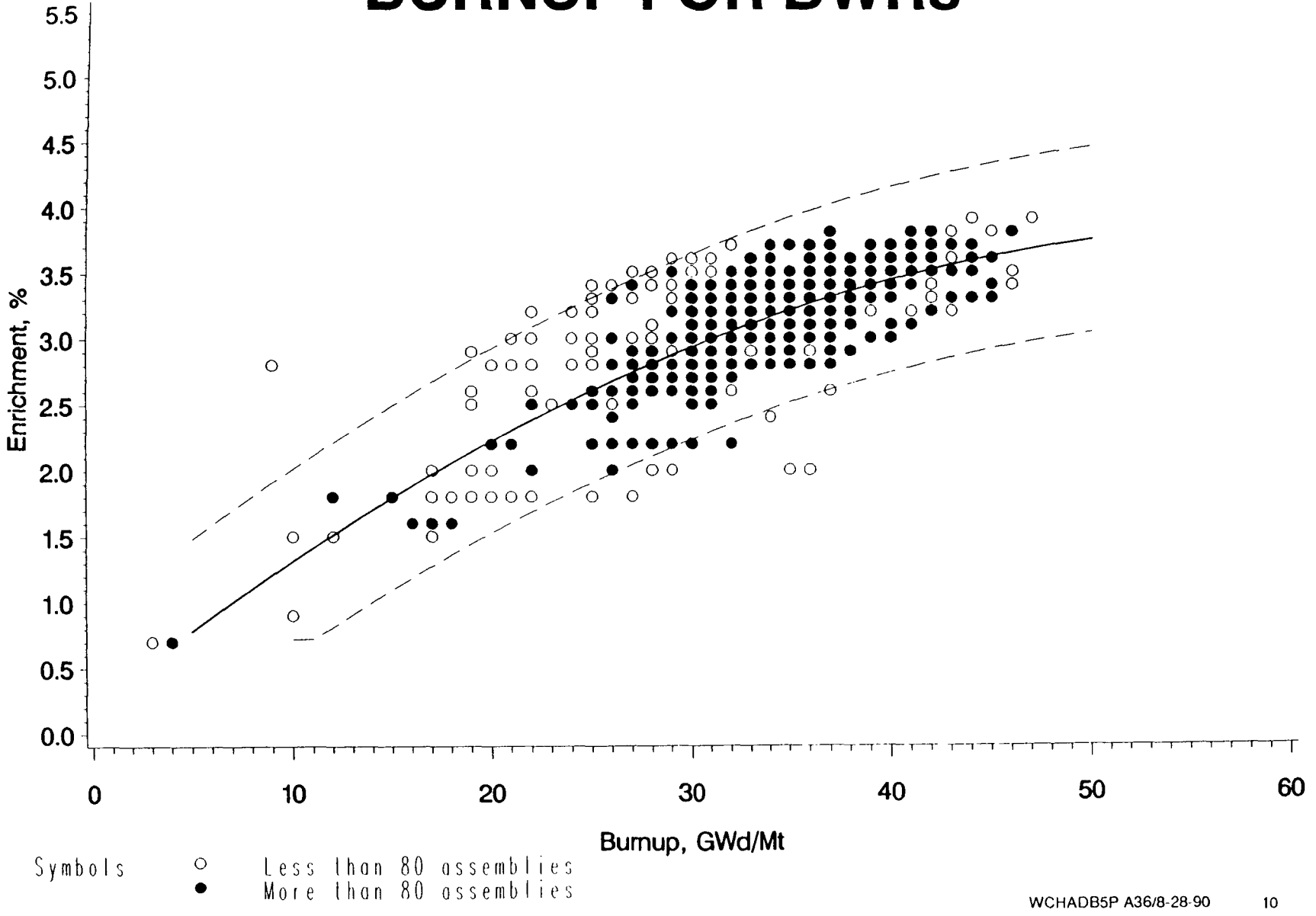
# ASSEMBLY CLASS QUANTITIES



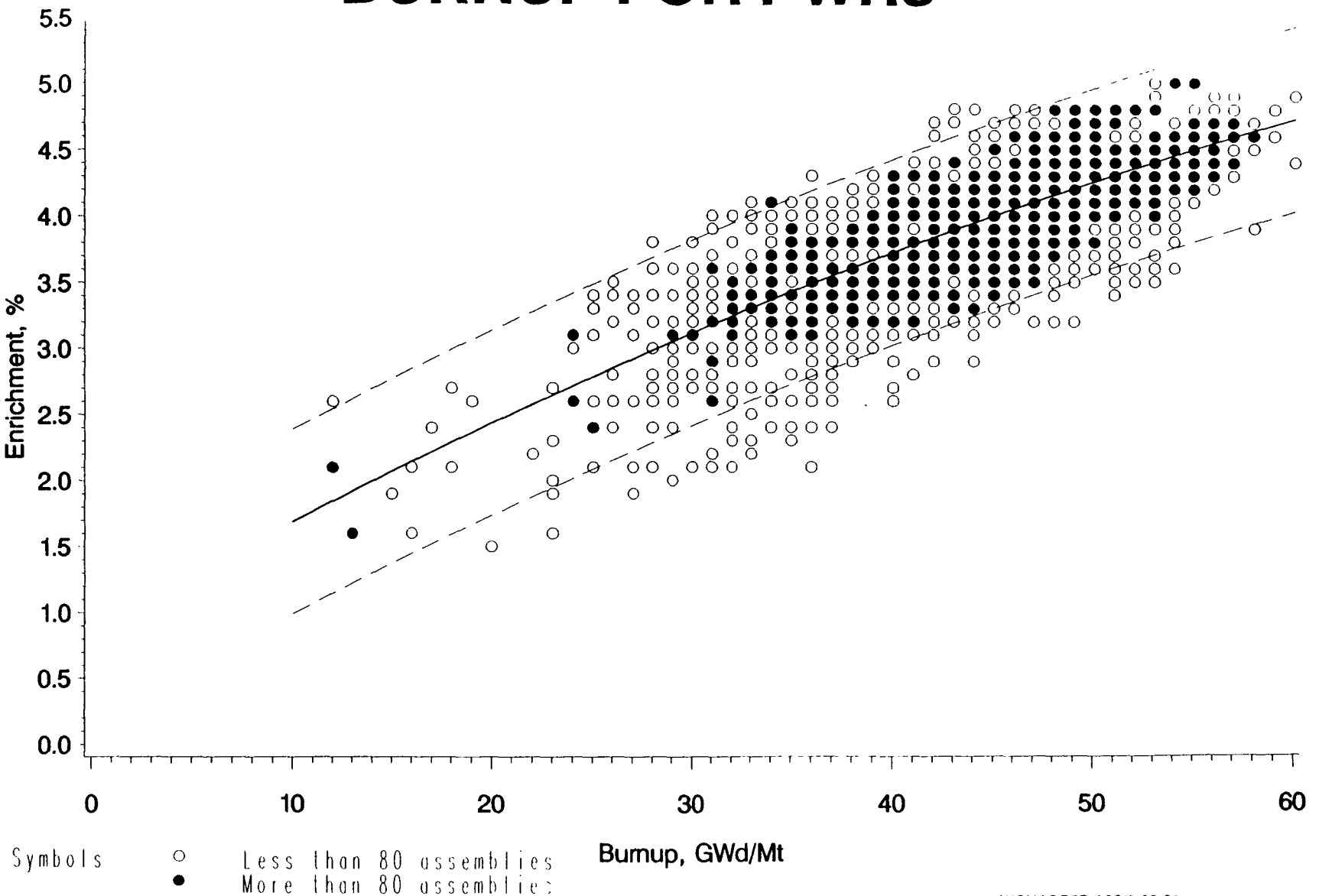
# RADIOLOGICAL PROPERTIES

- CALCULATED USING ORIGEN2
- SPENT FUEL BASED ON
  - ENRICHMENT
  - BURNUP
  - CYCLE DATA
  - DISCHARGE DATE (AGE)
- IMMOBILIZED HLW BASED ON
  - COMPOSITION
  - CANISTER FILL DATE (AGE)

# ENRICHMENT AS A FUNCTION OF BURNUP FOR BWRs



# ENRICHMENT AS A FUNCTION OF BURNUP FOR PWRs



# RADIOLOGICAL PROPERTIES

(CONTINUED)

- PROPERTIES
  - INDIVIDUAL NUCLIDES
    - * GRAM-ATOMS
    - * FP, AP, ACTINIDES
  - ALPHA EMISSIONS
  - BETA-GAMMA EMISSIONS
    - * 18 ENERGY GROUPS
  - NEUTRON EMISSIONS
    - * SF AND ALPHA-N
  - THERMAL OUTPUT
  - INTEGRAL HEATS

# CALCULATED C-14 CONTENTS OF LWR SPENT FUEL ASSEMBLIES

| | PWR W 17x17 Ci/MTIHM | BWR GE 8x8 Ci/MTIHM |
|---|---|---|
| $UO_2$ FUEL (BASED ON 25 ppm NITROGEN) | 0.49 | 0.43 |
| FUEL PIN HARDWARE* (CLADDING, SPRING) | 0.34 | 0.49 |
| PLENUM FILL GAS (FROM RESIDUAL NITROGEN) | $1 \times 10^{-4}$ | $5 \times 10^{-6}$ |
| ASSEMBLY HARDWARE* (END FITTINGS, GRIDS, GUIDE TUBES, SLEEVES, SPRINGS) | 0.37 | 0.22 |
| CHANNEL* (BWR ONLY; 120 MILS THICK) | - | 0.38 |
| CRUD (FROM OXYGEN ACTIVATION) | $4 \times 10^{-5}$ | $3 \times 10^{-4}$ |
| TOTAL | 1.2 | 1.5 |

(FROM DOE/RW-0184, R1; BURNUP OF 30,000 MWd/MT

* NITROGEN CONTENTS OF HARDWARE:

| | |
|---|---|
| ZIRCALOY -2 AND -4 | 80 ppm |
| INCONEL -718 AND -X750 | 1300 ppm |
| STAINLESS STEEL 304 | 1300 ppm |

# CHARACTERISTICS REPORT

## TOTAL OF 8 VOLUMES

**VOLUME 1: SUMMARY**
**LWR SPENT FUEL**
**IMMOBILIZED HLW**

**VOLUME 7: NON-LWR SPENT FUELS**
**MISCELLANEOUS WASTES**

## SIX VOLUMES OF SUPPORTING APPENDICES

# PC DATA BASES

- 5 FOR LWR SPENT FUEL
  - QUANTITIES
  - ASSEMBLIES
  - RADIOLOGICAL
  - NFA HARDWARE
  - SERIAL NUMBERS (NEW)
- ONE FOR HLW
  - INTERIM FORMS AND CANISTERS
- MENU-DRIVEN AND USER-ORIENTED

# FUEL ROD DIAMETERS FOR PWR REACTORS

## PWR CLASSES

| GENERIC | FUEL ROD DIAMETER (INCHES) | QUANTITY OF FUEL (MTIHM) |
|---|---|---|
| BW 15x15 ARRAY | 0.430 | 1,506.6 |
| BW 17x17 ARRAY | 0.379 | 1.8 |
| CE 14x14 ARRAY | 0.440 | 952.6 |
| CE 16x16 ARRAY | 0.382 | 359.7 |
| WE 14x14 ARRAY | 0.440 | 76.8 |
| | 0.422 | 914.4 |
| | 0.400 | 7.3 |
| WE 15x15 ARRAY | 0.422 | 1,551.1 |
| WE 17x17 ARRAY | 0.374 | 2,086.8 |
| | 0.360 | 151.0 |

# FUEL ROD DIAMETERS FOR BWR REACTORS

## BWR CLASSES

| GENERIC | FUEL ROD DIAMETER (INCHES) | QUANTITY OF FUEL (MTIHM) |
|---|---|---|
| GE BWR/2,3 | 0.570 | 712.3 |
| | 0.563 | 222.7 |
| | 0.490 | 693.9 |
| GE BWR/4,5,6 | 0.563 | 1,150.6 |
| | 0.490 | 2,210.5 |

# GE ASSEMBLY DATA*

- NEEDED BECAUSE MUCH OF GE's ASSEMBLY DETAILS ARE PROPRIETARY
- DESCRIPTIONS ARE COMPLEX AND INCLUDE
  - CLASS (1, 2/3, 4/5/6)
  - DESIGN (TO #11 NOW)
  - ARRAY SIZE (FROM 6x6 TO 10x10)
    (BURNABLE POISONS)
    (ENRICHMENT PATTERN)
- INCLUDES 26 GE MODEL TYPES

*REPORT ISSUED ORNL/TM-10901, JUNE 1989

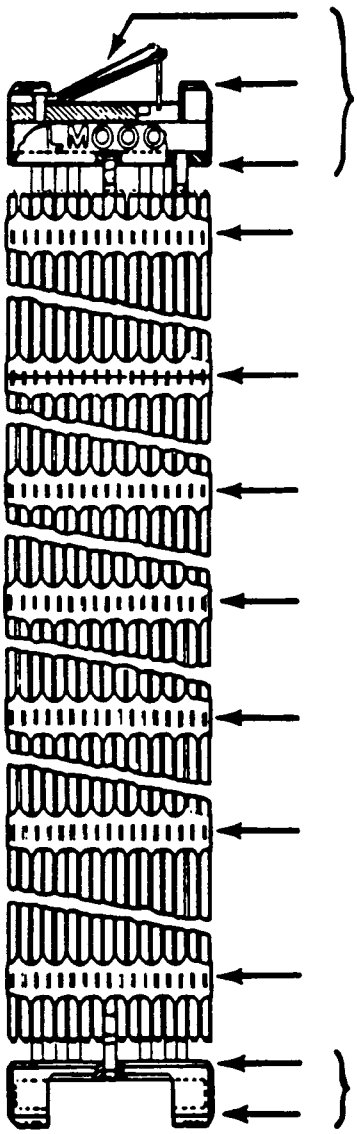
# HARDWARE ACTIVATION DATA*

- CONCERN re GTCC CLASSIFICATION IF CONSOLIDATION TAKES PLACE
  - SFD HARDWARE FROM CONSOLIDATION
  - NFA HARDWARE IN ANY EVENT
- ACTUAL MEASUREMENTS ON 3 ASSEMBLIES AT THE MATERIALS CHARACTERIZATION CENTER (MCC)
- MEASURED 12 NUCLIDES AT MULTIPLE LOCATIONS IN 4 ZONES
  - TOP, PLENUM, CORE, BOTTOM
- ALSO PERFORMED ORIGEN2 CALCULATIONS

*REPORT ISSUED: PNL-6906, VOLUME 1, JUNE 1989

# ZONE FACTORS FOR HARDWARE ACTIVATION





| SAMPLING POINTS | ZONE | FACTOR |
|---|---|---|
| Top End Fitting | TOP END | 0.1 |
| Grid | PLENUM | 0.2 |
| Grid | CORE REGION | 1.0 |
| Grid | | |
| Grid | | |
| Grid | | |
| Grid | | |
| Grid | | |
| Bottom End Fitting | BOTTOM END | 0.2 (PWR) 0.15 (BWR) |

# NON-LWR SPENT FUEL REPORT*

- **MAJOR CONTRIBUTORS:** (EST.CANISTERS)
  - HTGR
    - * FORT ST. VRAIN (554)
    - * PEACH BOTTOM-1 (138)
  - DEGRADED LWR
    - * TMI-2 (350)
- **OTHER CONTRIBUTORS:**
  - SHIPPINGPORT LWBR (65)
  - FERMI-1 BLANKET (43)
  - TRIGA (40)
- **ALL OTHERS** (245)

*REPORT ISSUED: ORNL/TM-11016, JANUARY 1990

# NON-LWR SPENT FUEL REPORT*

(CONTINUED)

- **SPECIAL CONCERNS**
  - CHEMICAL COMPOSITION
  - CLADDING
  - PHYSICAL CONDITION
  - HIGH ENRICHMENT/LOW BURNUP
  - U-233 (PLUS U-232)

# ORIGEN2 SENSITIVITY STUDY*

- USE NEW CROSS SECTIONS (ORNL/TM-11018)
- MAJOR IMPACT OF ENRICHMENT
  - ACTINIDES
  - NEUTRON SOURCE STRENGTH
  - CRITICALITY
  - SOME ACTIVATION PRODUCTS
- MINOR IMPACT
  - FISSION PRODUCTS
  - POWER LEVEL
  - DECAY TIME

* REPORT: ORNL/TM-11333, IN PREPARATION

# IMPROVEMENTS AND ADDITIONS TO DOE/RW-0184-R1

- AN IMPROVED LWR ASSEMBLY CLASSIFICATION SCHEME
- MORE DATA ON LWR ASSEMBLIES, ESPECIALLY GE BWR ASSEMBLIES
- REVISED LWR RADIOLOGICAL DATA, INCLUDING
  - SPECIFIC INCLUSION OF ENRICHMENT
  - NEWLY RECALCULATED EFFECTIVE CROSS SECTIONS
  - UTILITY DATA ON CYCLE- AND DOWN-TIMES
  - BUILT-IN INTERPOLATION FUNCTIONS
  - IMPROVED METHOD FOR INTEGRAL HEATS

# IMPROVEMENTS AND ADDITIONS TO DOE/RW-0184-R1

(CONTINUED)

- ANOTHER PC DATA BASE, FOR LWR ASSEMBLY SERIAL NUMBERS
- NEW ACTIVATION FACTORS FOR HARDWARE
- THE ADDITION OF FUEL PIN DATA TO THE ASSEMBLY DATA BASE
- CORRECTED NEUTRON SOURCE STRENGTH FOR THE HLW DATA BASE
- IMPROVED USER INTERFACE WITH ALL OF THE DATA BASES