OCRWM	DESIGN CALCULATION OR ANALYSIS COVER SHEET	1. QA: QA 2. Page 1

3. System	4. Document Identifier
Waste Handling System	100-00C-WHS0-00100-000-00C

5. Title
Dry Transfer Facility Criticality Safety Calculations

6. Group
Licensing & Nuclear Safety/Criticality

7. Document Status Designation
☒ Preliminary ☐ Final ☐ Cancelled

8. Notes/Comments
An LP-2.14Q-BSC review was completed on May 16, 2005. During the review, the document title was changed from Surface Facility Criticality Safety Calculations to Dry Transfer Facility Criticality Safety Calculations.

NOTICE OF OPEN CHANGE DOCUMENTS - THIS DOCUMENT IS IMPACTED BY THE LISTED CHANGE DOCUMENTS AND CANNOT BE USED WITHOUT THEM.

--

1) ECN-001, DATED 07/27/2005
2) ECN-002, DATED 07/27/2005
3) ECN-003, DATED 09/09/2005

Attachments	Total Number of Pages
Attachment I: List of Computer Files	5
Attachment II: One Compact Disc	N/A
Attachment III: General Arrangement Drawings of the Dry Transfer Facility and its Remediation Area	26
Attachment IV: Sketch of DTF Staging Tube Layouts	1

RECORD OF REVISIONS

9. No.	10. Reason For Revision	11. Total # of Pgs.	12. Last Pg. #	13. Originator (Print/Sign/Date)	14. Checker (Print/Sign/Date)	15. QER (Print/Sign/Date)	16. Approved/Accepted (Print/Sign)	17. Date
00A	Initial issue	68	III-7	C.E. Sanders	G. Radulescu	D.J. Tunney	S. Su	8/14/03
00B	Update and revise the criticality safety evaluation of the DTF and RB. Revision includes new Boral loading for BWR assembly calculations, updated Category 1 and 2 event sequences, and inclusion of Y-12 review comments. Extensive Revision. All pages are affected.	76	III-8	C.E. Sanders	D.S. Kimball	D.J. Tunney	S. Su	3/02/04
00C	Update and revise the criticality safety evaluation of the DTF. Revision includes new DTF staging rack and remediation pool design as well as updated Category 1 and 2 event sequences. Extensive Revision. All pages are affected.	79	IV-1	C.E. Sanders [signature] 05/17/2005	J.M. Scaglione [signature] 5/17/05	D.J. Tunney [signature] 5/17/2005	W.E. Hutchins [signature]	5-17-05

INTENTIONALLY LEFT BLANK

CONTENTS

FIGURES

Page

TABLES

Page

INTENTIONALLY LEFT BLANK

1. PURPOSE

This design calculation updates the previous criticality evaluation for the fuel handling, transfer, and staging operations to be performed in the Dry Transfer Facility (DTF) including the remediation area. The purpose of the calculation is to demonstrate that operations performed in the DTF and RF meet the nuclear criticality safety design criteria specified in the *Project Design Criteria (PDC) Document* (BSC 2004 [DIRS 171599], Section 4.9.2.2), the nuclear facility safety requirement in *Project Requirements Document* (Canori and Leitner 2003 [DIRS 166275], p. 4-206), the functional/operational nuclear safety requirement in the *Project Functional and Operational Requirements* document (Curry 2004 [DIRS 170557], p. 75), and the functional nuclear criticality safety requirements described in the *Dry Transfer Facility Description Document* (BSC 2005 [DIRS 173737], p. 3-8). A description of the changes is as follows:

- Update the supporting calculations for the various Category 1 and 2 event sequences as identified in the *Categorization of Event Sequences for License Application* (BSC 2005 [DIRS 171429], Section 7).
- Update the criticality safety calculations for the DTF staging racks and the remediation pool to reflect the current design.

This design calculation focuses on commercial spent nuclear fuel (SNF) assemblies, i.e., pressurized water reactor (PWR) and boiling water reactor (BWR) SNF. U.S. Department of Energy (DOE) Environmental Management (EM) owned SNF is evaluated in depth in the *Canister Handling Facility Criticality Safety Calculations* (BSC 2005 [DIRS 173284]) and is also applicable to DTF operations. Further, the design and safety analyses of the naval SNF canisters are the responsibility of the U.S. Department of the Navy (Naval Nuclear Propulsion Program) and will not be included in this document. Also, note that the results for the Monitored Geologic Repository (MGR) Site specific Cask (MSC) calculations are limited to the specific design chosen (see Assumption 3.4). A more current design will be included in the next revision of the criticality calculations for the Aging Facility. In addition, this calculation is valid for the current design as provided in Attachment III of the DTF and may not reflect the ongoing design evolution of the facility. However, it is anticipated that design changes to the facility layout will have little or no impact on the criticality results and/or conclusions presented in this document.

This calculation is subject to the *Quality Assurance Requirements and Description* (DOE 2004 [DIRS 171539]) because the DTF and the staging racks/baskets in the remediation pool are included as safety category items in the *Q-List* (BSC 2005 [DIRS 171190], pp. A-4 and A-7) as items important to safety. This calculation is prepared in accordance with AP-3.12Q, *Design Calculations and Analyses* [DIRS 168413].

2. METHOD

2.1 CRITICALITY SAFETY ANALYSIS

The criticality safety calculations presented in this document evaluate fuel handling, transfer and staging operations in the DTF and remediation area to ensure they meet the criticality safety requirements under normal conditions as well as for Category 1 and 2 event sequences, in accordance with 10 CFR 63 [DIRS 173273]. Minimum spacing for PWR and BWR fuel storage racks in the DTF and remediation pool is determined along with varied neutron poison (Boral) panel thickness. The off-normal and accident conditions are inclusive of Category 1 and 2 event sequences as defined in 10 CFR 63.2 [DIRS 173273]. Moderator and reflector conditions are varied to find the most reactive configuration. The process and methodology for criticality safety analysis given in the *Preclosure Criticality Analysis Process Report* (BSC 2004 [DIRS 172058], Section 2.2.7) will be implemented in these calculations, and the following method will be followed:

- The criticality safety design of the facility will be based on the most reactive fuel.
- The effective neutron multiplication factor (k_{eff}), including all biases and uncertainties at a 95 % confidence level, will not exceed 0.95 under all credible normal, and Category 1 and 2 event sequences (NRC 2000 [DIRS 149756], Section 8.4.1.1).
- Conservative modeling assumptions leading to maximum reactivity for dimensional variables (e.g., pitch and manufacturing tolerances for assemblies) will be used.
- Conservative modeling assumptions will also be used regarding materials in the fuel including no accounting for burnable poisons in fuel, no credit for ^{234}U and ^{236}U in fuel, no credit for fission products or transuranic absorbers in fuel, and use of the most reactive fuel stack density.
- Fixed neutron absorbers used for criticality control can only take credit for up to 75% of the neutron absorbing content (NRC 2000 [DIRS 149756], Section 8.4.1.1).

Note that the terms "model(s)" and "modeling" as used in this calculation document refer to the geometric configurations of the criticality cases analyzed and not scientific models per LP-SIII.10Q-BSC, *Models* [DIRS 172972].

These calculations use the qualified software MCNP (CRWMS M&O 1998 [DIRS 154060]). MCNP is a three-dimensional Monte Carlo particle transportation code with the capability to calculate eigenvalues. The Nuclear Regulatory Commission (NRC) accepts MCNP in NUREG-1567 (NRC 2000 [DIRS 149756], p. 8-10) for criticality calculations.

2.2 ELECTRONIC MANAGEMENT OF INFORMATION

Electronic management of information generated from these calculations is controlled in accordance with Section 5.1.2 of AP-3.13Q, *Design Control* [DIRS 167460]. The computer input and output files generated from this calculation are stored on a Compact Disc (CD), and submitted as an attachment to this document (Attachment II).

3. ASSUMPTIONS

3.1 LOADING OF STAGING RACKS AND POOL

Assumption: It is assumed that the DTF staging racks and remediation pool are full.

Rationale: In reality, the storage racks may not always be full. However, for modeling purposes this should give maximum reactivity.

Confirmation Status: This assumption requires no further confirmation based on the stated rationale.

Use in the Calculation: Sections 5.1.4.1, 5.1.5.1, 5.2.1, and 5.2.2.

3.2 HYDRAULIC FLUID COMPOSITION

Assumption: It is assumed that the hydraulic fluid used as an alternative moderator material was a conventional silicone fluid (polysiloxane fluid) with a degree of polymerization of four (Gelest 2004 [DIRS 169915], p. 11).

Rationale: The basis for this assumption is that the DTF design has not identified the hydraulic fluid for lubrication, but the candidate material used for lubrication is expected to be less effective as a moderator than water. The material used for this calculation to demonstrate criticality safety is a common silicone based hydraulic fluid (Gelest 2004 [DIRS 169915], p. 7). It should be recognized that this material might not represent the most reactive condition. Any change in the design selection of the hydraulic fluid would require re-evaluation of criticality safety to ensure that all the criticality design criteria are met.

Confirmation Status: This assumption requires no further confirmation based on the stated rationale.

Use in the Calculation: Section 5.1.7.

3.3 WP BREACH

Assumption: It is assumed that a WP failure caused by drops and/or collisions is a non-credible event (i.e., beyond Category 2).

Rationale: The primary mechanisms that can cause the WP to breach (e.g., drops or collisions) have been screened in *Categorization of Event Sequences for License Application* (BSC 2005 [DIRS 171429]), and show that drops onto sharp objects are beyond Category 2 (BSC 2005 [DIRS 171429], Table III-9), as well as collisions are beyond Category 2 (BSC 2005 [DIRS 171429], Table III-9). Therefore, it is reasonable to assume that a breach of a WP is a beyond Category 2 event.

Confirmation Status: This assumption requires no further confirmation based on the stated rationale.

Use in the Calculation: Section 6.3

3.4 MSC DESIGN

Assumption: The Monitored Geologic Repository (MGR) Site specific Cask (MSC) is assumed to be similar in design, other than the neutron poison loading/configuration, to the Multi Purpose Canister (MPC)-24 for PWR fuel and the MPC-68 for BWR fuel that is part of the Holtec HI-STORM 100 cask system (Holtec International 2002 [DIRS 168494]).

Rationale: Since the MSC is still being developed, the criticality control features will be made similar to the existing NRC-certified storage casks.

Confirmation Status: This assumption requires no further confirmation based on the stated rationale.

Use in the Calculation: Sections 1, 6.3, and 6.4.

3.5 SELECTION OF REPRESENTATIVE TRANSPORTATION CASK

Assumption: It is assumed that the HI-STAR transportation cask is a representative and bounding cask for operations in the DTF.

Rationale: Performance requirement 3.1.1.3.1 of the *Transportation Cask Receipt/Return Facility Description Document* (BSC 2005 [DIRS 171702]) states that no decision has been made as to which transportation casks will be used. However, the following approved casks by the NRC should be bounding for operations of CSNF: (1) GA-4; (2) HI-STAR; (3) NAC-UMS; (4) TS-125; (5) NAC-STC; (6) NUHOMS-MP-187; (7) TN-68; and (8) NUHOMS-MP-197. Tables 3.6-1 and 3.6-2 compare k_{eff} values along with enrichment of the various transportation casks. It can be seen that the HI-STAR cask has one of the highest k_{eff} values for PWR fuel and the highest k_{eff} value for BWR fuel in addition to a relatively high enrichment. Therefore, HI-STAR is an acceptable choice for a representative cask for this calculation. The selection of this cask is bounding for normal conditions of transport under 10 CFR 71 [DIRS 171308]. Further evaluation should be made in future revisions of this calculation to address the applicability to repository conditions including normal operations and Category 1 and Category 2 conditions.

Confirmation Status: This assumption requires no further confirmation based on the stated rationale.

Use in the Calculation: Section 5.1.8.

Table 3.6-1 Comparison of Most Reactive PWR Fuel in Various Transportation Casks

Cask Type	PWR Fuel				
	Fuel Type	Enrichment (wt% ^{235}U)	k_{eff}	St. Dev.	Reference
GA-4	W 15x15 OFA	3.15	0.9300	0.0011	General Atomics 1998 [DIRS 103042], Table 6.4-2
HI-STAR	B&W 15x15	4.1	0.9395 [a]	N/A	Holtec International 2003 [DIRS 172633], p. 6.2-27
NAC-UMS	W 17x17 OFA	4.2	0.9247	0.0009	NAC International 2002 [DIRS 164612], Section 6.1 & Table 6.1-1
TS-125 (W21 canister)	W 17x17 OFA	4.6	0.94025	0.00093	Sisley, S.E. 2002 [DIRS 171545], Table 6.4-6
NAC-STC	Framatome-Cogema 17x17	4.5	0.92541	0.00086	Thompson, T.C. 2003 [DIRS 169362], Section 6.1.1
NUHOMS-MP-187	B&W 15x15	3.43	0.9374 [b]	N/A	Transnuclear West 2002 [DIRS 161510], Table 6.1-1 & Table 6.2-1
TN-68	Not applicable to PWR fuel				
NUHOMS-MP-197	Not applicable to PWR fuel				

[a] maximum k_{eff}.
[b] k_{eff} includes 2 standard deviations uncertainty.

Table 3.6-2 Comparison of Most Reactive BWR Fuel in Various Transportation Casks

Cask Type	BWR Fuel				
	Fuel Type	Enrichment (wt% ^{235}U)	k_{eff}	St. Dev.	Reference
GA-4	Not applicable to BWR fuel				
HI-STAR	GE 8x8 [a]	4.2	0.9384	0.0007	Holtec International 2003 [DIRS 172633], p. 6.2-36
NAC-UMS	Exxon/ANF 9x9	4.0	0.9055	0.0008	NAC International 2002 [DIRS 164612], Section 6.1 & Table 6.1-1
TS-125 (W74 canister)	Siemens 11x11	4.1	0.93422	0.00089	Sisley, S.E. 2002 [DIRS 171545], Table 6.4-10
NAC-STC	Not applicable to BWR fuel				
NUHOMS-MP-187	Not applicable to BWR fuel				
TN-68	GE 10x10	3.7	0.9250	0.0008	Transnuclear 2001 [DIRS 167988], Sections 6.1 & 6.4.2
NUHOMS-MP-197	GE 10x10	4.4	0.9349	0.0011	Transnuclear 2002 [DIRS 160736], Sections 6.4.4 & 6.4.2

[a] Some other fuel assembly types have higher k_{eff} values (see Section 5.1.2).

3.6 SELECTION OF REPRESENTATIVE FUEL BASKET

Assumption: It is assumed that the fuel basket design used in both the HI-STAR and HI-STORM cask systems is a representative fuel basket design for staging operations in the DTF and remediation pool.

Rationale: Storage rack cells, in the United States, designed to accommodate spent fuel are generally composed of stainless steel walls with a fixed neutron absorber panel (e.g., Boral) on each side (Wagner and Parks 2000 [DIRS 163140], p.7). This is consistent with the fuel baskets featured in the Holtec cask systems. Therefore, it is acceptable to use the fuel basket design used in the HI-STAR/HI-STORM cask systems as a representative fuel basket for this calculation.

Confirmation Status: This assumption requires no further confirmation based on the stated rationale.

Use in the Calculation: Section 5.1.6.

4. USE OF COMPUTER SOFTWARE

4.1 BASELINED SOFTWARE

4.1.1 MCNP

The MCNP code (CRWMS M&O 1998 [DIRS 154060]) was used to calculate k_{eff} for all systems presented in this report. The software specifications are as follows:

- Program Name: MCNP (CRWMS M&O 1998 [DIRS 154060])
- Version/Revision Number: Version 4B2LV
- Status/Operating System: Qualified/HP-UX B.10.20
- Software Tracking Number: 30033 V4B2LV
- Computer Type: HP 9000 Series Workstations
- CPU Number: 700887

The input and output files for the various MCNP calculations are contained on a CD (Attachment II) and the files are listed in Attachment I.

The MCNP software used was: (1) appropriate for the criticality (k_{eff}) calculations, (2) used only within the range of validation as documented through Briesmeister (1997 [DIRS 103897]) and CRWMS M&O (1998 [DIRS 102836]), and (3) obtained from Software Configuration Management in accordance with appropriate procedures.

4.2 COMMERCIAL OFF-THE-SHELF SOFTWARE

4.2.1 MICROSOFT EXCEL 97 SR-2

- Title: Excel
- Version/Revision Number: Microsoft® Excel 97 SR-2
- This version is installed on a PC running Microsoft Windows 2000 with CPU number 503009

The file for the Excel calculation is contained on a CD (Attachment II) and the file is listed in Attachment I.

Excel was used to illustrate data in Section 6.3.2. Excel is exempt from qualification per Section 2.1.6 of LP-SI.11Q-BSC, *Software Management* [DIRS 171923].

5. CALCULATION

All technical product inputs and sources of the inputs used in the development of this calculation are documented in this section. Attachment III features General Arrangement Drawings of the DTF and its remediation area as of the date of this calculation, and may not reflect the ongoing design evolution. The purpose of these drawings is to show the functional areas where the SNF will be handled and staged as well as to show the area where moderator control is required.

5.1 CALCULATIONAL INPUTS

5.1.1 Design Requirements and Criteria

The design criteria for criticality safety analysis provided in Section 4.9.2.2 of the *Project Design Criteria Document* (BSC 2004 [DIRS 171599]) are used in these calculations. The pertinent criteria for DTF criticality include the following (BSC 2004 [DIRS 171599], Section 4.9.2.2):

- The multiplication factor, k_{eff}, including all biases and uncertainty at a 95 percent confidence level, shall not exceed 0.95 under all normal conditions, and Category 1 and Category 2 event sequences.

- For fixed-neutron absorbers used for criticality control such as grid plates or inserts, no more than 75 percent credit of the neutron absorber content is used for preclosure criticality analyses, unless standard acceptance tests verify that the presence and uniformity of the neutron absorber are more effective.

- To use moderator control for nuclear criticality safety during preclosure for a facility, the facility shall limit the amount of moderator that may be present in any area where radioactive waste is being handled to show that there is no criticality concern under all normal conditions, Category 1 event sequences, and Category 2 event sequences.

The *Project Requirements Document* seeks to 'prevent unplanned nuclear criticality events' through requirement PRD-015/P-096 (Canori and Leitner 2003 [DIRS 166275], p. 4-206). From an operational/performance requirement point of view, 'the staging racks … shall be designed to maintain criticality safety' per the *Project Functional and Operational Requirements* document (Curry 2004 [DIRS 170557], Section 1.1.6-4). The functional requirement 3.2.3.1 of the *Dry Transfer Facility Description Document* (BSC 2005 [DIRS 173737], p. 3-8) states that the "design of the DTF spacing and neutron absorbers shall ensure that there is no credible criticality event under all normal conditions and Category 1 and 2 event sequences".

5.1.2 Fuel Assembly Selection

The Westinghouse 17x17 optimized fuel assembly (OFA) was chosen as a representative PWR fuel assembly for the DTF and remediation pool staging rack criticality calculations. The basket cell designs utilized in this calculation is that of the HI-STAR 100 cask system (Holtec International 2003 [DIRS 172633]). Studies have shown that either the B&W 15x15 or the Westinghouse 17x17 OFA (optimized fuel assembly) are the most reactive fuel assemblies inside the HI-STAR basket cells (Holtec International 2003 [DIRS 172633], p. 6.2-2). Therefore, the Westinghouse 17x17 OFA was chosen for the DTF and remediation area staging rack calculations. Evaluations of the HI-STAR transportation cask were also considered for Category 2 event sequences in the DTF. The Babcock & Wilcox (B&W) 15x15 fuel assembly (4.1 wt% enriched) was chosen as a representative fuel assembly inside the multi-purpose canister (MPC) for PWR fuel (note that MPC is a name of a component of the HI-STAR cask system). This is consistent with previously performed HI-STAR transportation cask calculations (BSC 2005 [DIRS 173616]).

The GE 8x8 fuel assembly was selected as representative of BWR fuel, because it is the most numerous design, inside the HI-STAR 100 basket cell design. Studies have shown that an 8x8 fuel array is one of the more reactive assembly configurations in the design inventory (Holtec International 2003 [DIRS 172633], Tables 6.2.20 – 6.2.36). There is a 10x10 assembly design that produces a slightly higher k_{eff} than the 8x8 fuel assembly (Table 6.2.32). However, this 10x10 fuel assembly design is not an actual assembly design, due to artificial bounding parameters for maximizing reactivity (Holtec International 2003 [DIRS 172633], p. 6.2-3), and was therefore not considered for this evaluation. A 9x9 fuel assembly design (Holtec International 2003 [DIRS 172633], Table 6.2.27) also produced a slightly higher k_{eff} value than the selected 8x8 design. For completeness, one calculation was performed with this 9x9 fuel design in the staging racks to show the difference in calculated k_{eff} values (see Section 6.1).

5.1.3 Upper Subcritical Limit

The upper subcritical limit (USL) is the value characterized by statistical tolerance limits that account for biases and uncertainties associated with the criticality code trending process, any uncertainties due to extrapolation outside the range of experimental data, or limitations in the geometrical or material representations used in the computational method, and an administrative margin-to-criticality that can reduce the actual critical limit. The critical limit is a limiting value of k_{eff} at which a configuration is considered potentially critical (BSC 2004 [DIRS 172058], Section 3.4.1).

The USL for CSNF (both PWR and BWR fuel) used in this calculation is 0.9472 as a limit in order to meet the design criteria that k_{eff} shall not exceed 0.95 including bias and uncertainties at 95% confidence level (BSC 2004 [DIRS 171599], Section 4.9.2.2). This number was calculated based on applicable code bias for similar fuel type and enrichment range of this analysis that has been estimated to be 0.0021 (value increased by truncation) with a standard deviation of ± 0.0007 (Holtec International 2003 [DIRS 172633], Appendix 6.A-2). Consequently, the USL provides a margin of 0.0028 (0.95 – (0.0021+0.0007) = 0.9472) to account for code bias and uncertainties at 95% confidence level. Note that the uncertainties associated with the MCNP calculated k_{eff} values are not included in the USL (see discussion in the last paragraph of this section).

All evaluations utilizing the HI-STAR/HI-STORM 100 cask system design are using worst case combination of manufacturing tolerances with respect to criticality determined by Holtec International (Holtec International 2003 [DIRS 172633], p. 6.3-2). The values presented in Sections 5.1.6.1, 5.1.6.2, and 5.1.8 of this document include the tolerances that maximize criticality potential. Evaluations have been performed to determine the effects of tolerances (Holtec International 2003 [DIRS 172633], Tables 6.3.1 & 6.3.2). It was determined that design parameters important to criticality safety are fuel enrichment, the inherent geometry of the fuel basket structure and the fixed neutron absorbing panels (Boral) (Holtec International 2003 [DIRS 172633], p. 6.3-3).

For preclosure, the USL criterion is used for comparison to predicted k_{eff} values to determine a configuration's potential of exceeding the k_{eff} limit that ensures subcriticality. In equation notation, the definition of the USL criterion is (BSC 2004 [DIRS 172058], Section 3.5):

$$k_S + \Delta k_S \leq USL \qquad (1)$$

where k_S is the MCNP calculated value for the system, Δk_S is an allowance for (a) statistical or convergence uncertainties, or both in the computation of k_s, (b) material and fabrication tolerances, and (c) uncertainties due to the geometric or material representations used in the computational method. Based on using a bounding representation in this calculation, items (b) and (c) were eliminated.

The uncertainty associated with the MCNP calculated value is accounted for by adding 2 times the standard deviation to the calculated k_{eff} value and compare against USL. As an example, if the standard deviation associated with the MCNP calculated value for CSNF fuel is 0.00028 (see Section 6), the MCNP calculated value may not exceed 0.94664 (0.94664 + 2x0.00028=0.9472) in order to not violate the USL.

For a more detailed description of USL determination and criterion, see BSC 2004 [DIRS 172058] (Sections 3.4.1, 3.4.2, and 3.5).

5.1.4 DTF Staging Rack Calculation Inputs

The staging racks in the DTF were modeled as they are currently designed in accordance with Attachment III. Physical inputs for the staging racks are described in the following subsection.

5.1.4.1 DTF Staging Rack Configuration and Physical Dimensions

The various layout plans considered for the staging tubes are shown in Attachment IV. The staging rack configuration for the DTF PWR and BWR fuel assemblies for this calculation consists mainly of a 9 x 11 array of 16 in. (outside diameter) single staging tubes. The tubes were modeled with 0.5 in. thickness of stainless steel. A sensitivity study was performed with a 1.0 in. thick stainless steel tube (the distance between assemblies was maintained the same) to ensure that a varied thickness would not impact the k_{eff} values (see results in Section 6.1). The spacing between the tubes has not been determined (that is part of this evaluation), and the different spacing distances considered are 10 in., 12 in., and 16 in. of concrete between the tubes. The calculation considers the full length of the spacing between the tubes to consist of concrete. It should be mentioned that the current design plans do not include concrete for the full length (only approximately the top 5 ft). However, including the full length of concrete in the MCNP model will be conservative from a criticality perspective. In addition to the 9 x 11 array configuration, the 10 in. concrete spacing also considers a 10x12 array configuration with staggered lines (triangular pitch). Attachment IV displays the various layout plans and the dimensions.

For conservatism in criticality safety analysis, the MCNP models of the DTF fuel staging racks are always modeled as full (Assumption 3.1). In addition, only the active fuel region is modeled in the MCNP models (the active fuel length is extended slightly to cover the end-fittings regions). A previous study has shown that the fuel rod can be modeled either with or without end-regions included for criticality calculations (BSC 2005 [DIRS 173616], Table 5.2-1). The DTF staging tube was modeled with a length of 27 ft and the top of the tube beginning 5 ft below the floor, comprising a total length of 32 ft. The total length was estimated from the General Arrangement Drawing presented in Attachment III, p. III-24. The area below the staging tube, that holds the fuel assembly, was modeled as a stainless steel structure.

5.1.5 Remediation Pool Calculation Inputs

The pool in the RF was modeled per the current design as shown in Attachment III. Physical inputs for the RF pool are described in the following subsection.

5.1.5.1 Remediation Pool Configuration and Physical Dimensions

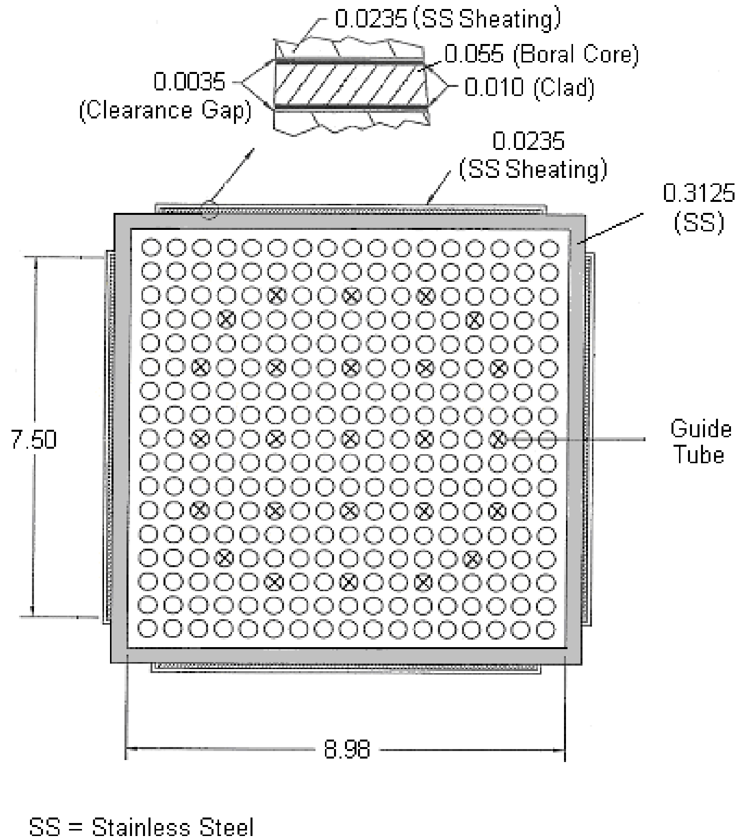
The remediation pool allows for 14 staging racks placed in 2 rows in accordance with p. III-13 of Attachment III. Each staging rack is 3'-4"x 3'-4" and can hold a 3x3 array of PWR fuel assemblies and a 4x4 array of BWR fuel assemblies (Cogema 2003 [DIRS 167153]). The width of the pool is 59 ft. and 3 in. and the pool along with the crane maintenance platform is 55 ft. deep (Cogema 2004 [DIRS 173297]). To minimize neutron leakage and account for reflection, the pool itself was modeled as 55 ft deep whereof 5 ft is a bottom steel plate. The maximum spacing of the first to last staging rack in one row is limited to 35'-1" due to travel capacity of the bridge crane (Cogema 2004 [DIRS 173297). In addition, the stainless steel liner surrounding the pool is 5 ft. wide (BSC 2004 [DIRS 170728]). As with the DTF staging rack, the MCNP models of the staging racks in the remediation pool are always modeled as full (Assumption 3.1). In addition, only the active fuel region is modeled in the MCNP models (the active fuel length is extended slightly to cover the end-fittings regions).

5.1.6 Basket Cell and Fuel Assembly Calculation Inputs

Since a final design of the basket cells contained in the staging racks has not been selected, the HI-STAR 100 cask system cell baskets were utilized (Assumption 3.6). The following sub-sections describe the basket cell geometry and the fuel assembly dimensions.

5.1.6.1 PWR Basket Cell and Fuel Assembly Dimensions

The PWR fuel cell basket features SS walls with a Boral panel situated on each side. The PWR fuel cell basket contains a Westinghouse 17 x 17 OFA (Section 5.1.2). Figure 5.1-1 displays the cell basket with the Westinghouse 17 x 17 OFA and Table 5.1-1 features the dimensions of the cell basket. Table 5.1-2 displays the specifications of the PWR fuel assembly.



NOTE: Dimensions are in inches. Figure is not to scale.

Figure 5.1-1 PWR Fuel Basket Cell Containing Westinghouse 17 x 17 OFA
(Source: Holtec International 2003 [DIRS 172633], Figure 6.3.1)

Table 5.1-1 Radial Dimensions of the Basket Cell Geometry

Component	**Dimension (cm)**	**Reference**
Cell box inside dimension	22.8092 (8.98 in.)	Holtec International 2003 [DIRS 172633], Table 6.3.3
Cell pitch	27.7012 (10.906 in.)	Holtec International 2003 [DIRS 172633], Table 6.3.3
Cell wall thickness (SS)	0.79375 (0.3125 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.1
SS sheathing	0.05969 (0.0235 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.1
Boral thickness	0.1397 (0.055 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.1
Al thickness (Clad)	0.0254 (0.010 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.1
Boral width	19.05 (7.50 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.1
Boral clearance gap	0.00889 (0.0035 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.1

Table 5.1-2 Specifications of the PWR W 17 x 17 OFA

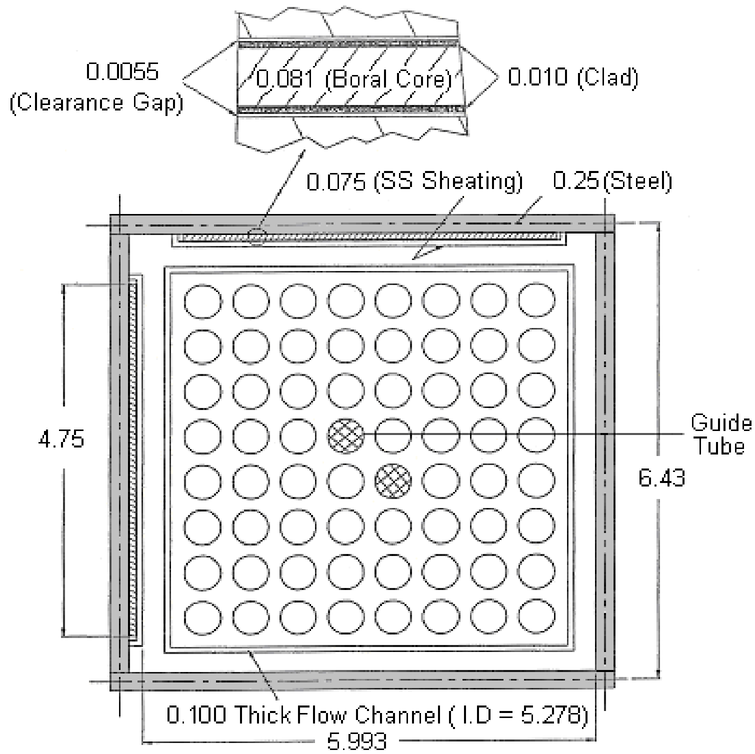
Parameter	Dimension (cm)	Reference [b]
Rod pitch	1.2598 (0.496 in.)	Holtec International 2002 [DIRS 168494], p. 2.1-11
Active fuel length	381.0 (150.0 in.)	Holtec International 2002 [DIRS 168494], p. 2.1-11
Cladding outside diameter	0.9144 (0.360 in.)	Holtec International 2002 [DIRS 168494], p. 2.1-11
Cladding inside diameter	0.8001 (0.315 in.)	Holtec International 2002 [DIRS 168494], p. 2.1-11
Pellet outside diameter	0.784352 (0.3088 in.)	Holtec International 2002 [DIRS 168494], p. 2.1-11
Guide/instrument tube outside diameter	1.204	Sanders and Wagner 2002 [DIRS 163141], p.8
Guide/instrument tube thickness	0.04064 (0.016 in.)	Holtec International 2002 [DIRS 168494], p. 2.1-11
Array size	17 x 17	Holtec International 2002 [DIRS 168494], p. 2.1-11
Number of fuel rods	264	Holtec International 2002 [DIRS 168494], p. 2.1-11
Number of guide/instrument tubes [a]	25	Holtec International 2002 [DIRS 168494], p. 2.1-11

[a] Locations of guide tubes are shown in Figure 5.1-1.
[b] Holtec International 2002 [DIRS 168494], p. 6.2-37 demonstrates that the dimensions cited are conservative

5.1.6.2 BWR Basket Cell and Fuel Assembly Dimensions

The BWR fuel cell basket features SS walls with a Boral panel situated on the top and on the left hand side. The BWR fuel cell basket contains the GE 8x8 assembly (see Section 5.1.2). Figure 5.1-2 displays the basket cell with the GE 8x8 assembly. Table 5.1-3 provides the radial dimensions of the basket cell while Table 5.1-4 displays the specifications of the 8x8 BWR fuel assembly.

For completeness, one calculation was also performed for a 9x9 fuel array arrangement to ensure criticality safety and most reactive BWR fuel configuration (see Section 5.1.2). Table 5.1-5 displays the specifications of the 9x9 BWR fuel assembly.



NOTE: Dimensions are in inches. Figure not to scale.

Figure 5.1-2 BWR Fuel Basket Cell Containing GE 8x8 Assembly
(Source: Holtec International 2003 [DIRS 172633], Figure 6.3.3)

Table 5.1-3 Radial Dimensions of the BWR Basket Cell

Component	Dimension (cm)	Reference
Cell box inside dimension	15.2222 (5.993 in.)	Holtec International 2003 [DIRS 172633], Table 6.3.3
Cell pitch	16.3322 (6.43 in.)	Holtec International 2003 [DIRS 172633], Table 6.3.3
Cell wall thickness (SS)	0.635 (0.25 in.)	Holtec International 2003 [DIRS 172633], Table 6.3.3
SS sheathing	0.1905 (0.075 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.3
Boral thickness	0.2057 (0.081 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.3
Al thickness (Clad)	0.0254 (0.010 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.3
Boral width	12.065 (4.75 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.3
Boral clearance gap	0.01397 (0.0055 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.3
Flow channel thickness	0.254 (0.100 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.3

Table 5.1-4 Specifications of the BWR GE 8 x 8 Standard Assembly

Parameter	Dimension (cm)	Reference
Rod pitch	1.6256 (0.640 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.22
Active fuel length	381.0 (150 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.22
Cladding outside diameter	1.2268 (0.483 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.22
Cladding inside diameter	1.0796 (0.425 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.22
Pellet outside diameter	1.0566 (0.416 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.22
Guide tube (Thimble) outside diameter	1.3488	Holtec International 2003 [DIRS 172633], p. 6.D-15
Guide tube (Thimble) thickness	1.5012	Holtec International 2003 [DIRS 172633], p. 6.D-15
Array size	8 x 8	Holtec International 2003 [DIRS 172633], Table 6.2.22
Number of fuel rods	62	Holtec International 2003 [DIRS 172633], Table 6.2.22
Number of guide/instrument tubes [a]	2	Holtec International 2003 [DIRS 172633], Table 6.2.22

[a] Locations of guide tubes are shown in Figure 5.1-2.

Table 5.1-5 Specifications of the BWR 9 x 9 Assembly

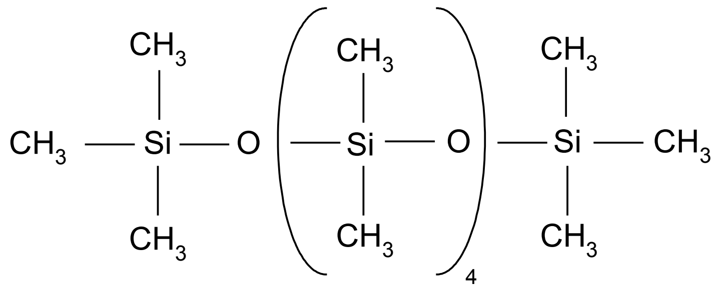
Parameter	Dimension (cm)	Reference
Rod pitch	1.45288 (0.572 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.27
Active fuel length	381.0 (150 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.27
Cladding outside diameter	1.09982 (0.433 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.27
Cladding inside diameter	0.96774 (0.381 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.27
Pellet outside diameter	0.94996 (0.374 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.27
Array size	9 x 9	Holtec International 2003 [DIRS 172633], Table 6.2.27
Number of fuel rods	72	Holtec International 2003 [DIRS 172633], Table 6.2.27
Number of guide/instrument tubes [a]	1	Holtec International 2003 [DIRS 172633], Table 6.2.27

[a] This tube replaces the space of 9 fuel rods.

5.1.7 Material Compositions

This section presents the material compositions for the PWR and BWR fuel along with the cell basket, DTF staging racks, and the remediation pool. The calculations were performed with either the isotopic compositions given in weight fraction, weight percent (wt%), or atom densities (atoms/barn-cm) depending on the source of the input. Table 5.1-6 displays the relevant materials used for the staging racks and the fuel.

Per Assumption 3.2, Polysiloxane fluid was chosen as an alternate moderator material (in the event hydraulic fluid/oil leak from a handling crane). Polysiloxane fluid was modeled with a density of 0.9 g/cm^3 (Gelest 2004 [DIRS 169915], p. 11). The chemical formula for this fluid is



Source: (Gelest 2004 [DIRS 169915], p. 11)

Table 5.1-6 Material Properties for the Staging Racks and Fuel

Material	Density (g/cm^3)	Element	Weight Fraction or Weight Percent (wt %)	Atom Fraction or Atom Density (atoms/barn-cm)	Reference/ Remark
H_2O (throughout model)	1.0	H O	N/A	6.688E-02 [c] 3.344E-02 [c]	Holtec International 2003 [DIRS 172633], Table 6.3.4
SS (tube, cell wall & reflector)	7.84	Cr Mn Fe Ni	N/A	1.761E-02 1.761E-03 5.977E-02 8.239E-03	Holtec International 2003 [DIRS 172633], Table 6.3.4
Al (Boral panel)	2.7	Al	1.0	N/A	Holtec International 2003 [DIRS 172633], Table 6.3.4
Boral (0.02 g ^{10}B/cm^2) [a]	2.66	B-10 B-11 C Al	5.443E-02 2.414E-01 8.210E-02 6.222E-01	N/A	Holtec International 2003 [DIRS 172633], Table 6.3.4
UO_2 – (fuel) 5.00 % enriched	10.522	U-235 U-238 O-16	4.408 83.74 11.85	N/A	Holtec International 2002 [DIRS 168494], p. 6.3-9
UO_2 – (fuel) 4.10 % enriched [b]	10.522	U-235 U-238 O-16	3.6140 84.536 11.850	N/A	Average value taken from Holtec International 2003 [DIRS 172633], Table 6.3.4 of 4.0 % and 4.2 % enrichment
Zr (Cladding)	6.55	Zr	100	N/A	Holtec International 2003 [DIRS 172633], Table 6.3.4
Concrete (floor & reflector material)	2.147	Fe, H, C, Na, O, Mg, Al, Si, S, Cl, K, Ca, Ti, Mn	0.5595, 0.3319, 10.5321, 0.1411, 49.9430, 9.4200, 0.7859, 4.2101, 0.2483, 0.0523 [d], 0.9445, 22.6318, 0.1488, 0.0512 [d]	N/A	Petrie, L. M. et. al. 2000 [DIRS 170550], p. M8.2.28

[a] The ^{10}B loading of 0.020 g/cm^2 is 75 % of the minimum loading 0.0267 g/cm^2 (Holtec International 2003 [DIRS 172633], p. 6.2-2)

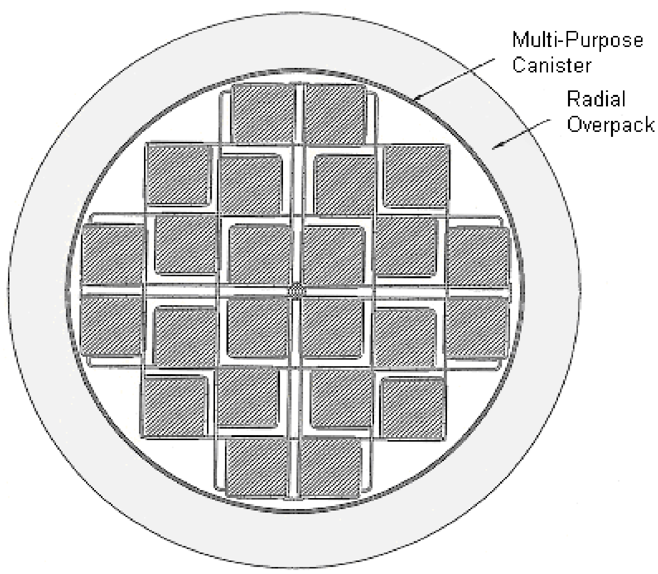
[b] Used for HI-STAR transportation cask calculations (Section 5.1.8)

[c] Fractions of 0.6667 and 0.3333 used in MCNP input

[d] 0.0520 used in MCNP input instead of 0.0523 and 0.0510 used instead of 0.0512

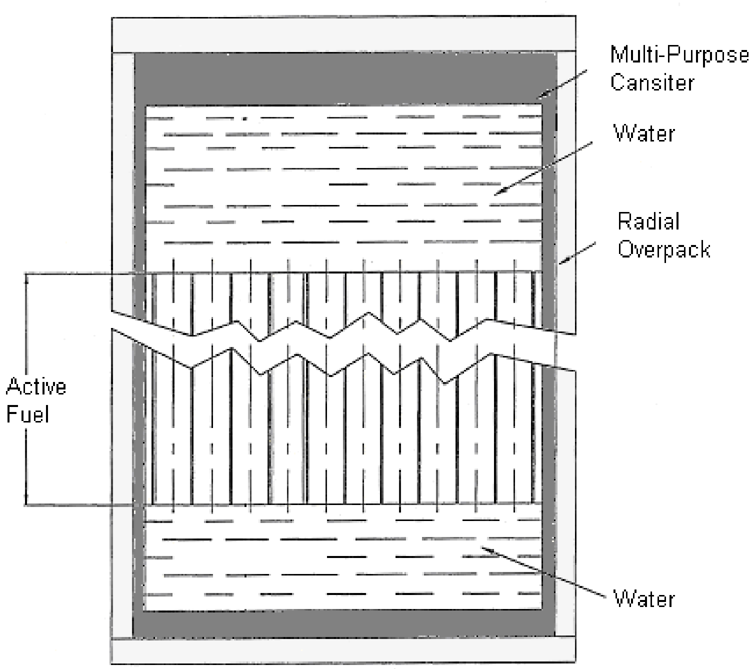
5.1.8 Category 1 and 2 Event Sequence Evaluations Input Description

Evaluations of Category 2 event sequences used the HI-STAR transportation cask (Assumption 3.5). B&W 15x15 fuel assembly at 4.1 wt% enrichment was used as a representative fuel (see Section 5.1.2) and the transportation cask was modeled in MCNP in accordance with the *HI-STAR 100 Transport Cask Safety Analysis Report* (Holtec International 2003 [DIRS 172633], Section 6.3). The physical dimensions and material compositions of the transportation cask and fuel are documented in BSC 2005 [DIRS 173616], Section 5.1.6. The MPC-24 for pressurized water reactor (PWR) fuel consists of a stainless steel (SS) cask/overpack and an interior 24 PWR assembly basket. Figure 5.1-3 displays the planar cross-section of the MPC-24 calculational model inside the overpack and Figure 5.1-4 presents the axial view. Table 5.1-7 provides the radial and axial dimensions of the MPC-24 and overpack. The material composition of the B&W 15x15 fuel is shown in Table 5.1-6 and the dimensions are shown in Table 5.1-8.



NOTE: Figure not to scale.

Figure 5.1-3 Radial View of the MPC-24 and Overpack
(Source: Holtec International 2003 [DIRS 172633], Figure 6.3.4)



NOTE: Figure is not to scale.

Figure 5.1-4 Axial View of the MPC-24 PWR Fuel Transportation Cask
(Source: Holtec International 2003 [DIRS 172633], Figure 6.3.7)

Table 5.1-7 Dimensions of the MPC-24, Overpack, and Cell Geometry

Component [b]	Dimension (cm)	Reference
Stainless steel (SS) overpack thickness	22.86 (9.00 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.4
SS overpack, i.d.	171.1325 (67.375 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.4
Center column	6.985 (2.75 in.)	Holtec International 2003 [DIRS 172633], Drawing 3926 (Sheet 2)
Flux trap	2.7686 (1.09 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.1 & Table 6.3.3
Boral width – narrow [a]	15.875 (6.25 in.)	Holtec International 2003 [DIRS 172633], Drawing 3926 (Sheet 2)
Lower water thickness (below active fuel region)	10.16 (4.0 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.7
Upper water thickness (above active fuel region)	15.24 (6.0 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.7
Bottom overpack SS plate thickness	21.59 (8.5 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.7
Top overpack SS plate thickness	39.37 (15.5 in.)	Holtec International 2003 [DIRS 172633], Figure 6.3.7

[a] The periphery Boral panels have reduced width. See Table 5.1-1 for regular Boral panel width.
[b] See Table 5.1-1 for additional dimensions.

Table 5.1-8 Specifications of the PWR B&W 15 x15 Assembly

Parameter	Dimension (cm) [a]	Reference
Rod pitch	1.4428 (0.568 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.2
Active fuel length	381.0 (150 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.2
Cladding outside diameter	1.0872 (0.428 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.2
Cladding thickness	0.05842 (0.023 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.2
Pellet outside diameter	0.9504 (0.3742 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.2
Guide/instrument tube outside diameter	1.3412 (0.528 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.2
Guide/instrument tube inside diameter	1.27 (0.50 in.)	Holtec International 2003 [DIRS 172633], Table 6.2.2
Array size	15 x 15	Holtec International 2003 [DIRS 172633], Table 6.2.2
Number of fuel rods	208	Holtec International 2003 [DIRS 172633], Table 6.2.2
Number of guide/instrument tubes [b]	17	Holtec International 2003 [DIRS 172633], Table 6.2.2

[a] Some of the values are rounded up slightly.
[b] Locations of guide tubes are shown in Holtec International 2003 [DIRS 172633], Figure 6.3.2.

To evaluate the impact of fuel reconfiguration on k_{eff} under dry and fully flooded moderator conditions for Category 1 and 2 event sequences, a simplified pin cell model was utilized. The calculations used 5 wt% fresh fuel initial enrichment with Westinghouse 17x17 OFA and GE 7x7 fuel assembly types for PWR and BWR fuel, respectively. Note that the pin cell model was only used to study trends and not to produce absolute k_{eff} values. Therefore, a different BWR fuel type was used for the pin cell model since the pin cell model has already been used in previous calculations. Table 5.1-9 lists the PWR and BWR fuel considered and their fuel parameters. Figure 5.1-5 displays a cross-sectional view of the pin cell model used for this analysis.

Table 5.1-9 Fuel Types Used for Fuel Reconfiguration Evaluation and their Fuel Parameters

PWR fuel						
Manufacturer	Array and Version	Pin pitch [a] (cm)	Clad o.d. [a] (cm)	Clad thickness (cm)	Pellet diameter [a] (cm)	U-235 wt % enrichment
Westinghouse	17x17 OFA	1.25984	0.91440	0.05715 [b]	0.784352	5.00
BWR fuel						
GE	7x7 Std	1.87452	1.43002	0.08128 [c]	1.23698	5.00

[a] Source: General Atomics 1993 [DIRS 101831], p. 6.2-2
[b] Source: DOE 1987 [DIRS 132333], p. 2A-351
[c] Source: DOE 1992 [DIRS 102812], p. 2A-15 and 2A-16

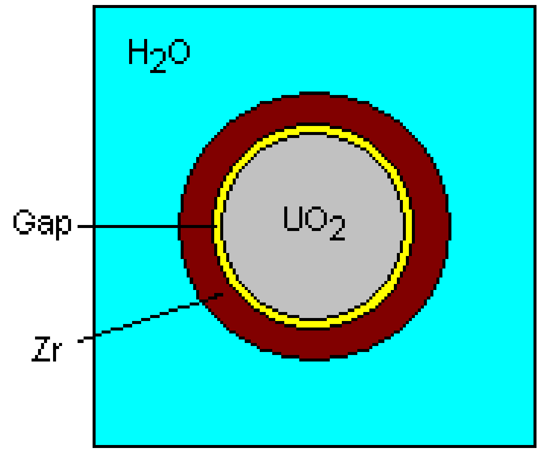


Figure 5.1-5 Cross-section View of Pin Cell Model

5.2 CRITICALITY CALCULATIONS

The process and methodology for criticality safety analysis given in the *Preclosure Criticality Analysis Process Report* (BSC 2004 [DIRS 172058], Section 2.2.7) was implemented in these calculations. This process and methodology requires, as stated earlier in Section 2, consideration of the most reactive fuel assembly, the effective neutron multiplication factor will not exceed 0.95 including all uncertainties and bias, no burnup credit, and no credit for ^{234}U and ^{236}U. Further, all calculations were performed with flooded fuel pin gaps except for dry moderator conditions, 5 wt% fresh fuel, and only 75 % credit for the fixed neutron absorber was applied.

5.2.1 DTF Staging Rack Calculations

Water moderator density, which could vary from dry to fully moderated conditions under accident conditions, was considered dry (0 % density water) and fully moderated (100 % density water) in the DTF staging racks. Hydraulic fluid/oil was also evaluated as an alternate moderator since it could possibly leak from a handling crane. Further, additional steel was included inside the steel tube (surrounding the fuel assembly) to be evaluated as a possible reflector.

Different spacings between the tubes were considered to allow room for reinforcing steel in the concrete slab. As mentioned in Section 5.1.4.1, the spacings considered are 10 in., 12 in., and 16 in. of concrete between the 9x11 array of tubes. For the 10 in. spacing scenario, a triangular pitch (staggered rows as opposed to straight rows) was also considered in a 10x12 array (see Attachment IV).

Per Assumption 3.1, the tubes in the DTF staging rack are modeled in MCNP as full (i.e., every available tube in the array is filled with an assembly).

5.2.2 Remediation Pool

The PWR and BWR storage rack configurations for the remediation pool were analyzed for various assembly pitches and 5.0 wt % enrichment in order to ensure that the configuration meets design criteria (BSC 2004 [DIRS 171599], Section 4.9.2.2). The various distances/pitches evaluated consist of a nominal scenario and a close spacing scenario. The nominal scenario spacing is based on the maximum traveling distance of the bridge crane (see Section 5.1.5.1) while the close spacing scenario spacing represents assemblies and staging racks more closely situated. The nominal arrangement distances for the staging racks are approximately 11 in. in the x-direction with the two rows of staging racks at approximately 39 in. apart (in the y-direction). The BWR assemblies inside each staging rack have an equal spacing of 3.2 in. (both in the x and y directions) and the PWR assemblies have an equal spacing of 4.0 in. (both in the x and y directions). The close spacing scenario feature arrangement distances for the staging racks at approximately 11 in. in the x-direction with the two rows of staging racks at approximately 3 in. apart (in the y-direction). The BWR assemblies inside each staging rack, for the close spacing scenario, have an equal spacing of 0.4 in. (both in the x and y directions) and the PWR assemblies have an equal spacing of 2.0 in. (both in the x and y directions). It should be mentioned that the distances in the x-direction between the staging racks vary slightly for both the nominal and close spacing scenario but will not impact the results significantly. The reason for this is that the spacings presented above represents the maximum distance between the staging racks and will ensure that the results presented in Section 6 are conservative.

As mentioned in Section 5.1.5.1, the staging rack can hold a 3x3 array for PWR fuel or a 4x4 array for BWR fuel. Per Assumption 3.1, the staging racks in the remediation pool are modeled in MCNP as full.

The neutron poison (e.g., Boral) loadings evaluated were for 0 g $^{10}B/cm^2$ and 0.02 g $^{10}B/cm^2$. In addition, the thickness of the Boral plate was reduced to half its width in the MCNP model for the 0.02 g $^{10}B/cm^2$ scenario.

5.2.3 Category 1 and 2 Event Sequences

The Category 1 and Category 2 event sequences applicable to the DTF and its remediation area have been identified in the *Categorization of Event Sequences for License Application* document (BSC 2005 [DIRS 171429], Section 7). Category 1 event sequences are presented in Table 5.2-1 and Category 2 event sequences are presented in Table 5.2-2. The supporting calculations for the event sequences are provided in Section 6.3.

Table 5.2-1 Category 1 Event Sequences

Event No.	Event Description	Annual Event Frequency	Reference
GET-03D	Drop of a CSNF assembly	0.5 drops/y	BSC 2005 [DIRS 171429], Section 7
GET-03B	Collision involving a CSNF assembly	0.5 collisions/y	

Table 5.2-2 Category 2 Event Sequences

Event No.	Event Description	Expected Occurrence	Reference
GET-01A	Drop of a transportation or transfer cask without impact limiters	5.7E-01	BSC 2005 [DIRS 171429], Section 7
GET-02B	Drop of inner lid of a transportation or transfer cask, MSC, or WP into a transportation cask, MSC, or WP	5.7E-01	
GET-03E	Drop of a CSNF assembly during transfer combined with HVAC failure	9.7E-02	
GET-03C	Collision involving a CSNF assembly during transfer combined with HVAC failure	9.7E-02	
GET-04B	Drop or collision of handling equipment onto a CSNF assembly	9.7E-02	
GET-05B	Drop of a canister during transfer by crane	5.7E-01	
GET-06B	Drop of handling equipment onto a canister	5.7E-01	
GET-07B	Drop of an unsealed WP	8.6E-02	
GET-09C	Drop of a WP with a known closure defect	2.6E-02	
GET-10C	Drop of a CSNF assembly during dry remediation activities	4.9E-01	
GET-10B	Collision involving a CSNF assembly during dry remediation activities	4.9E-01	
GET-11B	Drop of a canister from a crane during WP remediation or dry remediation activities	5.7E-02	
GET-12B	Drop of CSNF assembly transfer/handling equipment onto CSNF assemblies in the DTF remediation pool	4.9E-03	
GET-13A	Drop of a loaded transportation cask or MSC in the DTF wet remediation area	1.1E-01	
GET-15C	Drop of an empty or full canister for damaged CSNF assemblies (empty or full) onto or against a cask or basket in the DTF remediation pool	4.9E-02	
GET-15B	Collision of an empty or full canister for damaged CSNF assemblies (empty or full) onto or against a cask or basket in the DTF remediation pool	4.9E-02	
GET-16C	Drop of a CSNF assembly in the DTF remediation pool	4.9E-01	
GET-16B	Collision involving a CSNF assembly in the DTF remediation pool	4.9E-01	
GET-17B	Drop of a filled SNF basket from the spent fuel transfer machine onto the DTF remediation pool floor	5.4E-02	
GET-18B	Drop of handling equipment into or against an opened WP filled with CSNF during dry remediation activities	4.9E-03	
GET-19B	Drop of handling equipment into an open WP loaded with DOE canisters or a naval canister during dry remediation activities	3.6E-02	
GET-20B	Drop of a severed DPC lid back onto the DPC	1.0E-01	

6. RESULTS AND CONCLUSIONS

This section presents the results of the criticality calculations and makes recommendations for additional criticality safety design features as appropriate. The outputs presented in this document are all reasonable compared to the inputs and the results are suitable for the intended use. The uncertainties are taken into account by consistently using a conservative approach, which is the result of the methods and assumptions described in Sections 2 and 3, respectively.

6.1 DTF STAGING RACK

The concrete spacing between the tubes containing the staging racks with PWR fuel was altered in order to ensure criticality safety under the most reactive configuration. The scenarios considered include a fully flooded 9x11 tube array (straight lines) with 10 in., 12 in., and 16 in. spacing, respectively (see Section 5.2.1). Further, the 10 in. concrete spacing was also repeated for a 10x12 fully flooded tube array with a triangular pitch (staggered lines) as opposed to the regular square pitch. None of these calculations include fixed neutron poison. The results from the calculations are presented in Table 6.1-1. It can be seen from the results that each spacing and pitch scenario meets the criticality safety criteria. In addition, k_{eff} is not sensitive to the thickness of the stainless steel tube (see first and second entries in Table 6.1-1). Note that the distance between assemblies was maintained the same for the two calculations where the stainless steel thicknesses were varied. Consequently, there is only 9 in. of concrete between the tubes and 1 in. of stainless steel for the calculation with the thicker tube (second entry in Table 6.1-1).

Table 6.1-1 PWR Fuel in Various DTF Staging Tube Configurations (w/o Neutron Poison)

DTF Staging Tube Configuration	k_{eff}	St. Dev.	MCNP files
10 " concrete spacing square pitch (9x11 array)	0.91008	0.00028	DTF10pwr, DTF10pwr.out
10 " spacing square pitch (9x11 array) [a]	0.90996	0.00029	DTF10p10, DTF10p10.out
10 " concrete spacing triangular pitch (10x12 array)	0.90958	0.00030	DTF10tri, DTF10tri.out
12 " concrete spacing square pitch (9x11 array)	0.90920	0.00027	DTF12pwr, DTF12pwr.out
16 " concrete spacing square pitch (9x11 array)	0.90788	0.00030	DTF-pwr1, DTF-pwr1.out

[a] This calculation has a steel tube thickness of 1.0 in. (nominal thickness is 0.5 in.).

Table 6.1-2 shows the k_{eff} for a fully flooded 9x11 tube array (straight lines) with 16 in. of concrete spacing for PWR and BWR fuel. The cases containing fixed neutron poison (i.e., Boral) has a loading of 0.02 g $^{10}B/cm^2$ (regular width). Note that the table contains one BWR calculation using a 9x9 fuel assembly. It can be seen that it is only slightly more reactive than the 8x8 fuel assembly used throughout this calculation.

Table 6.1-2 PWR and BWR Fuel in DTF Staging Tubes (16 in. Spacing)

DTF Staging Rack Configuration	k_{eff}	St. Dev.	MCNP files
	PWR Fuel		
16 " concrete spacing no neutron poison present	0.90788	0.00030	DTF-pwr1, DTF-pwr1.out
16 " concrete spacing neutron poison present	0.85366	0.00029	DTF-pwr, DTF-pwr.out
	BWR Fuel		
16 " concrete spacing no neutron poison present	0.61263	0.00027	DTF1-bwr1, DTF-bwr1.out
16 " concrete spacing no neutron poison present [a]	0.61927	0.00027	DTF1-9x9, DTF1-9x9.out
16 " concrete spacing neutron poison present	0.56718	0.00027	DTF-bwr, DTF-bwr.out

[a] Featuring a 9x9 fuel array configuration

Various moderator and reflector conditions were evaluated for PWR and BWR fuel in the DTF staging racks. The 9x11 tube array (straight lines) with 16 in. of concrete spacing model was used with no fixed neutron poison present.

Table 6.1-3 PWR and BWR Fuel in DTF Staging Tubes with Varied Moderator and Reflector Conditions

Reflector/Moderator Material	k_{eff}	St. Dev.	MCNP files
	PWR Fuel		
Oil (moderator)	0.80101	0.00028	DTFopwr1, DTFopwr1.out
Void (moderator)	0.24831	0.00012	DTF-pwr0, DTF-pwr0.out
Steel (reflector) [a]	0.16869	0.00007	DTFsspwr, DTFsspwr.out
	BWR Fuel		
Oil (moderator)	0.52850	0.00024	DTFobwr1, DTFobwr1.out
Void (moderator)	0.16886	0.00010	DTF-bwr0, DTF-bwr0.out
Steel (reflector) [a]	0.11067	0.00005	DTFssbwr, DTFssbwr.out

[a] The inside of the assembly is dry.

In summary, the calculations for PWR and BWR fuel in the DTF staging racks show that for normal operations that the design is criticality safe. Either spacing between the tubes or line arrangement (straight versus staggered) in the array is acceptable. Further, no fixed neutron poison is required in the cell basket. Also, most of these evaluations were performed under fully flooded moderator conditions for conservatism.

6.2 REMEDIATION POOL

The PWR and BWR assembly pitches inside the staging racks as well as the distances between the staging racks were varied from a nominal to a close spacing scenario to evaluate the impact on k_{eff}. Table 6.2-1 presents the k_{eff} values as a function of spacing and neutron poison loading in a fully flooded remediation pool. The nominal and close spacing inside the staging racks and between the staging racks are defined in Section 5.2.2. The results from Table 6.2-1 indicate that no neutron poison is required for PWR or BWR fuel for a nominal arrangement. For staging racks more closely situated (i.e., the close spacing scenario), no neutron poison is required for BWR fuel but neutron poison should be present for PWR fuel for k_{eff} to be below USL.

Table 6.2-1 PWR and BWR Fuel in Various Remediation Pool Configurations

DTF Staging Rack Configuration	k_{eff}	St. Dev.	MCNP files
	PWR Fuel		
Nominal spacing neutron poison present	0.86578	0.00029	RB-pwr1, RB-pwr1.out
Nominal spacing no neutron poison present	0.93087	0.00027	RB-pwr2, RB-pwr2.out
Close spacing neutron poison present [a]	0.90811	0.00028	RBpw2aB, RBpw2aB.out
Close spacing neutron poison present [b]	0.91726	0.00029	RBpw2aB1, RBpw2aB1.out
Close spacing no neutron poison present	0.99742	0.00029	RBpwr2a, RBpwr2a.out
	BWR Fuel		
Nominal spacing neutron poison present	0.61817	0.00027	RB-bwr1, RB-bwr1.out
Nominal spacing no neutron poison present	0.68446	0.00025	RB-bwr2, RB-bwr2.out
Close spacing neutron poison present [a]	0.80855	0.00030	RB-bw2aB, RB-bw2aB.out
Close spacing neutron poison present [b]	0.82919	0.00027	RBbw2aB1, RBbw2aB1.out
Close spacing no neutron poison present	0.93280	0.00026	RB-bwr2a, RB-bwr2a.out

[a] Boral loading is 0.02 g $^{10}B/cm^2$.
[b] Boral panel at half width.

6.3 CATEGORY 1 AND 2 EVENT SEQUENCE EVALUATIONS

Table 6.3-1 describes the Category 1 event sequences and the applicable criticality safety evaluation performed for each event. Table 6.3-2 provides the criticality evaluation for the Category 2 event sequences. The supporting calculations for the criticality events and event sequences are provided in the subsections.

Table 6.3-1 Criticality Safety Evaluation for Category 1 Event Sequences

Event No.	Event Description [a]	Annual Event Frequency	Criticality Safety Evaluation
GET-03D	Drop of a CSNF assembly	0.50 drops/y	The fuel assemblies are transferred one at a time and a single flooded fuel assembly has a k_{eff} of less than 0.9 (see Section 6.3.1). Therefore, criticality safety is not an issue for this event. In addition, a potential reconfiguration of a fuel assembly (inside the fuel basket dimensions) will not pose a criticality concern (see Section 6.3.1).
GET-03B	Collision involving a CSNF assembly	0.50 collisions/y	See criticality safety evaluation for event number GET-03D.

[a] BSC 2005 [DIRS 171429], Section 7

Table 6.3-2 Criticality Safety Evaluation for Category 2 Event Sequences

Event No.	Event Description [a]	Expected Occurrences [b]	Criticality Safety Evaluation
GET-01A	Drop of a transportation or transfer cask without impact limiters	5.7E-01	The transportation casks are unopened and dry on the inside. Section 6.3.2 shows that a dry on the inside cask does not pose a criticality concern even if the fuel assemblies were rearranged. In the event the drop would cause the transportation cask to breach and rearrange the fuel, the moderator height must be controlled (see Section 6.3.2) to remain below USL.
GET-02B	Drop of inner lid of a transportation or transfer cask, MSC, or WP into a transportation cask, MSC, or WP	5.7E-01	See criticality safety evaluation for event number GET-01A for the transportation cask and MSC (Assumption 3.4). The WP design provides criticality safety for this event per Assumption 3.3.
GET-03E	Drop of a CSNF assembly during transfer combined with HVAC failure	9.7E-02	See criticality safety evaluation for event number GET-03D (Table 6.3-1).
GET-03C	Collision involving a CSNF assembly during transfer combined with HVAC failure	9.7E-02	See criticality safety evaluation for event number GET-03D (Table 6.3-1).
GET-04B	Drop or collision of handling equipment onto a CSNF assembly	9.7E-02	See criticality safety evaluation for event number GET-03D (Table 6.3-1).
GET-05B	Drop of a canister during transfer by crane	5.7E-01	Section 6.3 of BSC 2005 [DIRS 173284] demonstrates that a rearrangement of fuel for the DOE canisters does not pose a criticality concern. In addition, Section 5.2.3.2 of BSC 2004 [DIRS 170213] shows that losing the skirt, or impact limiter, of the canister due to a drop does not increase the reactivity.
GET-06B	Drop of handling equipment onto a canister	5.7E-01	See criticality safety evaluation for event number GET-05B
GET-07B	Drop of an unsealed WP	8.6E-02	The WP design provides criticality safety for this event per Assumption 3.3 (prevents moderator from intruding). Note, however, that moderator cannot intrude into an open/unsealed WP for bounding 5.0 wt% fresh fuel scenarios without exceeding the USL (BSC 2004 [DIRS 172553], p. 30).
GET-09C	Drop of a WP with a known closure defect	2.6E-02	See criticality safety evaluation for event number GET-07B
GET-10C	Drop of a CSNF assembly during dry remediation activities	4.9E-01	While k_{eff} will increase if assemblies were reconfigured due to the drop, this event will still not pose a criticality concern as demonstrated by fuel reconfiguration calculations in Section 6.3.1 and Table 6.3-5 (dry activities/scenarios).
GET-10B	Collision involving a CSNF assembly during dry remediation activities	4.9E-01	See criticality safety evaluation for event number GET-10C.
GET-11B	Drop of a canister from a crane during WP remediation or dry remediation activities	5.7E-02	See criticality safety evaluation for event number GET-05B
GET-12B	Drop of CSNF assembly transfer/handling equipment onto CSNF assemblies in the DTF remediation pool	4.9E-03	See criticality safety evaluation for event number GET-03D (Table 6.3-1).

Table 6.3-2 (cont.) Criticality Safety Evaluation for Category 2 Event Sequences

Event No.	Event Description [a]	Expected Occurrences [b]	Criticality Safety Evaluation
GET-13A	Drop of a loaded transportation cask or MSC in the DTF wet remediation area	1.1E-01	Regulatory compliance with 10 CFR 50 [DIRS 165855], 71 [DIRS 171308] and 72 [DIRS 173336] provides assurance of criticality safety (MSC per Assumption 3.4). However, drops causing severe fuel rearrangement in open casks should have moderator control (see Section 6.3.4).
GET-15C	Drop of an empty or full canister for damaged CSNF assemblies (empty or full) onto or against a cask or basket in the DTF remediation pool	4.9E-02	Damaged fuel impacts radiological releases for confinement analysis. The criticality evaluations already include gap flooding to cover this condition.
GET-15B	Collision of an empty or full canister for damaged CSNF assemblies (empty or full) onto or against a cask or basket in the DTF remediation pool	4.9E-02	See criticality safety evaluation for event number GET-15C.
GET-16C	Drop of a CSNF assembly in the DTF remediation pool	4.9E-01	The drop could cause reconfiguration of the CSNF assembly. Section 6.3.1 evaluates the k_{eff} of a reconfigured, fully flooded, CSNF and it remains safely below 0.9.
GET-16B	Collision involving a CSNF assembly in the DTF remediation pool	4.9E-01	See criticality safety evaluation for event number GET-16C
GET-17B	Drop of a filled SNF basket from the spent fuel transfer machine onto the DTF remediation pool floor	5.4E-02	The drop could cause reconfiguration of the CSNF assembly. Section 6.3.3 evaluate the k_{eff} of a reconfigured, fully flooded, CSNF in a basket and it remains below USL (with fixed neutron poison present).
GET-18B	Drop of handling equipment into or against an opened WP filled with CSNF during dry remediation activities	4.9E-03	Studies show that a WP for maximum dry fuel reactivity (i.e., 5.0 wt% fresh fuel) has a k_{eff} below 0.5 USL (BSC 2004 [DIRS 172553], p. I-4). In addition, Section 6.3.2 shows that k_{eff} is insensitive to fuel reconfiguration (caused by drop/crushing) in dry conditions.
GET-19B	Drop of handling equipment into an open WP loaded with DOE canisters or a naval canister during dry remediation activities	3.6E-02	See criticality safety evaluation for event number GET-05B for the DOE canisters. It is the responsibility of the U.S Department of the Navy to ensure criticality safety for the naval SNF canister.
GET-20B	Drop of a severed dual-purpose canister (DPC) lid back onto the DPC	1.0E-01	Regulatory compliance with 10 CFR 50 [DIRS 165855], 71 [DIRS 171308] and 72 [DIRS 173336] provides assurance of criticality safety.

[a] BSC 2005 [DIRS 171429], Section 7
[b] Before permanent closure

6.3.1 Single and Multiple Spent Fuel Assembly Drop

Category 1 and 2 event sequences include potential drops of single fuel assemblies on a floor, empty rack, empty cask or empty waste package as well as collision with handling equipment, building wall, etc. For this purpose, a single PWR W 17 x 17 OFA (most reactive fuel type) was modeled in MCNP. The fuel assembly was intact and fully flooded. Compression or compaction of the fuel assembly after the drop would result in a less reactive condition as compared to the intact condition, as demonstrated in Section 6.3.2. However, expansion of the fuel assembly after the drop would result in a higher reactive condition, per Section 6.3.2.

Table 6.3-3 lists on the first data row the k_{eff} of a single PWR fuel assembly (un-poisoned) and it can be seen that the reactivity is considerably below the USL (Section 5.1.3). In addition, calculations of single PWR fuel assemblies (un-poisoned) with the pin pitch reconfigured (i.e., expanded) were also performed. A maximum expansion of the pin pitch inside the fuel basket (pin pitch of 1.36 cm versus the nominal pin pitch of 1.2598 cm) produces a k_{eff} below the USL as shown in Table 6.3-3. Consequently, a drop of a single fuel assembly does not pose a criticality safety concern (even with moderator present). An expanded pin pitch (1.45 cm) beyond the fuel basket structure that produces maximum reactivity (see Section 6.3.2) was also modeled. It can be seen from the table that this case does, however, exceed the USL. This indicates that the amount of moderator present when handling fuel assemblies needs to be controlled. The table further shows multiple (un-poisoned) PWR assemblies stacked together. It can be seen that it takes two PWR fuel assembles in order to pose a criticality safety concern.

Table 6.3-3 k_{eff} of Single and Multiple PWR W 17 x17 Assemblies

Enrichment (wt %)	k_{eff}	St. Dev.	MCNP files
PWR W 17 x17 OFA (1 assembly - regular 1.2598 cm pitch)			
5.0	0.89792	0.00028	pwr-asm1, pwr-asm1.out
PWR W 17 x17 OFA (1 assembly - expanded 1.36 cm pitch)			
5.0	0.94063	0.00027	pwrBasm1, pwrBasm1.out
PWR W 17 x17 OFA (1 assembly – maximum 1.45 cm expanded pitch)			
5.0	0.99157	0.00026	pwrEasm1, pwrEasm1.out
PWR W 17 x17 OFA (2 assemblies with regular 1.2598 cm pitch)			
5.0	0.99999	0.00028	pwr-asm2, pwr-asm2.out
PWR W 17 x17 OFA (3 assemblies with regular 1.2598 cm pitch)			
5.0	1.06238	0.00028	pwr-asm3, pwr-asm3.out

6.3.2 Fuel Reconfiguration

In the event of a drop or collision, fuel may be reconfigured into a new geometry, i.e., either a pitch reduction or increase. In case of a pitch reduction, this can be modeled by decreasing the fuel pin pitch in the MCNP model. This scenario was evaluated utilizing the MCNP PWR and BWR pin cell models (Section 5.1.8), and featuring reflective boundary conditions to simulate an infinite array of fuel pins. The pin cell model was fully flooded. Also, note that this study was performed to demonstrate the trends of the infinite multiplication factor (k_{inf}) (i.e., not an absolute value) from a drop event, which would result in a pin pitch reduction (due to impact). Note that k_{inf} values are given instead of k_{eff} values since this is an infinite system.

Table 6.3-4 shows k_{inf} versus pin pitch for PWR and BWR fuel modeled as an array of infinite pin cells (Section 5.2.1). The table indicates that in case of reduction in fuel pin pitch, the reactivity will decrease.

Table 6.3-4 k_{inf} of Pin Pitch Reduction of PWR and BWR Fuel

Pin Pitch (cm)	k_{inf}	St. Dev.	MCNP files
PWR Fuel (W17 x 17 OFA pin cell model, 5.0 wt % enrichment)			
1.25984 (regular)	1.50521	0.00018	w17ofa5, w17ofa5.out
1.20	1.48433	0.00024	w17o12, w17o12.out
1.10	1.42603	0.00020	w17o11, w17o11.out
1.00	1.32650	0.00020	w17o10, w17o10.out
0.9145 (smallest)	1.18456	0.00020	w17o09, w17o09.out
BWR Fuel (GE 7 x7 Std pin cell model, 4.5 wt % enrichment)			
1.87452 (regular)	1.48306	0.00017	bwr7x7, bwr7x7.out
1.80	1.46316	0.00019	bwr18, bwr18.out
1.70	1.42416	0.00019	bwr17, bwr17.out
1.60	1.36543	0.00019	bwr16, bwr16.out
1.50	1.27844	0.00020	bwr15, bwr15.out
1.43003 (smallest)	1.19414	0.00020	bwr14, bwr14.out

The same scenario (i.e., pin pitch reduction) was also studied for PWR and BWR fuel in a completely dry environment. As before, this was evaluated utilizing the MCNP PWR and BWR pin cell models (Section 5.1.8), and featuring reflective boundary conditions to simulate an infinite array of fuel pins. Table 6.3-5 shows k_{inf} versus pin pitch for PWR and BWR fuel. It can be seen that k_{inf} is virtually insensitive to pin pitch alterations under dry conditions.

Table 6.3-5 k_{inf} of Pin Pitch Reduction of PWR and BWR Fuel (Dry Conditions)

Pin Pitch (cm)	k_{inf}	St. Dev.	MCNP files
PWR Fuel (W17 x 17 OFA pin cell model, 5.0 wt % enrichment)			
1.4	0.77376	0.00017	w17o14D, w17o14D.out
1.3	0.77377	0.00015	w17o13D, w17o13D.out
1.25984 (regular)	0.77368	0.00016	w17ofa5D, w17ofa5D.out
1.20	0.77394	0.00015	w17o12D, w17o12D.out
1.10	0.77362	0.00016	w17o11D, w17o11D.out
1.00	0.77343	0.00019	w17o10D, w17o10D.out
0.9145 (smallest)	0.77368	0.00016	w17o09D, w17o09D.out
BWR Fuel (GE 7 x7 Std pin cell model, 5.0 wt % enrichment)			
2.1	0.77856	0.00016	bwr21D, bwr21D.out
1.95	0.77890	0.00015	bwr195D, bwr195D.out
1.87452 (regular)	0.77884	0.00012	bwr7x75D, bwr7x75D.out
1.80	0.77873	0.00017	bwr18D, bwr18D.out
1.70	0.77896	0.00016	bwr17D, bwr17D.out
1.60	0.77897	0.00016	bwr16D, bwr16D.out
1.50	0.77901	0.00023	bwr15D, bwr15D.out
1.43003 (smallest)	0.77899	0.00017	bwr14D, bwr14D.out

In case of a pitch increase, this can be modeled by increasing the fuel pin pitch in the MCNP model. This scenario was evaluated utilizing the MCNP PWR and BWR pin cell models (Section 5.1.8), and featuring reflective boundary conditions to simulate an infinite array of fuel pins. The pin cell model was fully flooded. Also, note that this study was performed to demonstrate the trends of k_{inf} (i.e., not an absolute value) from a drop event, which would result in a pin pitch increase (due to impact).

Table 6.3-6 shows k_{inf} versus pin pitch for PWR and BWR fuel modeled as an array of infinite pin cells (Section 5.2.1). The table indicates that in case of an increase in fuel pin pitch, the reactivity will increase. Figure 6.3-1 graphically displays the results presented in Table 6.3-6 and shows that the peak in k_{inf} occurs at a pin pitch of 1.45 cm for PWR fuel and 2.15 cm for BWR fuel. The data and figure can be found in Excel file *pin_pitch.xls*.

Table 6.3-6 k_{inf} of Pin Pitch Increase for PWR and BWR Fuel (Flooded Conditions)

Pin Pitch (cm)	k_{inf}	St. Dev.	MCNP files
PWR Fuel (W17 x 17 OFA pin cell model, 5.0 wt % enrichment)			
1.20	1.48433	0.00024	w17o12, w17o12.out
1.30	1.51560	0.00025	w17o13, w17o13.out
1.40	1.52855	0.00025	w17o14, w17o14.out
1.45	1.53041	0.00021	w17o145, w17o145.out
1.50	1.52921	0.00021	w17o15, w17o15.out
1.60	1.52066	0.00022	w17o16, w17o16.out
1.70	1.50493	0.00021	w17o17, w17o17.out
1.80	1.48424	0.00020	w17o18, w17o18.out
1.90	1.45839	0.00022	w17o19, w17o19.out
BWR Fuel (GE 7 x7 Std pin cell model, 5.0 wt % enrichment)			
1.87452 (regular)	1.50116	0.00017	bwr7x75, bwr7x75.out
1.95	1.51473	0.00023	bwr195, bwr195.out
2.1	1.52811	0.00022	bwr21, bwr21.out
2.15	1.52924	0.00022	bwr215, bwr215.out
2.2	1.52851	0.00023	bwr22, bwr22.out
2.3	1.52309	0.00019	bwr23, bwr23.out
2.5	1.50050	0.00022	bwr25, bwr25.out

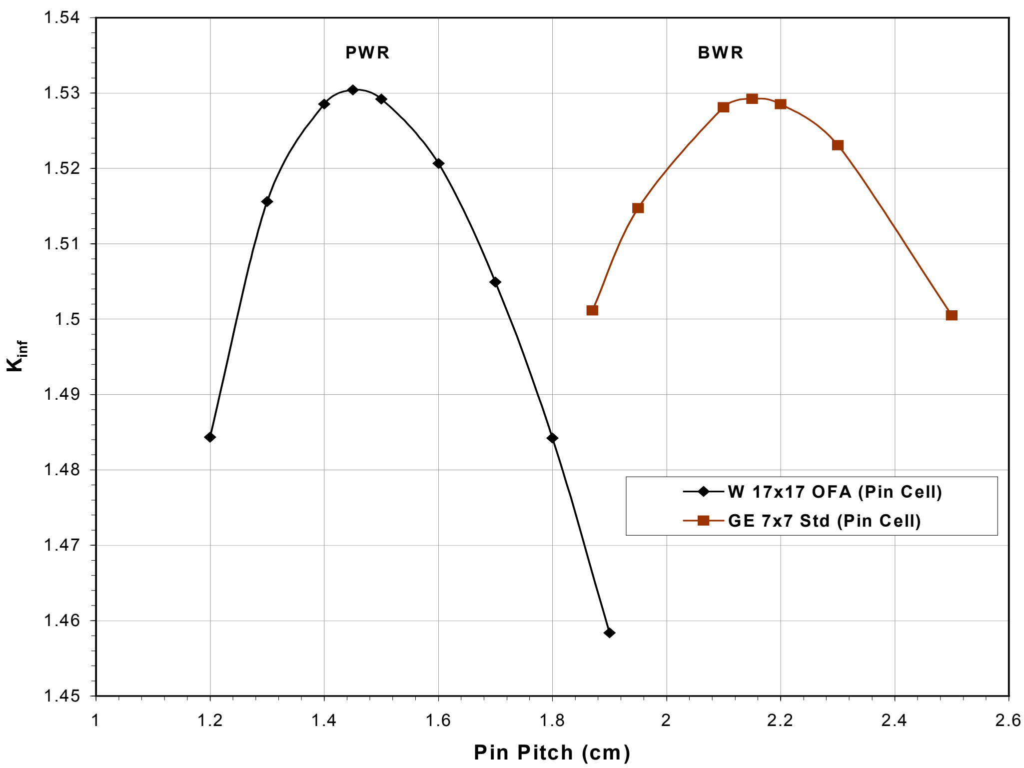


Figure 6.3-1 PWR and BWR Pin Pitch versus k_{inf} for Various Distances

6.3.3 Fuel Reconfiguration in DTF Staging Rack and Remediation Pool

Fuel reconfiguration of PWR and BWR fuel assemblies were evaluated in case of a drop into the staging racks in the DTF or remediation pool. Since the fuel assemblies will be moved one at a time, only one fuel assembly is modeled as reconfigured (entire fuel rod height is at maximum possible pitch inside fuel basket). The DTF staging rack consists of a 9x11 array with 16 in. concrete spacing with both partially and fully flooded tubes and no neutron poison present. The remediation pool features both the close and regular spacing with 0.02 g $^{10}B/cm^2$ Boral loading (both regular and half width Boral panels). Table 6.3-7 shows that moderator control is necessary around the DTF staging racks for a PWR fuel assembly reconfiguration to remain below the USL. The DTF staging racks can be filled with water to a height of approximately 190 cm (50 % of fuel height) when a reconfigured PWR fuel assembly is present in fully loaded DTF staging racks and be safely below the USL Table 6.3-7 further shows that regular spacing with a neutron poison loading of 0.02 g $^{10}B/cm^2$ (regular width) is required in the remediation pool in order to be below the USL in the event of a dropped, reconfigured PWR fuel assembly. BWR fuel poses no criticality concern in the DTF staging racks or the remediation pool.

Table 6.3-7 k_{eff} of DTF and Remediation Pool Staging Rack with Reconfigured Assembly

Case	k_{eff}	Standard Deviation	MCNP Files
	Reconfigured Assembly in DTF Staging Rack		
PWR fuel –fully flooded, no neutron poison	0.95058	0.00027	DTFdpwr5, DTFdpwr5.out
PWR fuel – 75 % of fuel height flooded, no neutron poison	0.94931	0.00027	DTFdpwrP, DTFdpwrP.out
PWR fuel – 50 % of fuel height flooded, no neutron poison	0.94557	0.00026	DTFdpwP1, DTFdpwP1.out
PWR fuel – 25 % of fuel height flooded, no neutron poison	0.93051	0.00027	DTFdpwP2, DTFdpwP2.out
BWR fuel - fully flooded, no neutron poison	0.63474	0.00027	DTFdbwr2, DTFdbwr2.out
	Reconfigured Assembly in the Remediation Pool		
PWR fuel – close spacing, half width Boral panel	0.97555	0.00032	RBp2aB1d,RBp2aB1d.out
PWR fuel – close spacing, 0.02 g $^{10}B/cm^2$	0.97144	0.00028	RBp2aB2d,RBp2aB2d.out
PWR fuel – nominal spacing, half width Boral panel	0.94508	0.00027	RBp2rB1d,RBp2rB1d.out
PWR fuel – nominal spacing, 0.02 g $^{10}B/cm^2$	0.94389	0.00029	RBp2rB2d,RBp2rB2d.out
BWR fuel - close spacing, half width Boral panel	0.85043	0.00028	RBb2aB1d,RBb2aB1d.out

6.3.4 Fuel Reconfiguration in HI-STAR Transportation Cask

Fuel reconfiguration was studied for PWR fuel in the HI-STAR transportation cask to ensure criticality safety in the event this would occur due to a drop. Both dry, partially and fully flooded cask inside conditions were evaluated. Since the transportation casks will remain unopened, the dry conditions will represent undamaged transportation cask containment. In the event a drop punctures the transportation cask containment, fully flooded conditions are conservatively considered.

Table 6.3-8 shows the k_{eff} values for uniformly rearranged PWR fuel (largest possible uniform pin pitch inside the fuel basket) at various water heights in the vertically orientated transportation cask. It can also be seen that fuel rearrangement does not impact k_{eff} significantly during dry conditions (k_{eff} is 0.36610 ± 0.00010 for a dry, nominal pitch configuration (BSC 2005 [DIRS 173616], Table 6.1-1)), but an increase in pin pitch during fully flooded conditions causes k_{eff} to exceed the USL under the bounding fresh fuel scenario. The transportation casks can be filled up to about 25 % of the fuel height (about 95 cm above the bottom of the cask) with rearranged fuel (entire fuel rod height) and not be in violation of the USL.

Table 6.3-8 also contains a fully flooded transportation cask with only 50 cm of the bottom portion of the active fuel region reconfigured. Spacers, preventing the fuel from bowing out, are located near the end, as well as approximately 28 cm and 50 cm from the ends, of the fuel assembly (DOE 1987 [DIRS 132333], p. 2A-353). In the event the drop or slap down is not of significant height/force, only a portion of the fuel is more likely to be reconfigured than the entire fuel rod. It can be seen that with only 50 cm of the fuel reconfigured, k_{eff} remains below the USL for fully flooded conditions.

In the event that hydraulic fluid/oil is present in the facility, due to a leak form the handling crane, a calculation was also performed for a cask containing rearranged fuel (from a drop) partially filled with oil. It can be seen that water is the bounding moderator compared to oil and will not violate the USL.

Table 6.3-8 Comparison of Various Partial Water Flooding Scenarios

Case [a]	k_{eff}	Standard Deviation	MCNP Files
	Reconfigured PWR fuel in HI-STAR cask		
0 % flooding	0.36537	0.00010	star15bD, star15bD.out
25 % flooding	0.93725	0.00030	sta15P25, sta15P25.out
50 % flooding	0.95444	0.00027	sta15P50, sta15P50.out
75 % flooding	0.95692	0.00026	sta15P75, sta15P75.out
75 % flooding (oil) [b]	0.86759	0.00028	sta15O75, sta15O75.out
100 % flooding	0.95935	0.00029	star15b, star15b.out
100 % flooding (50 cm reconfigured) [c]	0.93668	0.00027	sta15-50, sta15-50.out

[a] The percent value listed refers to the portion of the fuel height that is flooded
[b] Oil is used instead of water as a moderator
[c] Only 50 cm of the fuel height is expanded/reconfigured

6.4 CONCLUSIONS AND RECOMMENDATIONS

The processes for the DTF and its remediation area have been evaluated for criticality safety for normal operations, Category 1 and 2 event sequences. The results presented in this document lead to the following conclusions and recommendations:

- Fixed neutron absorber is required for PWR fuel in the storage racks in the remediation pool to ensure adequate safety margin for both normal operations and Category 1 and 2 event sequences. The minimum spacing between each staging rack is 11 in. in the x-direction and 39 in. between the two rows (y-direction). The spacing between assemblies inside the staging racks is 4.0 in. for PWR fuel (3x3 array) and 3.2 in. for BWR fuel (4x4 array). These spacings require a neutron poison (i.e., Boral) loading of 0.02 g ^{10}B/cm^2 (for PWR fuel). Additional work should be performed if smaller spacing is desired.

- Concrete spacings between the DTF staging tubes of 10 in., 12 in., and 16 in. were evaluated with array sizes of 9x11 and 10x12 (square and triangular pitches). Either configuration is criticality safe under normal operations for both dry and fully flooded conditions. Further, no neutron poison is needed for PWR or BWR fuel assemblies.

- Category 1 and 2 event sequences potentially occurring in these facilities do not compromise criticality safety. Moderator control is required in the DTF staging rack area in case a drop of a PWR fuel assembly into the DTF staging racks causes fuel reconfiguration. The acceptable water height that can cover the PWR active fuel region in the staging tubes to ensure a k_{eff} below the USL is approximately 190 cm. Further, a moderator height of 95 cm above the bottom of a vertically oriented transportation cask cannot be exceeded in order to maintain a k_{eff} below the USL. This is in case a drop of a transportation cask causes a breach that can flood the inside of the cask while also reconfiguring the fuel.

In summary, normal operations in the DTF and its remediation area prove to be criticality safe for CSNF. It should be mentioned that the results for the Monitored Geologic Repository (MGR) Site specific Cask (MSC) calculations are limited to the specific design chosen (see Assumption 3.4). A more current design will be included in the next revision of the criticality calculations for the Aging Facility. During Category 2 conditions, a controlled moderator (i.e., water) height of less than 190 cm above the bottom of the active PWR fuel region in the DTF staging tube is required in order for k_{eff} to not exceed the USL. Further, a maximum moderator height of 95 cm above the bottom of a vertically oriented transportation cask cannot be exceeded in order to maintain a k_{eff} below the USL. It should also be mentioned that although it is not explicitly shown in this calculation, moderator control is also needed in areas with open WPs to ensure criticality safety during Category 2 event sequences. Attachment III displays the areas requiring moderator control in the DTF.

7. REFERENCES

10 CFR 50. 2002 Energy: Domestic Licensing of Production and Utilization Facilities. TIC: 256945. [DIRS 165855]

10 CFR 63. 2005 Energy: Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada. ACC: MOL.20050405.0118. [DIRS 173273]

10 CFR 71. 2004 Energy: Packaging and Transportation of Radioactive Material. TIC: 256942. [DIRS 171308]

10 CFR 72. 2005 Energy: Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste. ACC: MOL.20050411.0074. [DIRS 173336]

AP-3.12Q, Rev. 2, ICN 2. *Design Calculations and Analyses.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20040318.0002. [DIRS 168413]

AP-3.13Q, Rev. 3, ICN 3. *Design Control.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20040202.0006. [DIRS 167460]

Briesmeister, J.F., ed. 1997. *MCNP-A General Monte Carlo N-Particle Transport Code.* LA-12625-M, Version 4B. Los Alamos, New Mexico: Los Alamos National Laboratory. ACC: MOL.19980624.0328. [DIRS 103897]

BSC (Bechtel SAIC Company) 2004. *21-PWR Waste Package with Absorber Plates Loading Curve Evaluation.* CAL-DSU-NU-000006 REV 00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20041220.0002. [DIRS 172553]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Ground Floor Plan A.* 110-P10-WHS0-00108-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040503.0007. [DIRS 169068]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Ground Floor Plan B.* 110-P10-WHS0-00109-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0005. [DIRS 170345]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Ground Floor Plan C.* 110-P10-WHS0-00110-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0006. [DIRS 170346]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Ground Floor Plan D.* 110-P10-WHS0-00111-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0007. [DIRS 170347]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Operating Floor Plan A.* 110-P10-WHS0-00112-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0008. [DIRS 170348]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Operating Floor Plan B.* 110-P10-WHS0-00113-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0009. [DIRS 170349]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Operating Floor Plan C.* 110-P10-WHS0-00114-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0010. [DIRS 170350]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Operating Floor Plan D.* 110-P10-WHS0-00115-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0011. [DIRS 170351]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Upper Floor Plan A.* 110-P10-WHS0-00116-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040503.0014. [DIRS 169076]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Upper Floor Plan B.* 110-P10-WHS0-00117-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0012. [DIRS 170380]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Upper Floor Plan C.* 110-P10-WHS0-00118-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040503.0016. [DIRS 169078]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Upper Floor Plan D.* 110-P10-WHS0-00119-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040503.0017. [DIRS 169079]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Pool Floor Plans.* 110-P10-WHS0-00124-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040503.0023. [DIRS 169084]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section A.* 110-P10-WHS0-00128-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0013. [DIRS 170381]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section B.* 110-P10-WHS0-00129-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0014. [DIRS 170382]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section C.* 110-P10-WHS0-00130-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0015. [DIRS 170383]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section D.* 110-P10-WHS0-00131-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0016. [DIRS 170384]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section E.* 110-P10-WHS0-00132-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0017. [DIRS 170385]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section F.* 110-P10-WHS0-00133-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0018. [DIRS 170386]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section G.* 110-P10-WHS0-00134-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0019. [DIRS 170387]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section J.* 110-P10-WHS0-00136-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0021. [DIRS 170391]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section K.* 110-P10-WHS0-00137-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0022. [DIRS 170392]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section L.* 110-P10-WHS0-00138-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0023. [DIRS 170393]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section M.* 110-P10-WHS0-00139-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0024. [DIRS 170394]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section N.* 110-P10-WHS0-00140-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0025. [DIRS 170395]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility General Arrangement Section P.* 110-P10-WHS0-00141-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0026. [DIRS 170396]

BSC (Bechtel SAIC Company) 2004. *Dry Transfer Facility #1 /Remediation Facility Pool Floor Overall Plan TOC El (–)55′–0″.* 110-DB0-WHS0-00101-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040831.0004. [DIRS 170728]

BSC (Bechtel SAIC Company) 2004. *Fuel Handling Facility Criticality Safety Calculations.* 210-00C-FH00-00400-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040630.0012. [DIRS 170213]

BSC (Bechtel SAIC Company) 2004. *Preclosure Criticality Analysis Process Report.* TDR-EBS-NU-000004 REV 04. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20041025.0005. [DIRS 172058]

BSC (Bechtel SAIC Company) 2004. *Project Design Criteria Document.* 000-3DR-MGR0-00100-000-003. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20041124.0001. [DIRS 171599]

BSC (Bechtel SAIC Company) 2005. *Canister Handling Facility Criticality Safety Calculations.* 190-00C-CH00-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050411.0001. [DIRS 173284]

BSC (Bechtel SAIC Company) 2005. *Categorization of Event Sequences for License Application.* 000-00C-MGR0-00800-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050414.0011. [DIRS 171429]

BSC (Bechtel SAIC Company) 2005. *Dry Transfer Facility Description Document.* 110-3YD-CD00-00100-000-002. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050512.0001. [DIRS 173737]

BSC (Bechtel SAIC Company) 2005. *Q-List.* 000-30R-MGR0-00500-000-001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050217.0010. [DIRS 171190]

BSC (Bechtel SAIC Company) 2005. *Transportation Cask Receipt/Return Facility Criticality Safety Evaluations.* 140-00C-HCR0-00300-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050427.0006. [DIRS 173616]

BSC (Bechtel SAIC Company) 2005. *Transportation Cask Receipt/Return Facility Description Document.* 140-3YD-CC00-00100-000-003. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050315.0004. [DIRS 171702]

Canori, G.F. and Leitner, M.M. 2003. *Project Requirements Document.* TER-MGR-MD-000001 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20031222.0006. [DIRS 166275]

Cogema. 2003. *Remediation System SNF Staging Racks Mechanical Equipment Envelope.* YMP-C0115-0738, Rev. A. Las Vegas, Nevada: Cogema. ACC: ENG.20040123.0122. [DIRS 167153]

Cogema. 2004. *Remediation System Fuel Handling Machine Mechanical Equipment Envelope.* YMP-C0115-0730, Rev. D. Las Vegas, Nevada: Cogema. ACC: ENG.20041216.0017. [DIRS 173297]

CRWMS M&O 1998. *Software Code: MCNP.* V4B2LV. HP, HPUX 9.07 and 10.20; PC, Windows 95; Sun, Solaris 2.6. 30033 V4B2LV. [DIRS 154060]

CRWMS M&O 1998. *Software Qualification Report for MCNP Version 4B2, A General Monte Carlo N-Particle Transport Code.* CSCI: 30033 V4B2LV. DI: 30033-2003, Rev. 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980622.0637. [DIRS 102836]

Curry, P.M. 2004. *Project Functional and Operational Requirements.* TDR-MGR-ME-000003 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20040714.0003. [DIRS 170557]

DOE (U.S. Department of Energy) 1987. *Appendix 2A. Physical Descriptions of LWR Fuel Assemblies.* Volume 3 of *Characteristics of Spent Fuel, High-Level Waste, and Other Radioactive Wastes Which May Require Long-Term Isolation.* DOE/RW-0184. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: HQX.19880405.0024. [DIRS 132333]

DOE (U.S. Department of Energy) 1992. *Characteristics of Potential Repository Wastes.* DOE/RW-0184-R1. Volume 1. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: HQO.19920827.0001. [DIRS 102812]

DOE (U.S. Department of Energy) 2004. *Quality Assurance Requirements and Description.* DOE/RW-0333P, Rev. 16. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20040907.0002. [DIRS 171539]

Gelest. 2004. Gelest Silicone Fluids: Stable, Inert Media. Morrisville, Pennsylvania: Gelest. TIC: 256122. [DIRS 169915]

General Atomics. 1993. *GA–4 Legal Weight Truck From-Reactor Spent Fuel Shipping Cask, Final Design Report.* 910353/0. San Diego, California: General Atomics. ACC: NNA.19940513.0215. [DIRS 101831]

General Atomics. 1998. *GA-4 Legal Weight Truck Spent Fuel Shipping Cask, Safety Analysis Report for Packaging (SARP).* 910469/H. Two volumes. San Diego, California: General Atomics. TIC: 245137. [DIRS 103042]

HOLTEC International. 2002. *Final Safety Analysis Report for the Holtec International Storage and Transfer Operation Reinforced Module Cask System (Hi-Storm 100 Cask System).* HOLTEC Report HI-2002444. Two volumes. NRC Docket No. 72-1014. Marlton, New Jersey: HOLTEC International. TIC: 255899. [DIRS 168494]

Holtec International 2003. *Storage, Transport, and Repository Cask Systems, (Hi-Star Cask System) Safety Analysis Report, 10 CFR 71, Docket 71-9261.* HI-951251, Rev. 10. [Marlton, New Jersey]: Holtec International. ACC: MOL.20050119.0271. [DIRS 172633]

LP-SI.11Q-BSC, Rev. 0, ICN 1. *Software Management.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20041005.0008. [DIRS 171923]

LP-SIII.10Q-BSC, Rev. 0, ICN 0. *Models.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20050203.0009. [DIRS 172972]

NAC International. 2002. *Safety Analysis Report for the UMS® Universal Transport Cask.* UMST-02E. EA790-SAR-001. Docket No. 71-9270. Volume 1. Norcross, Georgia: NAC International. TIC: 254855. [DIRS 164612]

NRC (U.S. Nuclear Regulatory Commission) 2000. *Standard Review Plan for Spent Fuel Dry Storage Facilities.* NUREG-1567. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 247929. [DIRS 149756]

Petrie, L.M.; Fox, P.B.; and Lucius, K. 2000. "Standard Composition Library." Volume 3, Section M8 of *SCALE: A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation.* NUREG/CR-0200, Rev. 6. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20040323.0056. [DIRS 170550]

Sanders, C.E. and Wagner, J.C. 2002. *Study of the Effect of Integral Burnable Absorbers for PWR Burnup Credit.* NUREG/CR-6760. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 254260. [DIRS 163141]

Sisley, S.E. 2002. "Transportation License Application for the FuelSolutions™ System (TAC No. L23311), Submittal of the FuelSolution™ Transportation SARs, Revision 3." Letter from S.E. Sisley (BNFL) to the NRC, April 11, 2002, BFS/NRC 02-011, with enclosures. TIC: 255245. [DIRS 171545]

Thompson, T.C. 2003. "NAC-STC Safety Analysis Report, Revision 14." Letter from T.C. Thompson (NAC International) to the NRC, June 18, 2003, with enclosures. TIC: 255255. [DIRS 169362]

Transnuclear. 2001. *TN-68 Transport Packaging Safety Analysis Report.* NRC Docket 71-9293. Hawthorne, New York: Transnuclear. ACC: MOL.20040517.0697. [DIRS 167988]

Transnuclear 2002. *NUHOMS-MP197 Transport Packaging Safety Analysis Report, Revision 3.* Hawthorne, New York: Transnuclear. TIC: 254016. [DIRS 160736]

Transnuclear West 2002. *NUHOMS-MP-187 Transportation Package Safety Analysis Report, Revision 16.* NUH-05-151. Fremont, California: Transnuclear West. TIC: 254012. [DIRS 161510]

Wagner, J.C. and Parks, C.V. 2000. *A Critical Review of the Practice of Equating the Reactivity of Spent Fuel to Fresh Fuel in Burnup Credit Criticality Safety Analyses for PWR Spent Fuel Pool Storage.* NUREG/CR-6683. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 254257. [DIRS 163140]

8. ATTACHMENTS

This calculation document includes four attachments:

ATTACHMENT I	List of Computer Files
ATTACHMENT II	One Compact Disc
ATTACHMENT III	General Arrangement Drawings of the Dry Transfer Facility and its Remediation Area (secondary references on these drawings are not applicable to this calculation)
ATTACHMENT IV	Sketch of DTF Staging Tube Layouts

ATTACHMENT I
LISTING OF COMPUTER FILES

All MCNP input and output files documented in this calculation were stored on an electronic medium (compact disc) as Attachment II. Also, the Microsoft® Excel spreadsheet used to illustrate results are included on the compact disc.

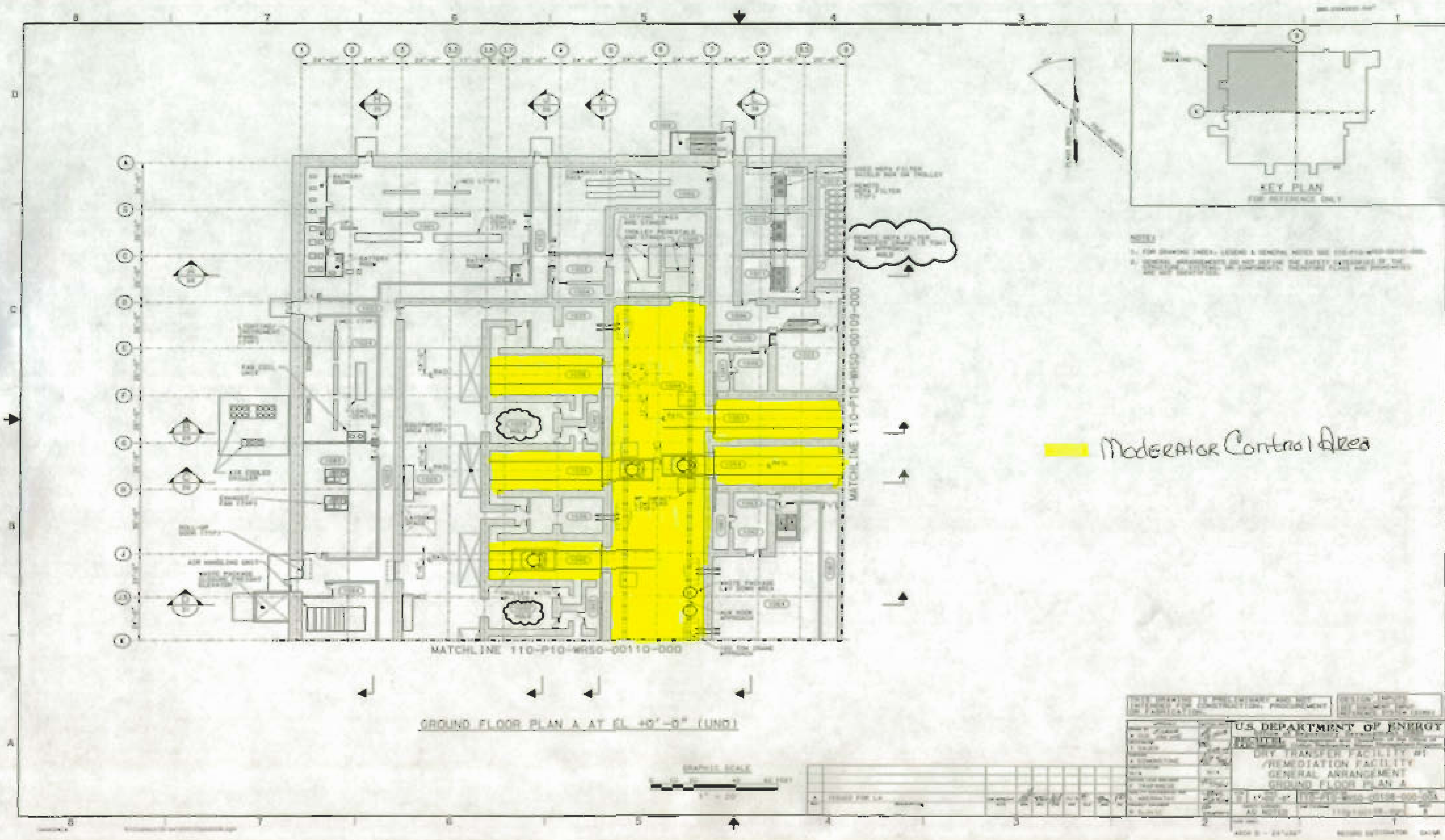
Date	Time	Size	File
04/18/2005	01:45p	18,432	pin_pitch.xls
04/13/2005	01:59p	33,927	HI-STAR/sta15-50
04/13/2005	01:59p	604,193	HI-STAR/sta15-50.out
04/13/2005	01:59p	18,396	HI-STAR/star15b
04/13/2005	01:59p	521,411	HI-STAR/star15b.out
04/13/2005	01:59p	34,425	HI-STAR/PARTIAL/sta15O75
04/13/2005	01:59p	605,444	HI-STAR/PARTIAL/sta15O75.out
04/13/2005	01:59p	34,383	HI-STAR/PARTIAL/sta15P25
04/13/2005	01:59p	605,667	HI-STAR/PARTIAL/sta15P25.out
04/13/2005	01:59p	34,384	HI-STAR/PARTIAL/sta15P50
04/13/2005	01:59p	605,667	HI-STAR/PARTIAL/sta15P50.out
04/13/2005	01:59p	34,384	HI-STAR/PARTIAL/sta15P75
04/13/2005	01:59p	605,667	HI-STAR/PARTIAL/sta15P75.out
04/13/2005	01:59p	18,874	HI-STAR/PARTIAL/star15bD
04/13/2005	01:59p	521,710	HI-STAR/PARTIAL/star15bD.out
04/13/2005	02:00p	18,496	DTF-RACK/DTF-pwr
04/13/2005	02:00p	517,094	DTF-RACK/DTF-pwr.out
04/13/2005	02:00p	18,148	DTF-RACK/DTF-pwr0
04/13/2005	02:00p	513,890	DTF-RACK/DTF-pwr0.out
04/13/2005	02:00p	18,496	DTF-RACK/DTF-pwr1
04/13/2005	02:00p	516,856	DTF-RACK/DTF-pwr1.out
04/18/2005	07:09p	23,684	DTF-RACK/DTFdpwr5
04/18/2005	07:09p	537,518	DTF-RACK/ DTFdpwr5.out
04/13/2005	02:00p	18,295	DTF-RACK/DTFopwr1
04/13/2005	02:00p	514,866	DTF-RACK/DTFopwr1.out
04/13/2005	02:00p	18,153	DTF-RACK/DTFsspwr
04/13/2005	02:00p	513,897	DTF-RACK/DTFsspwr.out
05/02/2005	10:58a	40,938	DTF-RACK/DTFdpwP1
05/02/2005	10:58a	627,718	DTF-RACK/DTFdpwP1.out
05/02/2005	10:58a	40,937	DTF-RACK/DTFdpwP2
05/02/2005	10:58a	626,234	DTF-RACK/DTFdpwP2.out
05/02/2005	10:59a	40,938	DTF-RACK/DTFdpwrP
05/02/2005	10:59a	627,767	DTF-RACK/DTFdpwrP.out
05/04/2005	04:21p	18,496	DTF-RACK/10IN/DTF10pwr
05/04/2005	04:21p	514,494	DTF-RACK/10IN/DTF10pwr.out
05/04/2005	04:21p	20,948	DTF-RACK/10IN/DTF10tri
05/04/2005	04:21p	526,794	DTF-RACK/10IN/DTF10tri.out
05/12/2005	11:33a	18,496	DTF-RACK/10IN/DTF10p10

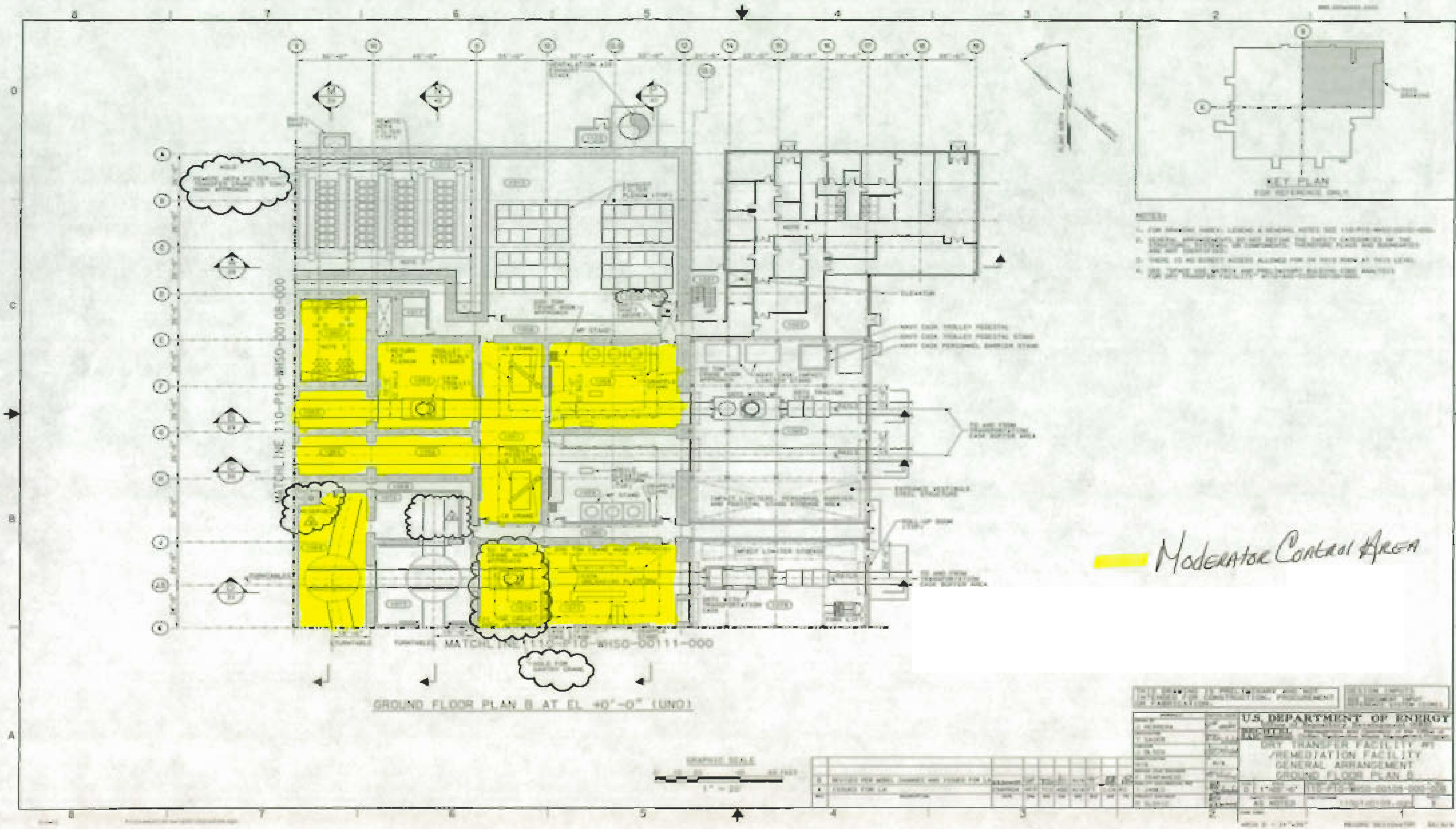
Date	Time	Size	File
05/12/2005	11:34a	515,876	DTF-RACK/10IN/DTF10p10.out
04/13/2005	02:01p	18,496	DTF-RACK/12IN/DTF12pwr
04/13/2005	02:01p	515,974	DTF-RACK/12IN/DTF12pwr.out
05/02/2005	11:00a	17,705	DTF-RACK/BWR/DTF-bwr
05/02/2005	11:00a	514,282	DTF-RACK/BWR/DTF-bwr.out
05/02/2005	11:00a	17,625	DTF-RACK/BWR/DTF-bwr0
05/02/2005	11:00a	512,698	DTF-RACK/BWR/DTF-bwr0.out
05/02/2005	11:00a	17,705	DTF-RACK/BWR/DTF-bwr1
05/02/2005	11:00a	515,426	DTF-RACK/BWR/DTF-bwr1.out
05/02/2005	11:02a	17,756	DTF-RACK/BWR/DTF1-9x9
05/02/2005	11:03a	515,374	DTF-RACK/BWR/DTF1-9x9.out
05/02/2005	11:00a	21,525	DTF-RACK/BWR/DTFdbwr2
05/02/2005	11:00a	531,749	DTF-RACK/BWR/DTFdbwr2.out
05/02/2005	11:00a	17,727	DTF-RACK/BWR/DTFobwr1
05/02/2005	11:00a	515,039	DTF-RACK/BWR/DTFobwr1.out
05/02/2005	11:00a	17,631	DTF-RACK/BWR/DTFssbwr
05/02/2005	11:00a	512,904	DTF-RACK/BWR/DTFssbwr.out
04/13/2005	02:03p	12,195	RB-POOL/RB-pwr1
04/13/2005	02:03p	489,675	RB-POOL/RB-pwr1.out
04/13/2005	02:03p	12,207	RB-POOL/RB-pwr2
04/13/2005	02:03p	489,352	RB-POOL/RB-pwr2.out
05/02/2005	10:54a	17,313	RB-POOL/RBp2aB2d
05/02/2005	10:54a	501,075	RB-POOL/RBp2aB2d.out
04/18/2005	12:11p	17,396	RB-POOL/RBp2aB1d
04/18/2005	12:11p	472,077	RB-POOL/RBp2aB1d.out
04/18/2005	12:11p	17,430	RB-POOL/RBp2rB1d
04/18/2005	12:11p	514,601	RB-POOL/RBp2rB1d.out
04/18/2005	12:11p	17,347	RB-POOL/RBp2rB2d
04/18/2005	12:11p	515,657	RB-POOL/RBp2rB2d.out
04/13/2005	02:02p	12,180	RB-POOL/RBpw2aB
04/13/2005	02:02p	476,513	RB-POOL/RBpw2aB.out
04/13/2005	02:02p	11,756	RB-POOL/RBpw2aB1
04/13/2005	02:02p	475,139	RB-POOL/ RBpw2aB1.out
04/13/2005	02:03p	12,191	RB-POOL/RBpwr2a
04/13/2005	02:03p	475,896	RB-POOL/RBpwr2a.out
05/02/2005	10:50a	9,680	RB-POOL/BWR/RB-bw2aB
05/02/2005	10:50a	481,612	RB-POOL/BWR/RB-bw2aB.out
05/02/2005	10:50a	10,699	RB-POOL/BWR/RB-bwr1
05/02/2005	10:50a	483,607	RB-POOL/BWR/RB-bwr1.out
05/02/2005	10:50a	10,699	RB-POOL/BWR/RB-bwr2
05/02/2005	10:50a	469,934	RB-POOL/BWR/RB-bwr2.out
05/02/2005	10:50a	9,680	RB-POOL/BWR/RB-bwr2a
05/02/2005	10:50a	481,191	RB-POOL/BWR/RB-bwr2a.out
05/02/2005	10:50a	14,775	RB-POOL/BWR/RBb2aB1d
05/02/2005	10:50a	504,687	RB-POOL/BWR/RBb2aB1d.out

Date	Time	Size	File
05/02/2005	10:50a	9,757	RB-POOL/BWR/RBbw2aB1
05/02/2005	10:50a	481,612	RB-POOL/BWR/RBbw2aB1.out
05/02/2005	11:06a	4,999	ASM/pwr-asm1
05/02/2005	11:06a	430,292	ASM/pwr-asm1.out
05/02/2005	11:06a	6,258	ASM/pwr-asm2
05/02/2005	11:06a	440,013	ASM/pwr-asm2.out
05/02/2005	11:06a	6,360	ASM/pwr-asm3
05/02/2005	11:06a	440,537	ASM/pwr-asm3.out
05/02/2005	11:06a	4,995	ASM/pwrBasm1
05/02/2005	11:06a	430,292	ASM/pwrBasm1.out
05/02/2005	11:07a	5,009	ASM/pwrEasm1
05/02/2005	11:07a	430,292	ASM/pwrEasm1.out
02/26/2004	10:05a	2,969	PinCell/bwr195
02/26/2004	10:05a	279,566	PinCell/bwr195.out
02/26/2004	10:05a	2,950	PinCell/bwr195D
02/26/2004	10:05a	278,290	PinCell/bwr195D.out
02/26/2004	10:05a	2,965	PinCell/bwr21
02/26/2004	10:05a	279,360	PinCell/bwr21.out
02/26/2004	10:05a	2,969	PinCell/bwr215
02/26/2004	10:05a	279,360	PinCell/bwr215.out
02/26/2004	10:05a	2,945	PinCell/bwr21D
02/26/2004	10:05a	278,290	PinCell/bwr21D.out
02/26/2004	10:05a	2,965	PinCell/bwr22
02/26/2004	10:05a	279,360	PinCell/bwr22.out
02/26/2004	10:05a	2,965	PinCell/bwr23
02/26/2004	10:05a	279,360	PinCell/bwr23.out
02/26/2004	10:05a	2,965	PinCell/bwr25
02/26/2004	10:05a	279,360	PinCell/bwr25.out
05/06/2003	09:13a	2,980	PinCell/bwr7x7
05/06/2003	10:37a	440,588	PinCell/bwr7x7.out
07/09/2003	02:44p	2,981	PinCell/bwr7x75
07/09/2003	12:16p	440,588	PinCell/bwr7x75.out
02/26/2004	10:05a	2,962	PinCell/bwr7x75D
02/26/2004	10:05a	439,502	PinCell/bwr7x75D.out
07/10/2003	10:31a	2,980	PinCell/bwr14
07/11/2003	05:33a	440,588	PinCell/bwr14.out
02/26/2004	10:05a	2,959	PinCell/bwr14D
02/26/2004	10:05a	278,496	PinCell/bwr14D.out
07/10/2003	10:26a	2,964	PinCell/bwr15
07/11/2003	02:48a	440,588	PinCell/bwr15.out
02/26/2004	10:05a	2,944	PinCell/bwr15D
02/26/2004	10:05a	70,883	PinCell/bwr15D.out
07/10/2003	10:26a	2,964	PinCell/bwr16
07/10/2003	04:26p	440,588	PinCell/bwr16.out
02/26/2004	10:05a	2,942	PinCell/bwr16D

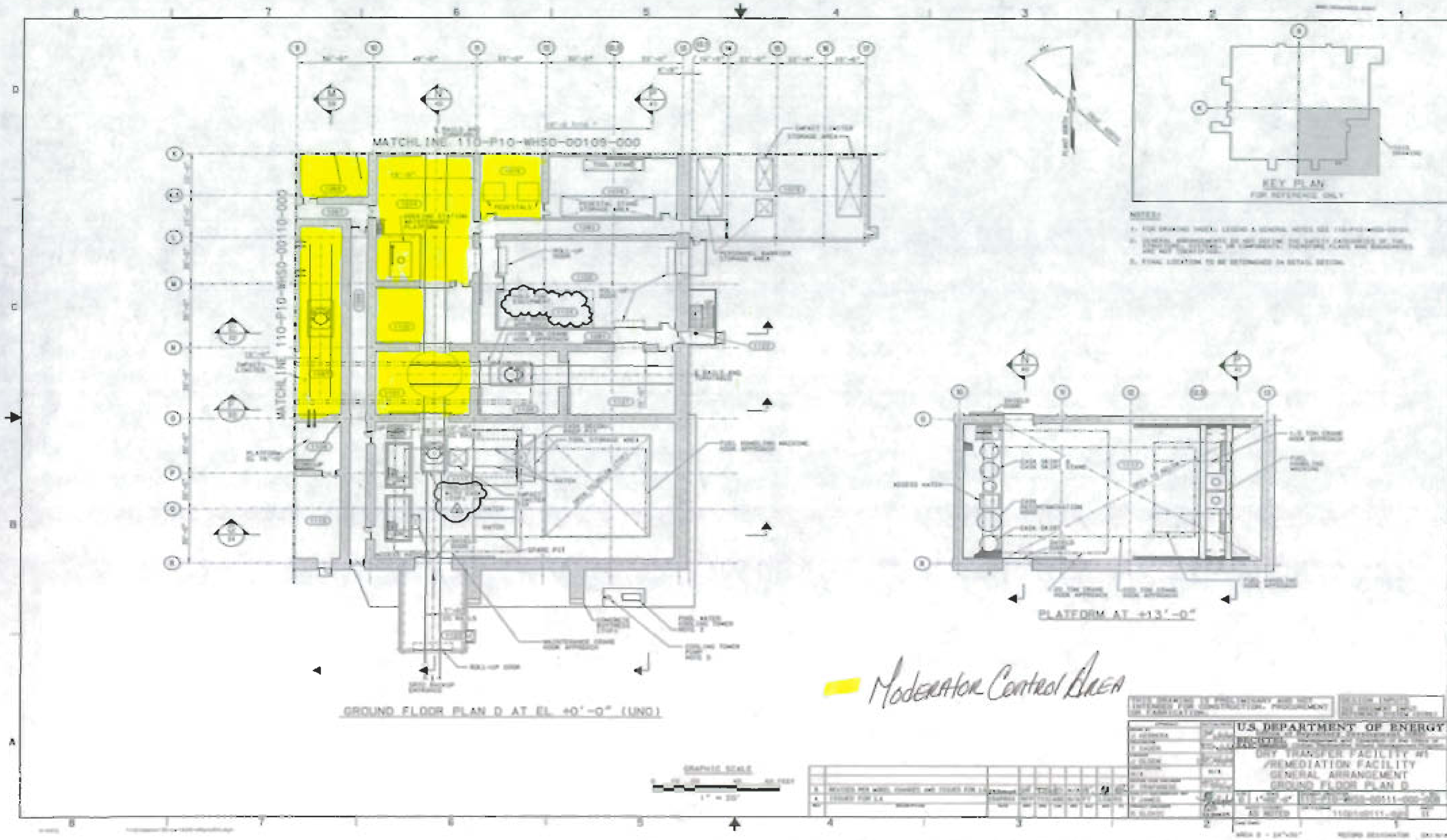
Date	Time	Size	File
02/26/2004	10:05a	278,496	PinCell/bwr16D.out
07/10/2003	10:25a	2,964	PinCell/bwr17
07/10/2003	02:24p	440,794	PinCell/bwr17.out
02/26/2004	10:05a	2,948	PinCell/bwr17D
02/26/2004	10:05a	278,290	PinCell/bwr17D.out
07/10/2003	10:25a	2,964	PinCell/bwr18
07/10/2003	12:33p	440,794	PinCell/bwr18.out
02/26/2004	10:05a	2,943	PinCell/bwr18D
02/26/2004	10:05a	278,496	PinCell/bwr18D.out
07/08/2003	09:49a	3,229	PinCell/w17o09
07/08/2003	01:30p	440,667	PinCell/w17o09.out
03/02/2004	12:33p	3,209	PinCell/w17o09D
03/02/2004	12:33p	278,307	PinCell/w17o09D.out
07/08/2003	09:50a	3,209	PinCell/w17o10
07/08/2003	04:12p	440,667	PinCell/w17o10.out
03/02/2004	12:33p	3,191	PinCell/w17o10D
03/02/2004	12:33p	197,425	PinCell/w17o10D.out
07/08/2003	09:52a	3,201	PinCell/w17o11
07/09/2003	02:25a	440,461	PinCell/w17o11.out
03/02/2004	12:33p	3,184	PinCell/w17o11D
03/02/2004	12:33p	278,101	PinCell/w17o11D.out
02/26/2004	10:06a	3,128	PinCell/w17o12
02/26/2004	10:06a	279,233	PinCell/w17o12.out
03/02/2004	12:33p	3,181	PinCell/w17o12D
03/02/2004	12:33p	278,101	PinCell/w17o12D.out
02/26/2004	10:06a	3,128	PinCell/w17o13
02/26/2004	10:06a	279,233	PinCell/w17o13.out
02/26/2004	10:05a	3,110	PinCell/w17o13D
02/26/2004	10:05a	278,306	PinCell/w17o13D.out
02/26/2004	10:06a	3,128	PinCell/w17o14
02/26/2004	10:06a	279,233	PinCell/w17o14.out
02/26/2004	10:06a	3,128	PinCell/w17o145
02/26/2004	10:06a	279,233	PinCell/w17o145.out
03/02/2004	12:33p	3,111	PinCell/w17o14D
03/02/2004	12:33p	278,100	PinCell/w17o14D.out
02/26/2004	10:06a	3,128	PinCell/w17o15
02/26/2004	10:06a	279,233	PinCell/w17o15.out
02/26/2004	10:06a	3,128	PinCell/w17o16
02/26/2004	10:06a	279,233	PinCell/w17o16.out
02/26/2004	10:06a	3,128	PinCell/w17o17
02/26/2004	10:06a	279,233	PinCell/w17o17.out
02/26/2004	10:06a	3,128	PinCell/w17o18
02/26/2004	10:06a	279,233	PinCell/w17o18.out
02/26/2004	10:06a	3,128	PinCell/w17o19
02/26/2004	10:06a	279,233	PinCell/w17o19.out

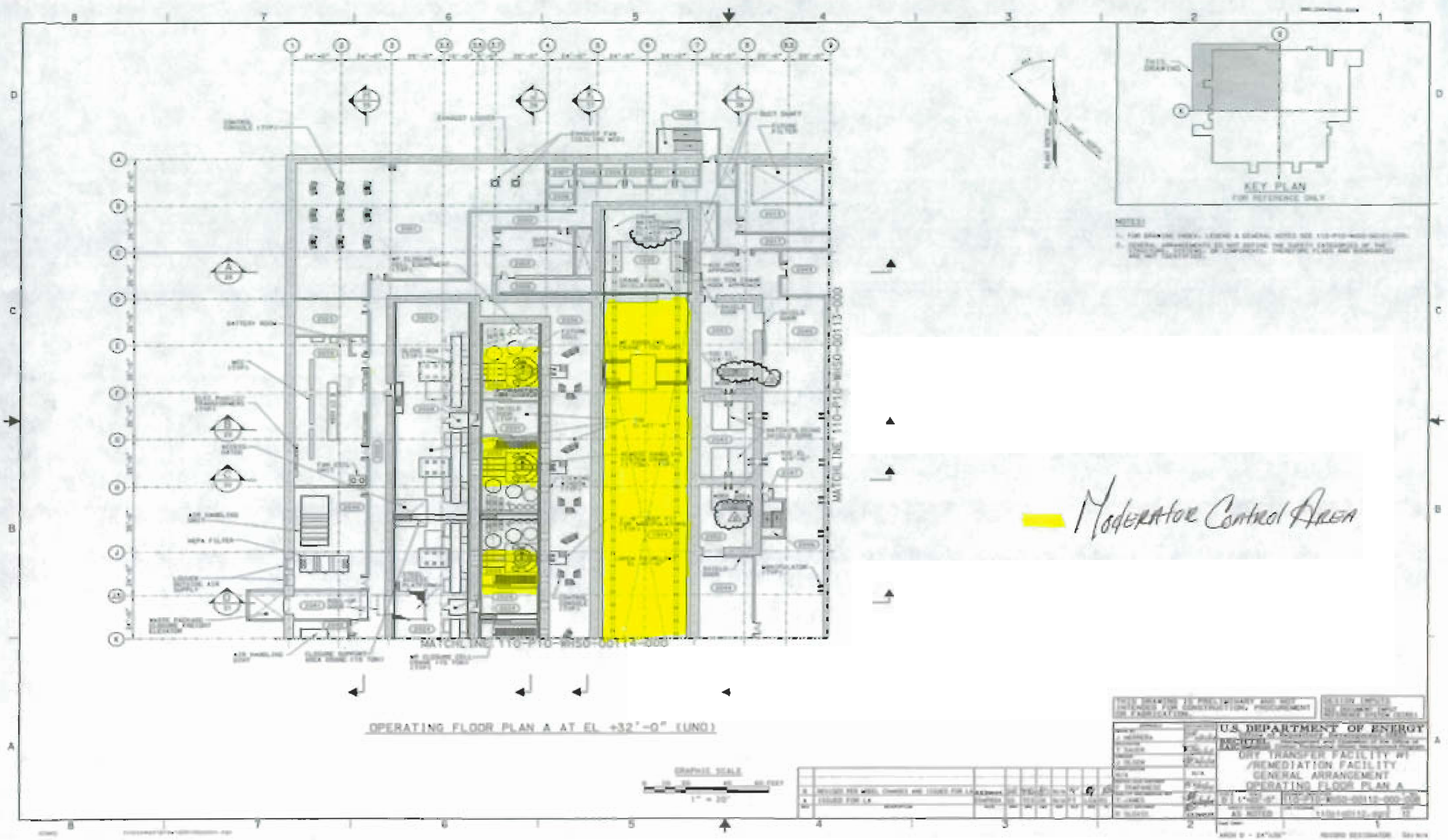
Date	Time	Size	File
05/07/2003	08:00a	3,277	PinCell/w17ofa
05/07/2003	10:10a	279,280	PinCell/w17ofa.out
04/19/2003	09:31a	3,275	PinCell/w17ofa5
04/19/2003	01:03p	440,461	PinCell/w17ofa5.out
03/02/2004	12:33p	3,231	PinCell/w17ofa5D
03/02/2004	12:34p	278,101	PinCell/w17ofa5D.out


KEY PLAN
FOR REFERENCE ONLY
MATCHLINE 110-P10-WHS0-00109-000
MATCHLINE 110-P10-WHS0-00110-000
GROUND FLOOR PLAN A AT EL +0'-0" (UNO)
GRAPHIC SCALE
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
GROUND FLOOR PLAN A

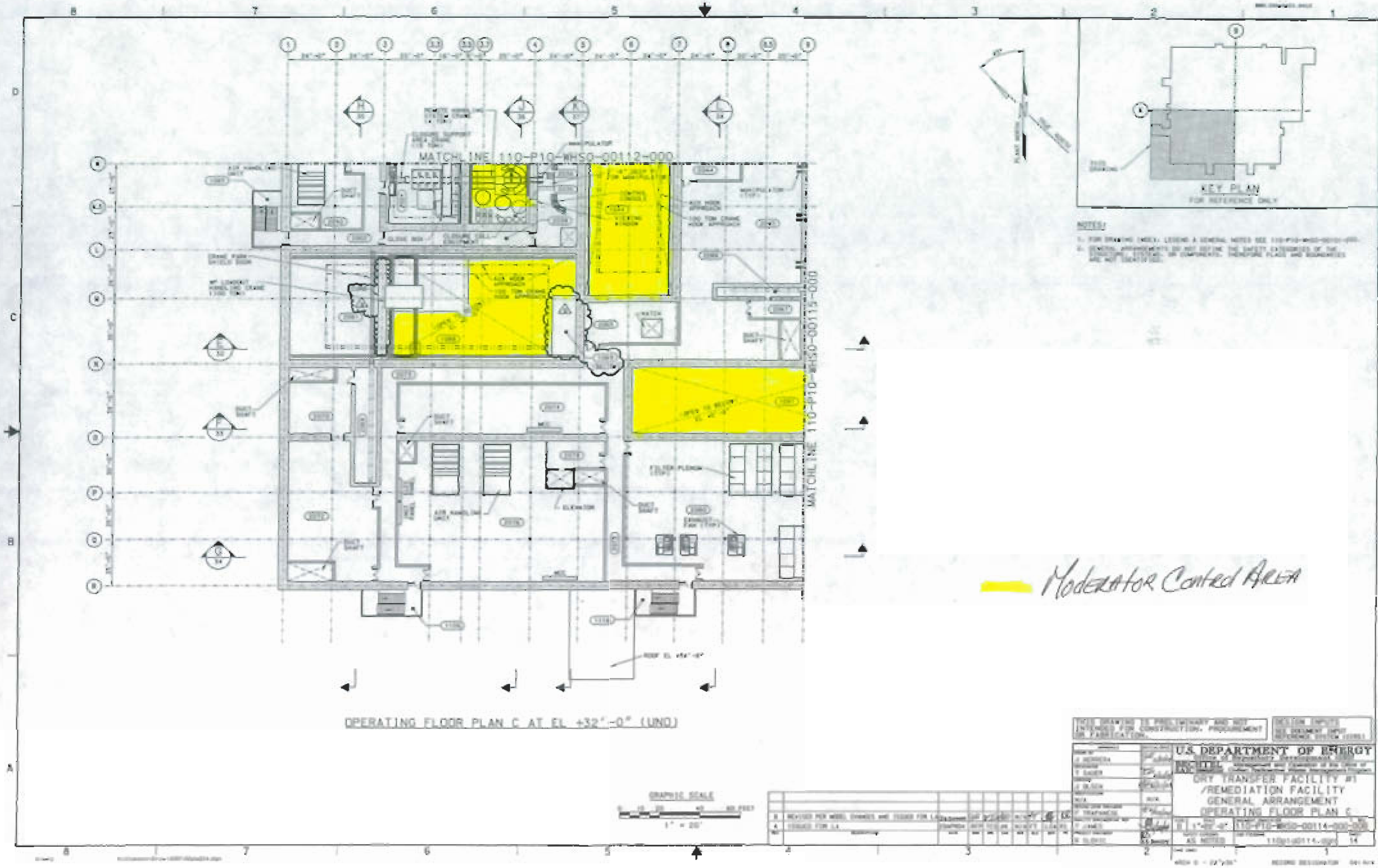

KEY PLAN
MATCHLINE 110-P10-WHS0-00108-000
MATCHLINE 110-P10-WHS0-00111-000
GROUND FLOOR PLAN B AT EL +0'-0" (UNO)
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
GROUND FLOOR PLAN B

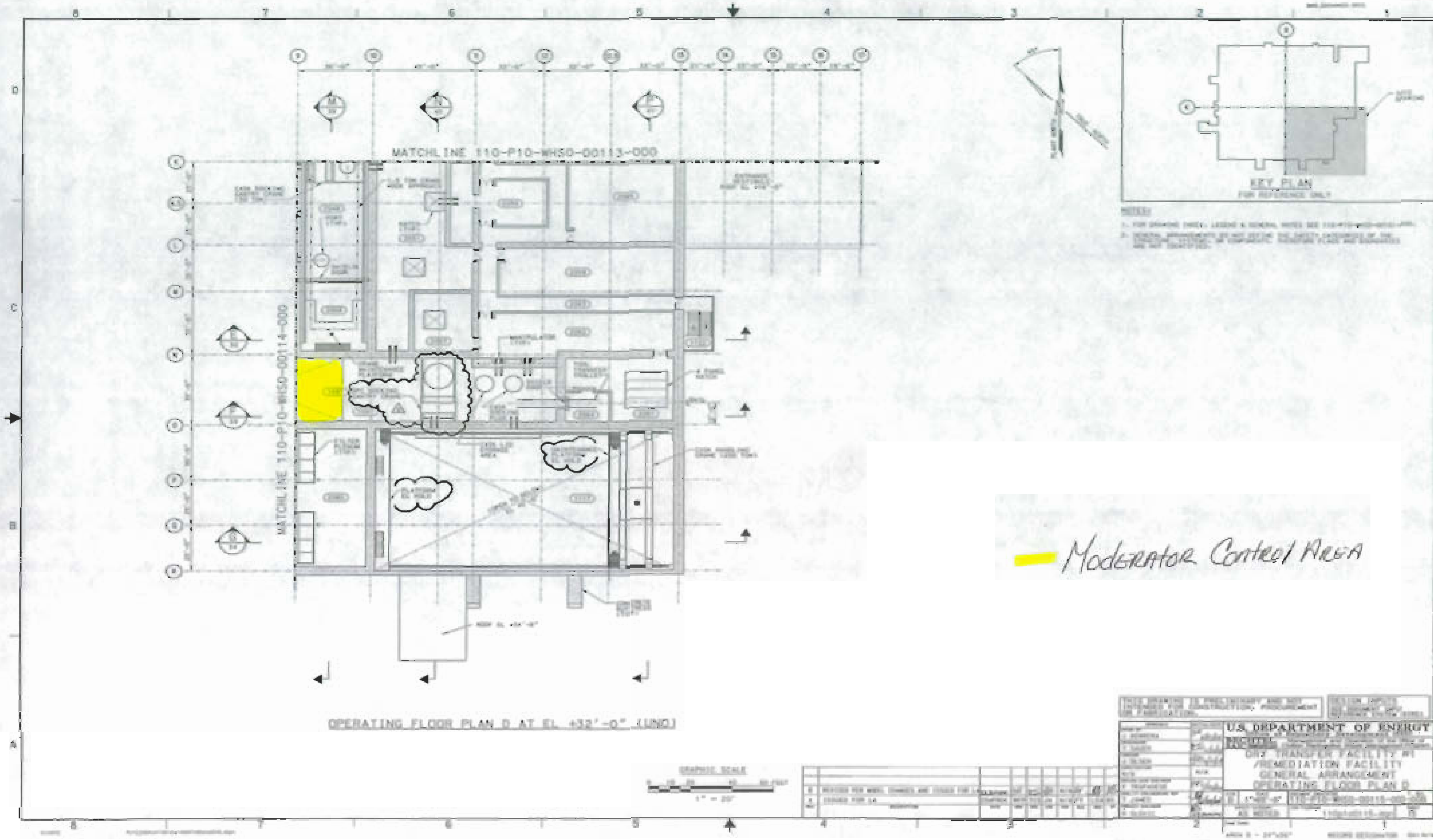

MATCHLINE 110-P10-WHS0-00108-000
MATCHLINE 110-P10-WHS0-00111-000
KEY PLAN
GROUND FLOOR PLAN C AT EL +0'-0" (UNO)
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1 /REMEDIATION FACILITY GENERAL ARRANGEMENT GROUND FLOOR PLAN C

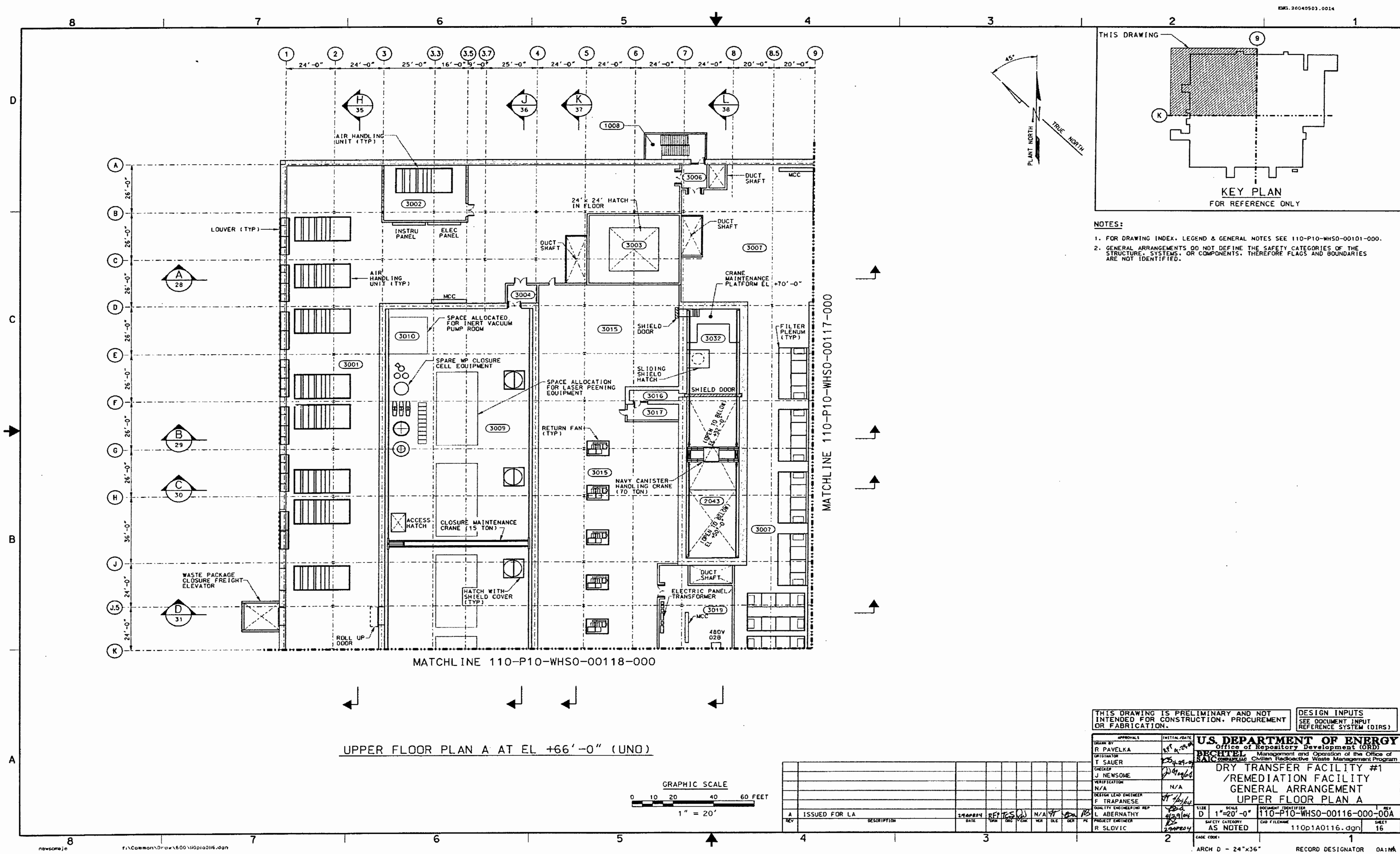

MATCHLINE 110-P10-WHS0-00109-000
MATCHLINE 110-P10-WHS0-00110-000
KEY PLAN
GROUND FLOOR PLAN D AT EL +0'-0" (UNO)
PLATFORM AT +13'-0"
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
GROUND FLOOR PLAN D

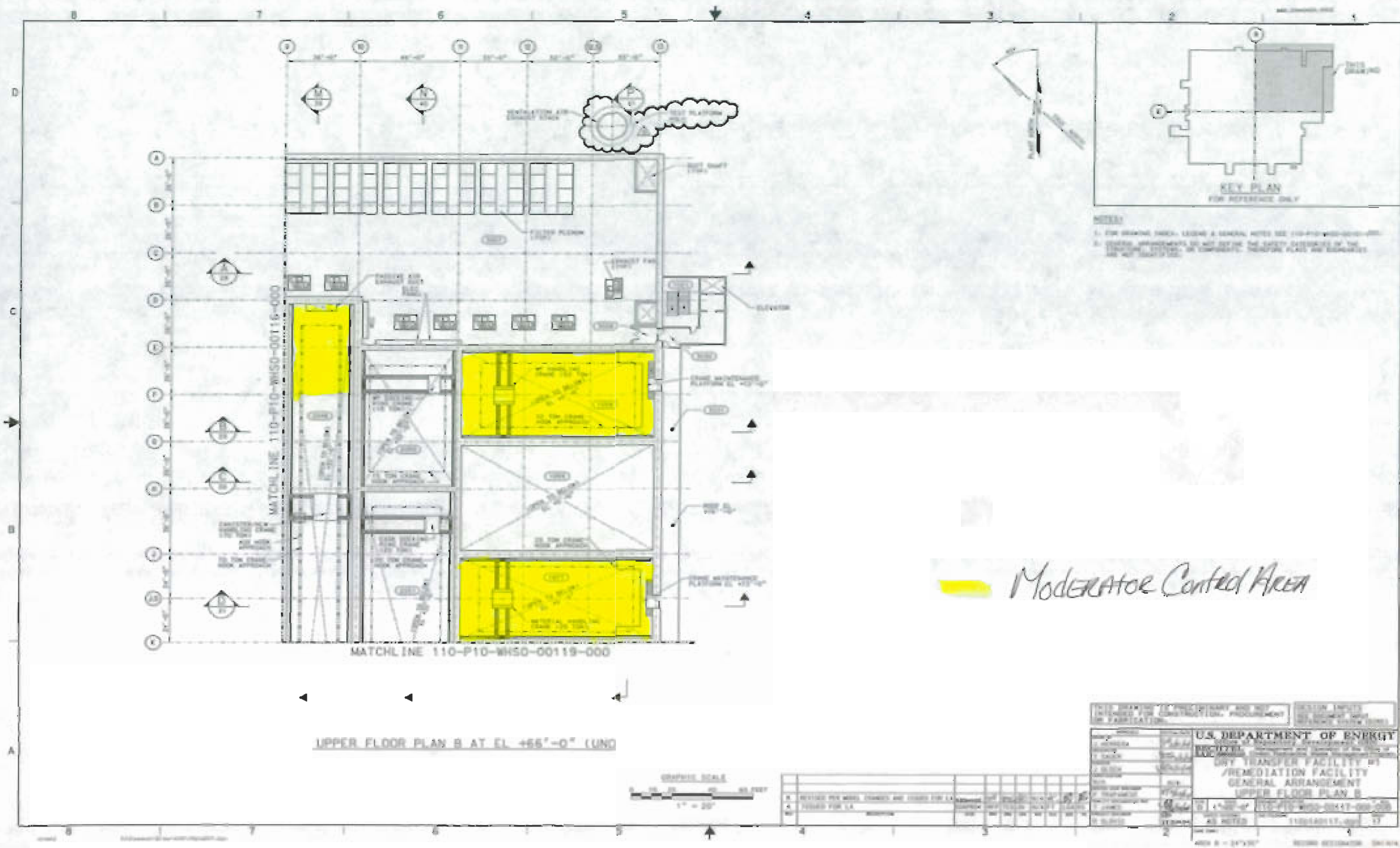

KEY PLAN
Moderator Control Area
OPERATING FLOOR PLAN A AT EL. +32'-0" (UNO)
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
OPERATING FLOOR PLAN A

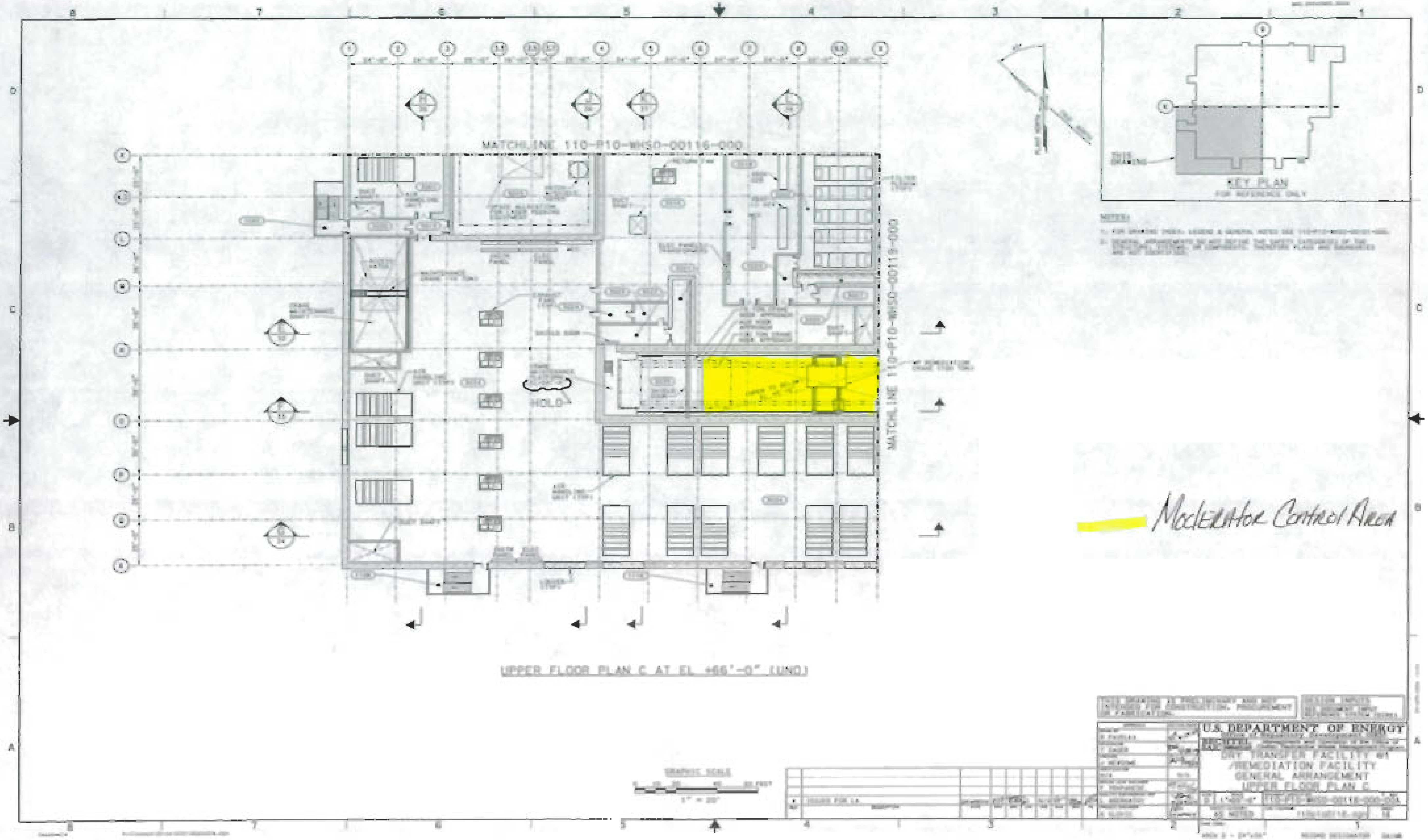

KEY PLAN
Moderator Control Area
MATCHLINE 110-P10-WHS0-00115-000
OPERATING FLOOR PLAN B AT EL +32'-0" (UNO)
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
OPERATING FLOOR PLAN B

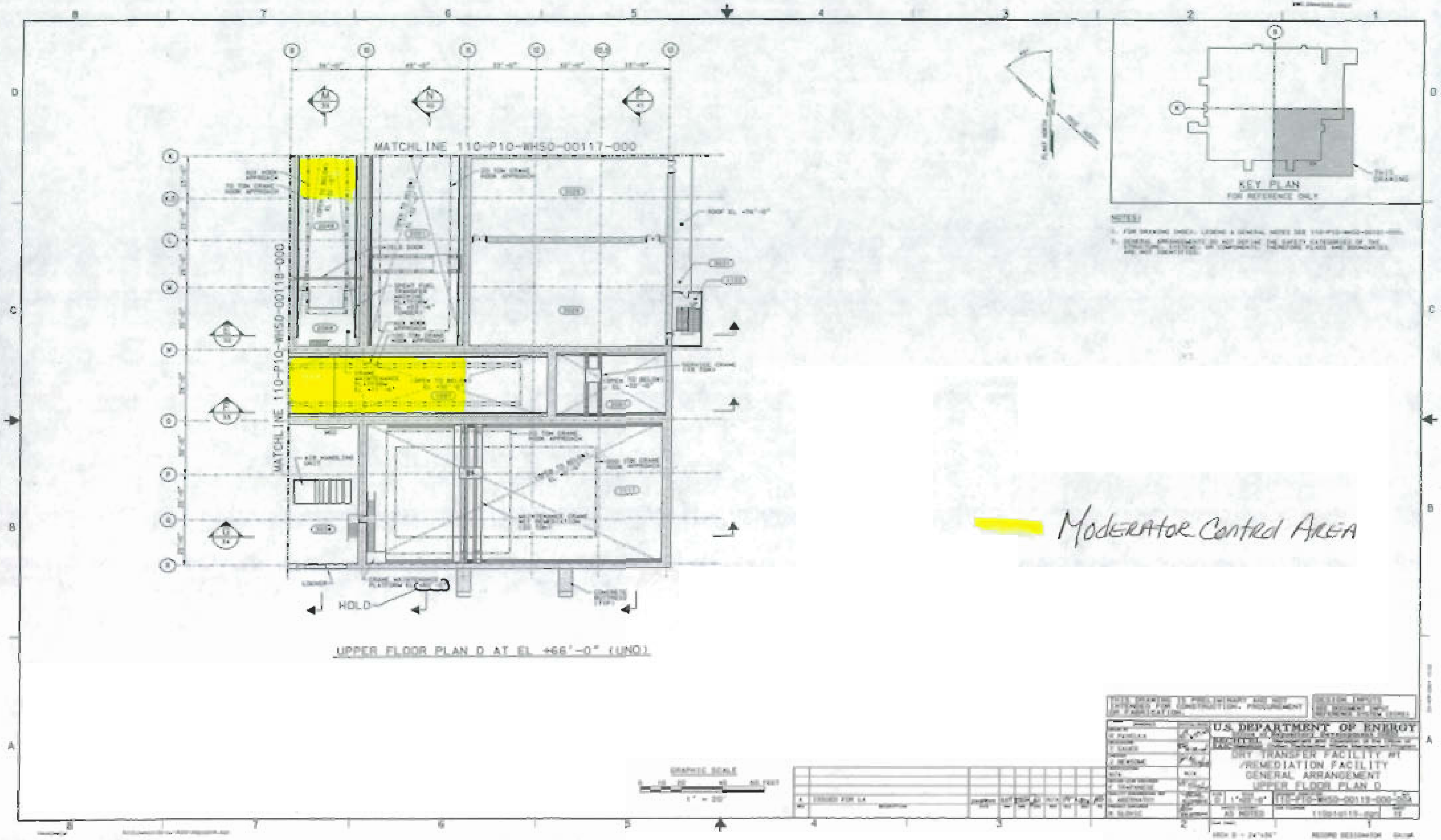

MATCHLINE 110-P10-WHS0-00112-000
MATCHLINE 110-P10-WHS0-00113-000
KEY PLAN
FOR REFERENCE ONLY
Moderator Control Area
OPERATING FLOOR PLAN C AT EL +32'-0" (UNO)
GRAPHIC SCALE
1" = 20'
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
OPERATING FLOOR PLAN C

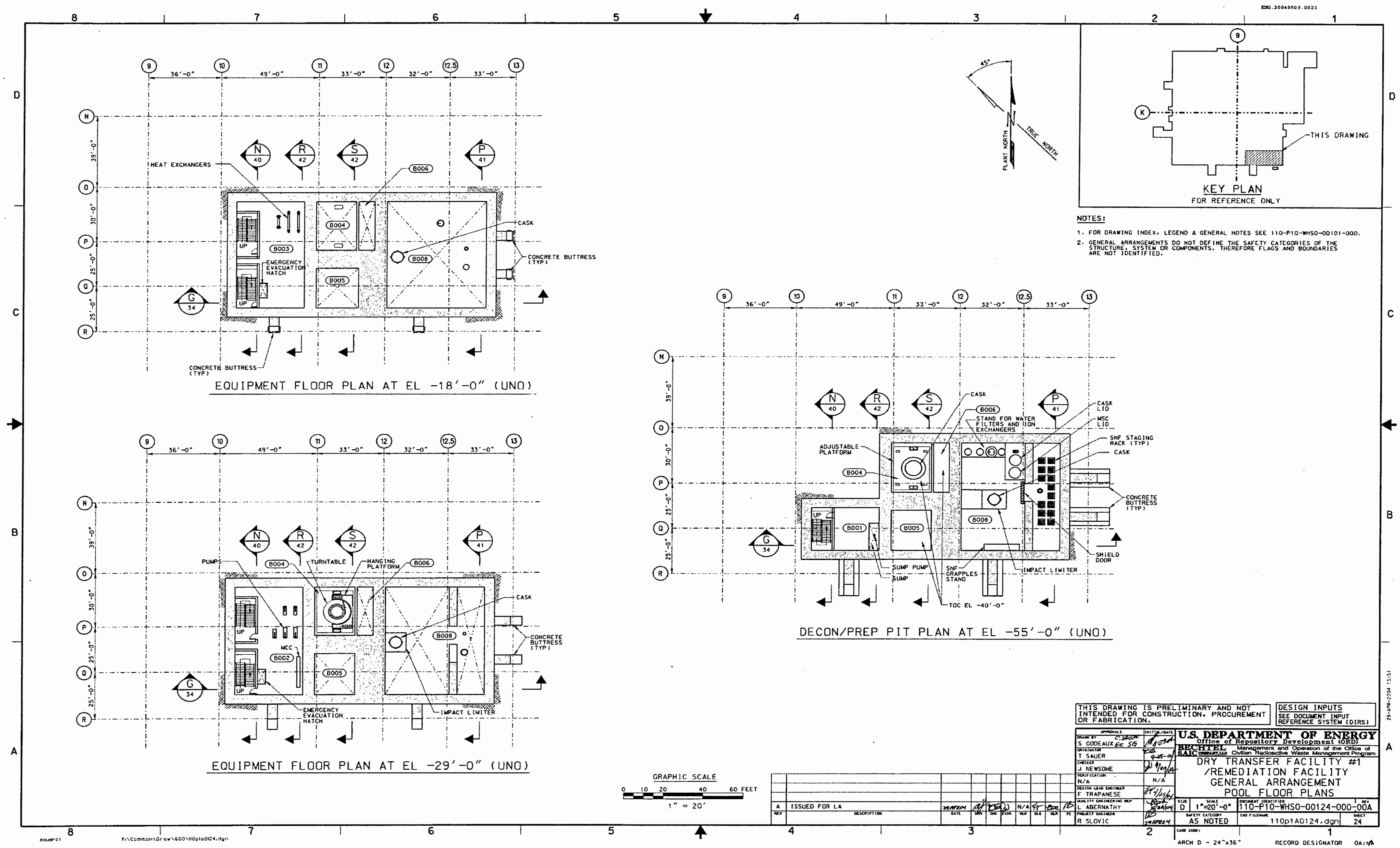

MATCHLINE 110-P10-WHS0-00113-000
MATCHLINE 110-P10-WHS0-00114-000
KEY PLAN
OPERATING FLOOR PLAN D AT EL +32'-0" (UNO)
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1 /REMEDIATION FACILITY GENERAL ARRANGEMENT OPERATING FLOOR PLAN D

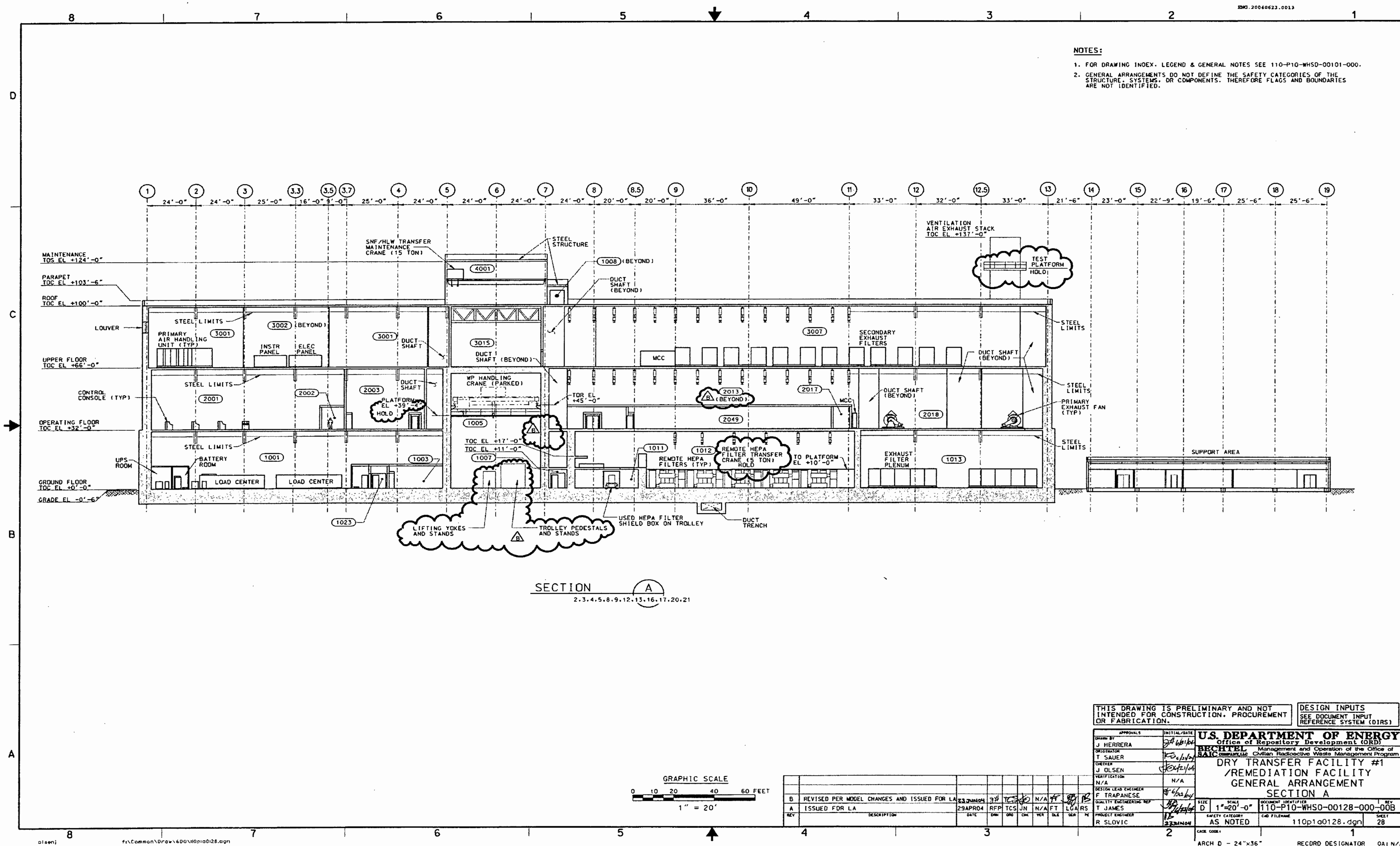

KEY PLAN
FOR REFERENCE ONLY
NOTES:
1. FOR DRAWING INDEX, LEGEND & GENERAL NOTES SEE 110-P10-WHS0-00101-000.
2. GENERAL ARRANGEMENTS DO NOT DEFINE THE SAFETY CATEGORIES OF THE STRUCTURE, SYSTEMS, OR COMPONENTS. THEREFORE FLAGS AND BOUNDARIES ARE NOT IDENTIFIED.
MATCHLINE 110-P10-WHS0-00117-000
MATCHLINE 110-P10-WHS0-00118-000
UPPER FLOOR PLAN A AT EL +66'-0" (UNO)
GRAPHIC SCALE
1" = 20'
THIS DRAWING IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION, PROCUREMENT OR FABRICATION.
DESIGN INPUTS
SEE DOCUMENT INPUT REFERENCE SYSTEM (DIRS)
U.S. DEPARTMENT OF ENERGY
Office of Repository Development (ORD)
DRY TRANSFER FACILITY #1 /REMEDIATION FACILITY GENERAL ARRANGEMENT UPPER FLOOR PLAN A
110-P10-WHS0-00116-000-00A
A ISSUED FOR LA
ARCH D - 24"x36"

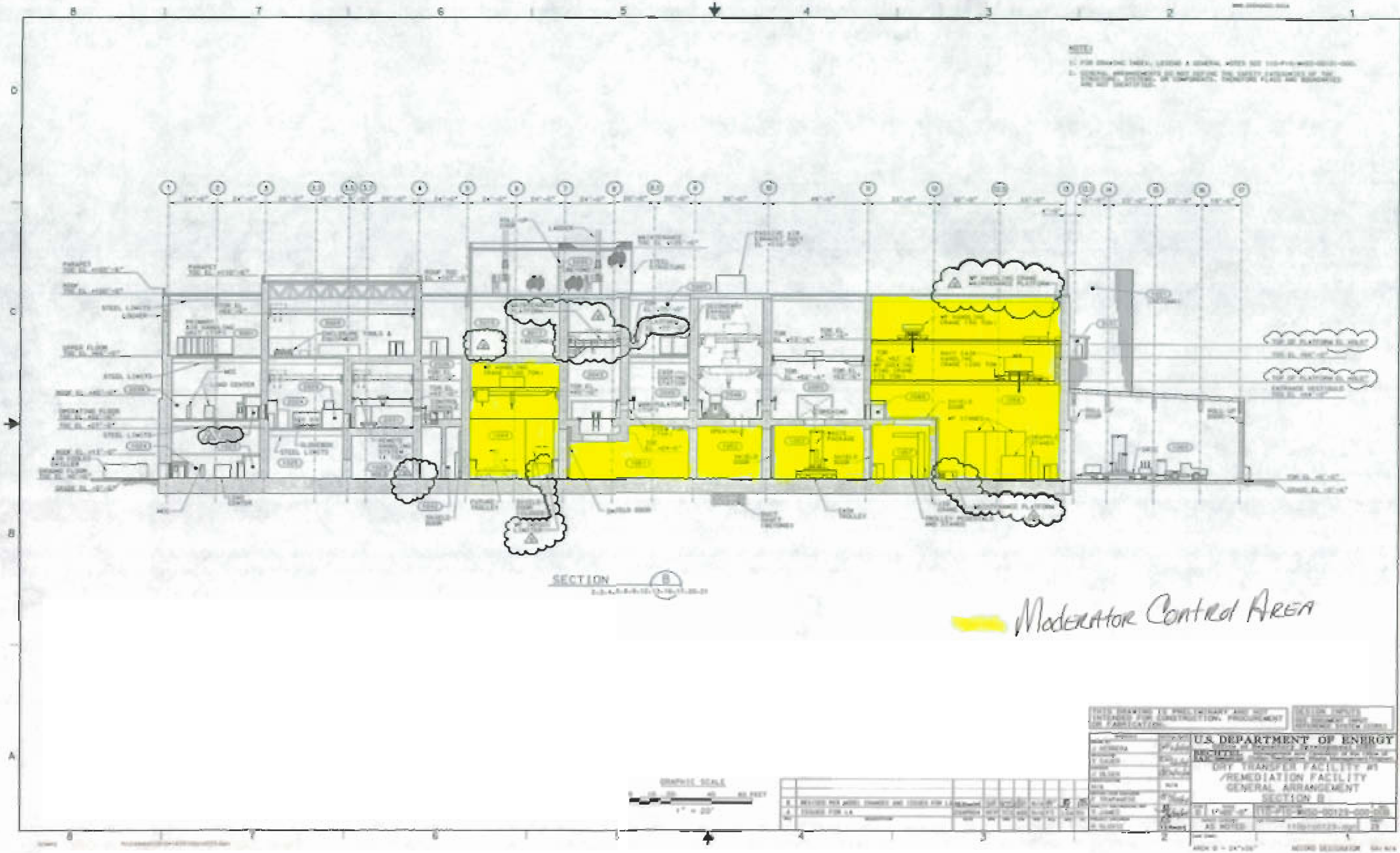

MATCHLINE 110-P10-WHS0-00116-000
MATCHLINE 110-P10-WHS0-00119-000
UPPER FLOOR PLAN B AT EL +66'-0" (UNO
KEY PLAN
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1 /REMEDIATION FACILITY GENERAL ARRANGEMENT UPPER FLOOR PLAN B

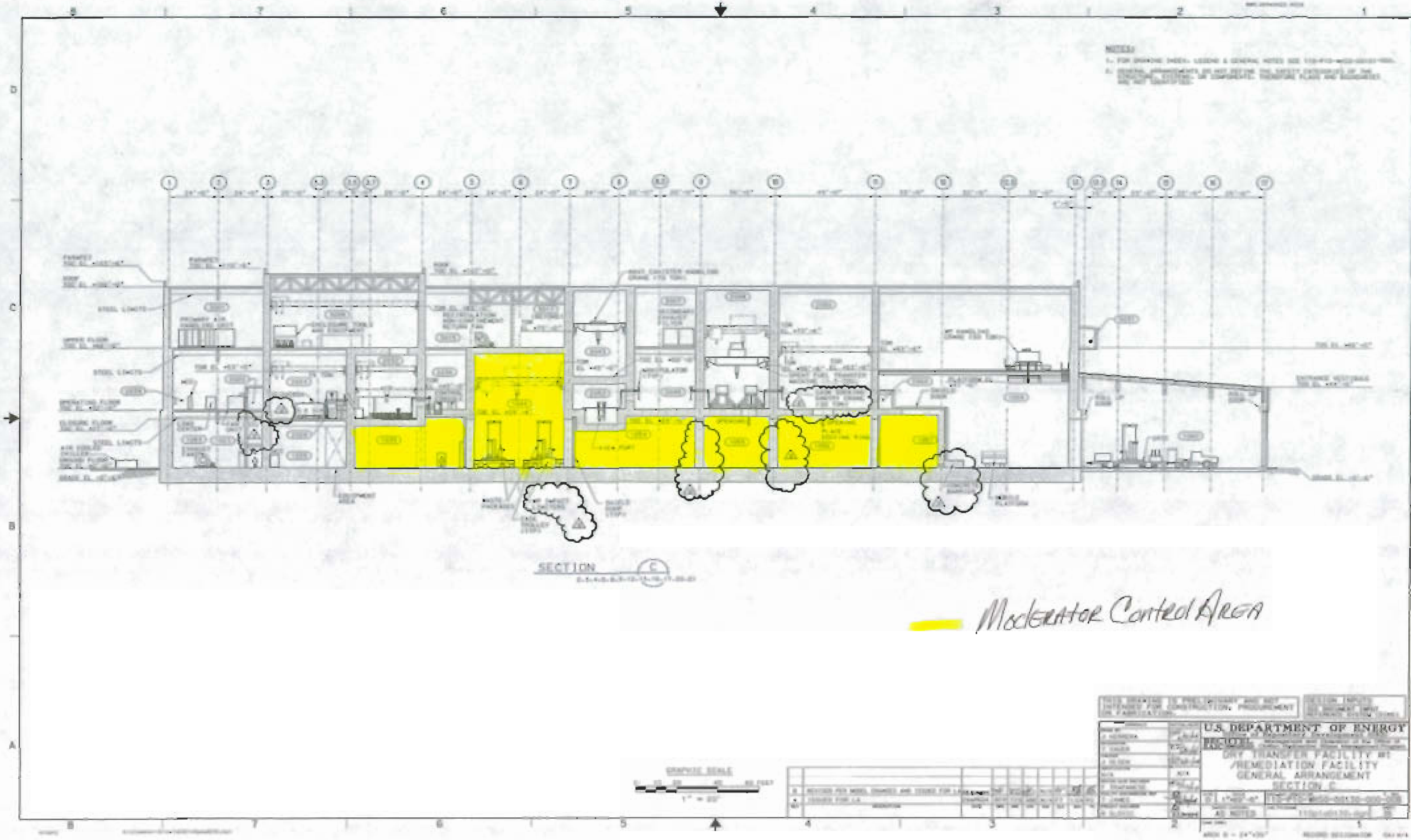

MATCHLINE 110-P10-WHS0-00116-000
MATCHLINE 110-P10-WHS0-00119-000
HOLD
KEY PLAN
UPPER FLOOR PLAN C AT EL +66'-0" (UNO)
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
UPPER FLOOR PLAN C
Moderator Control Area

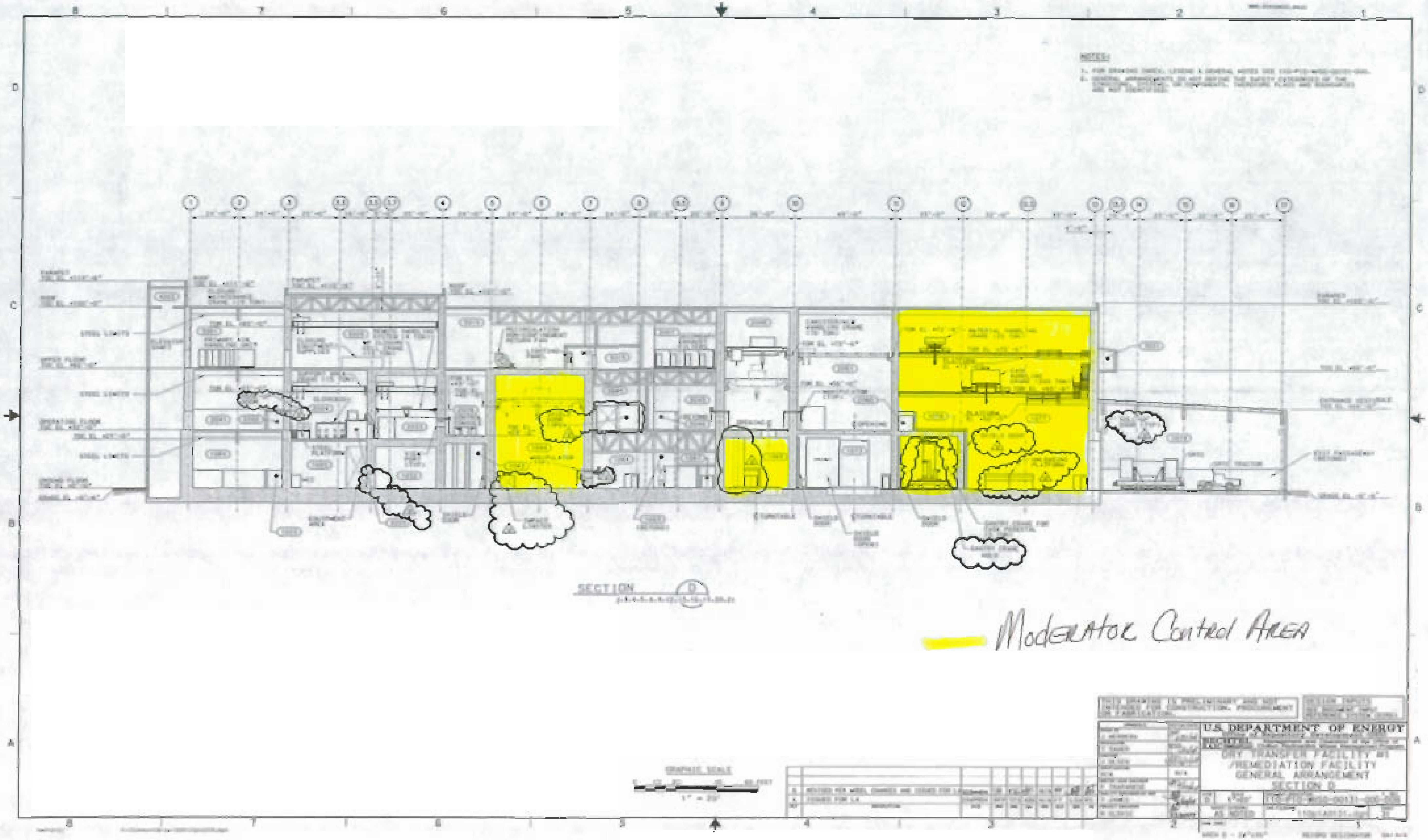

MATCHLINE 110-P10-WHS0-00117-000
MATCHLINE 110-P10-WHS0-00118-000
HOLD
UPPER FLOOR PLAN D AT EL +66'-0" (UNO)
KEY PLAN
FOR REFERENCE ONLY
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
UPPER FLOOR PLAN D

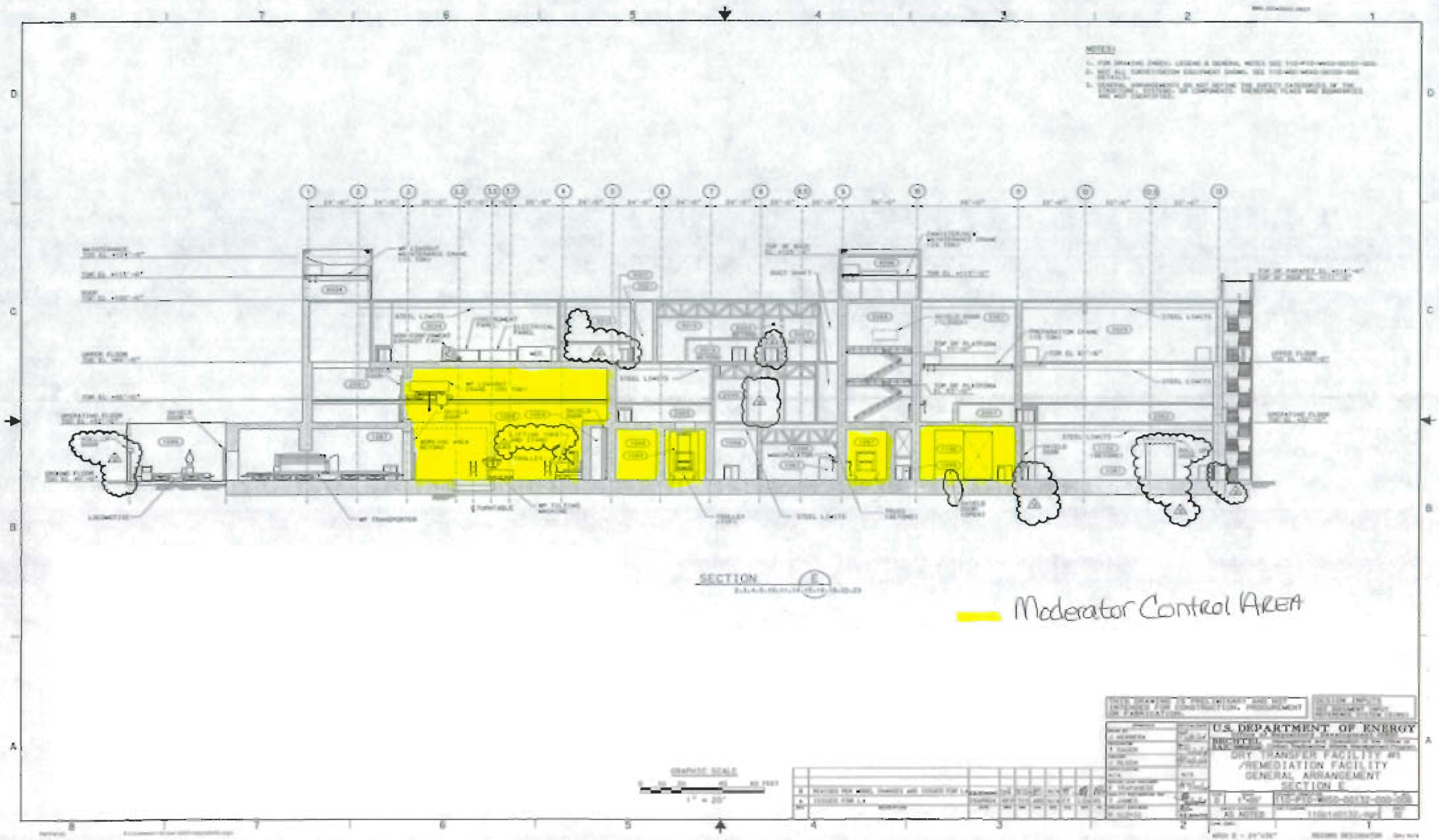

EQUIPMENT FLOOR PLAN AT EL -18'-0" (UNO)
EQUIPMENT FLOOR PLAN AT EL -29'-0" (UNO)
DECON/PREP PIT PLAN AT EL -55'-0" (UNO)
KEY PLAN
FOR REFERENCE ONLY
THIS DRAWING
PLANT NORTH
TRUE NORTH
NOTES:
1. FOR DRAWING INDEX, LEGEND & GENERAL NOTES SEE 110-P10-WHS0-00101-000.
2. GENERAL ARRANGEMENTS DO NOT DEFINE THE SAFETY CATEGORIES OF THE STRUCTURE, SYSTEM OR COMPONENTS. THEREFORE FLAGS AND BOUNDARIES ARE NOT IDENTIFIED.
HEAT EXCHANGERS
EMERGENCY EVACUATION HATCH
CONCRETE BUTTRESS (TYP)
CASK
PUMPS
TURNTABLE
HANGING PLATFORM
MCC
IMPACT LIMITER
ADJUSTABLE PLATFORM
STAND FOR WATER FILTERS AND ION EXCHANGERS
CASK LID
MSC LID
SNF STAGING RACK (TYP)
SHIELD DOOR
SUMP PUMP
SUMP
SNF GRAPPLES STAND
TOC EL -40'-0"
GRAPHIC SCALE
1" = 20'
THIS DRAWING IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION, PROCUREMENT OR FABRICATION.
DESIGN INPUTS
SEE DOCUMENT INPUT REFERENCE SYSTEM (DIRS)
U.S. DEPARTMENT OF ENERGY
Office of Repository Development (ORD)
BECHTEL SAIC
DRY TRANSFER FACILITY #1 /REMEDIATION FACILITY GENERAL ARRANGEMENT POOL FLOOR PLANS
S GODEAUX
T SAUER
J NEWSOME
F TRAPANESE
L ABERNATHY
R SLOVIC
A ISSUED FOR LA
110-P10-WHS0-00124-000-00A
110p1A0124.dgn
AS NOTED
ARCH D - 24"x36"
RECORD DESIGNATOR

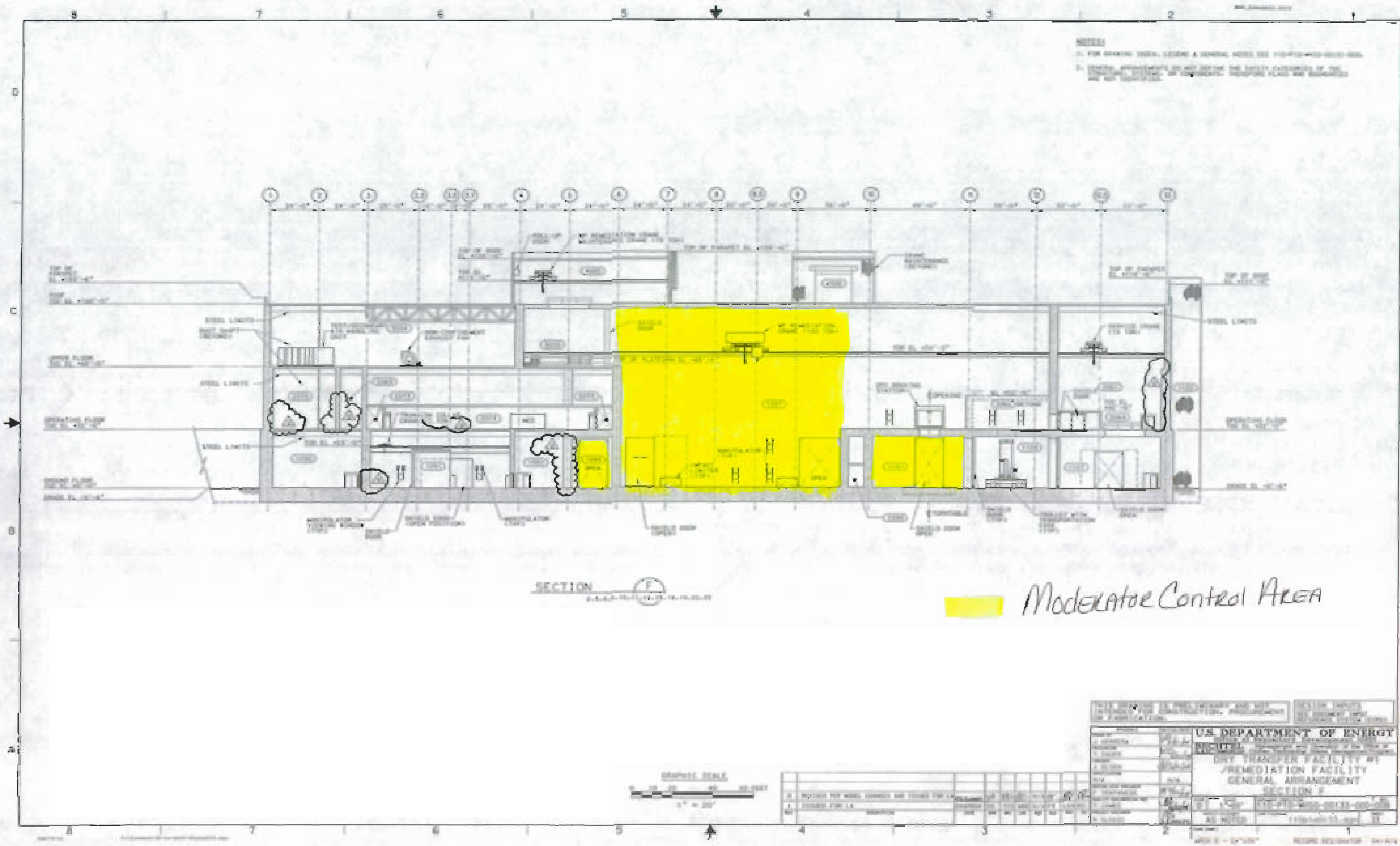

NOTES:
1. FOR DRAWING INDEX, LEGEND & GENERAL NOTES SEE 110-P10-WHSO-00101-000.
2. GENERAL ARRANGEMENTS DO NOT DEFINE THE SAFETY CATEGORIES OF THE STRUCTURE, SYSTEMS, OR COMPONENTS. THEREFORE FLAGS AND BOUNDARIES ARE NOT IDENTIFIED.
SECTION A
THIS DRAWING IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION, PROCUREMENT OR FABRICATION.
DESIGN INPUTS
SEE DOCUMENT INPUT REFERENCE SYSTEM (DIRS)
U.S. DEPARTMENT OF ENERGY
Office of Repository Development (ORD)
DRY TRANSFER FACILITY #1 /REMEDIATION FACILITY GENERAL ARRANGEMENT SECTION A
110-P10-WHS0-00128-000-00B
GRAPHIC SCALE
1" = 20'
B REVISED PER MODEL CHANGES AND ISSUED FOR LA
A ISSUED FOR LA 29APR04
J HERRERA
T SAUER
J OLSEN
F TRAPANESE
T JAMES
R SLOVIC
AS NOTED
110p1a0128.dgn

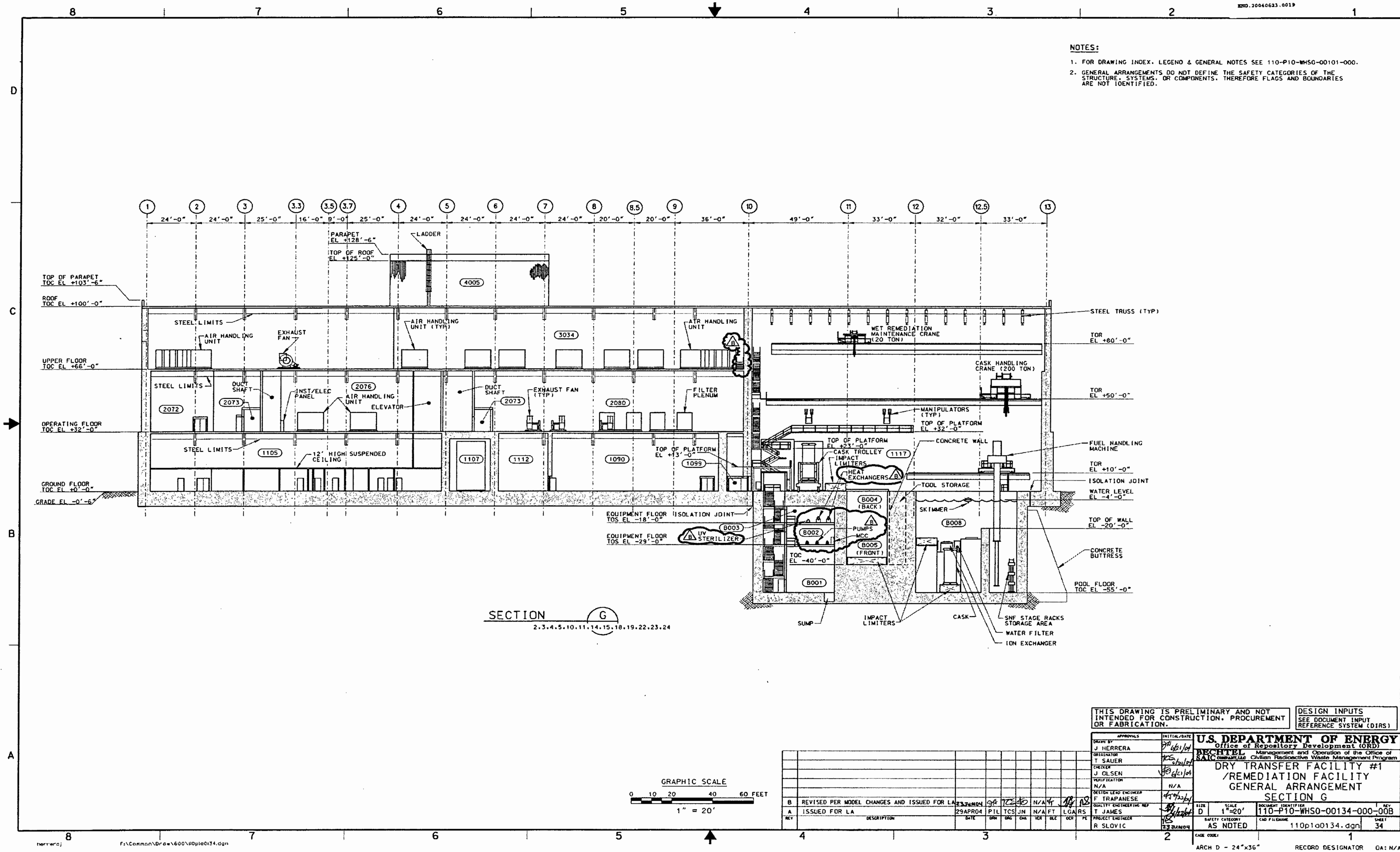

SECTION B
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION B

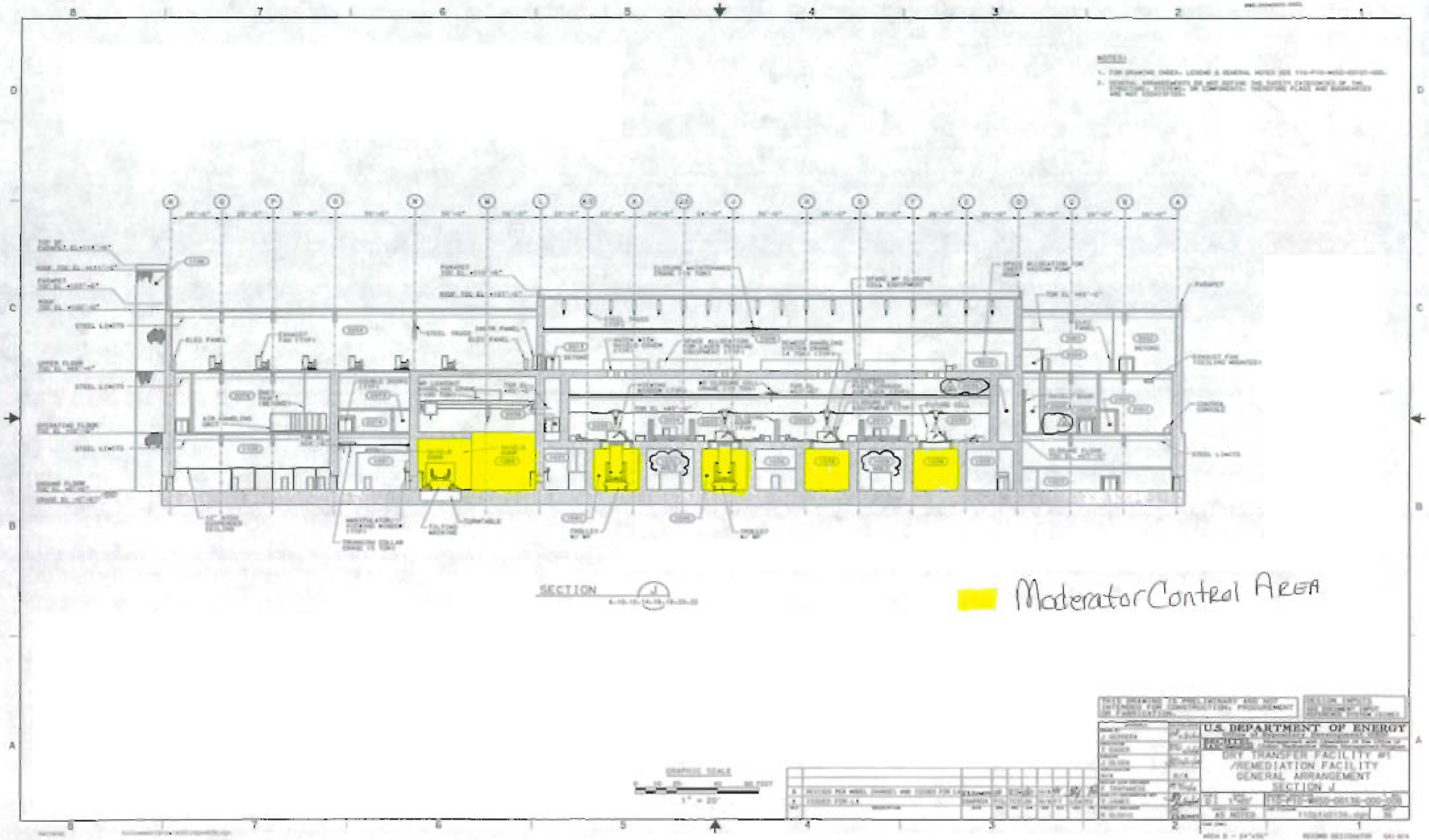

NOTES:
SECTION C
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION C

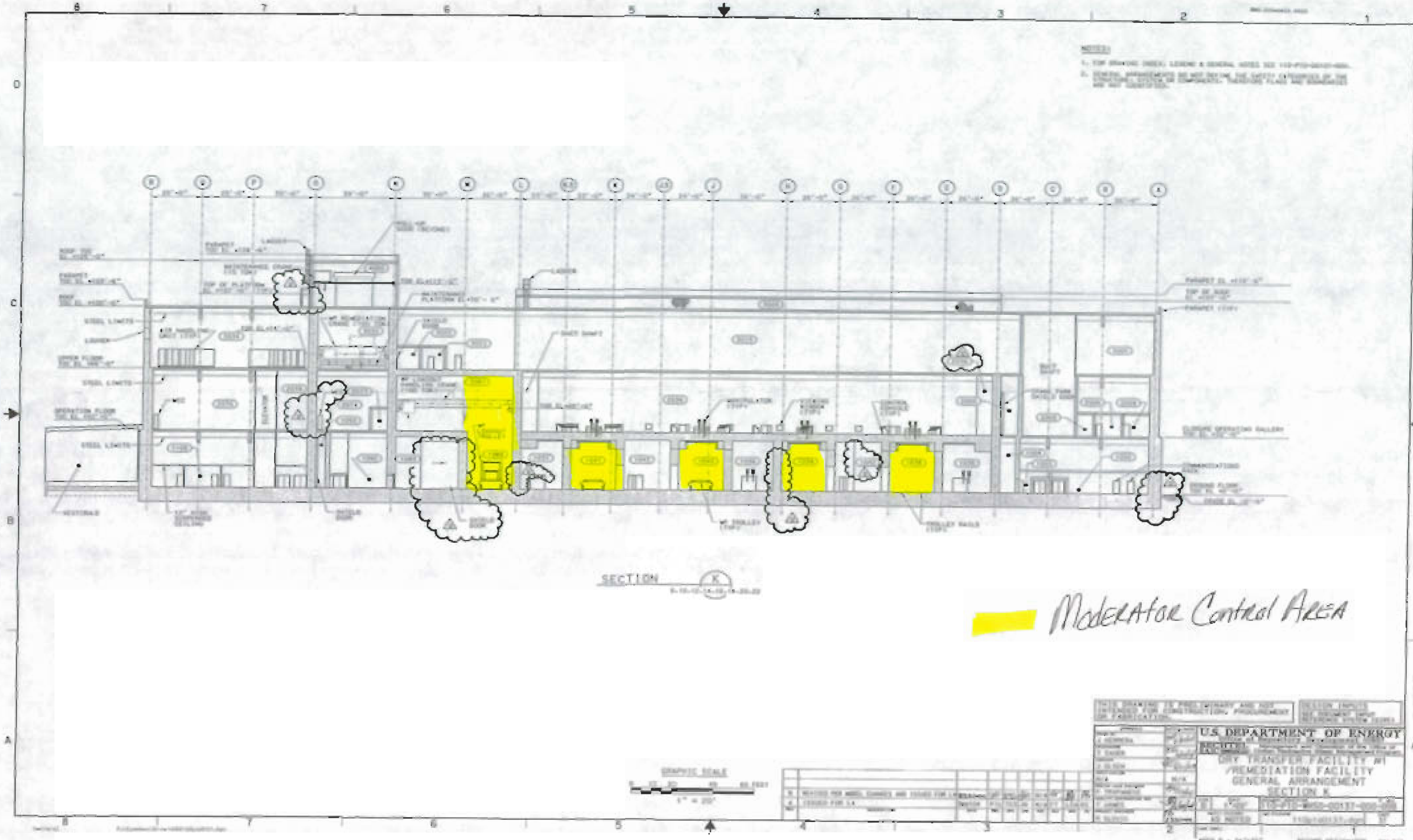

SECTION D
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
BECHTEL
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION D
AS NOTED

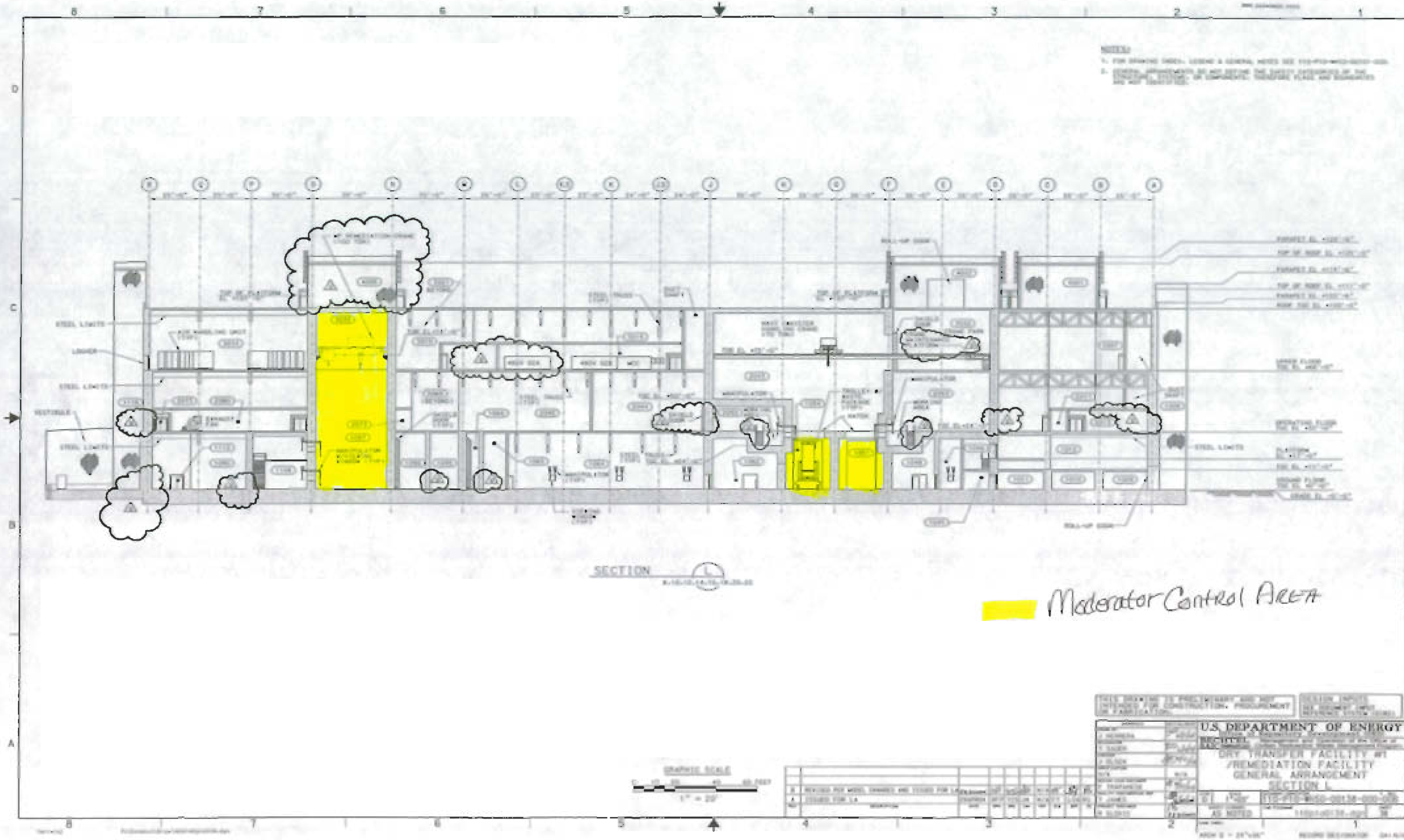

SECTION E
Moderator Control AREA
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION E

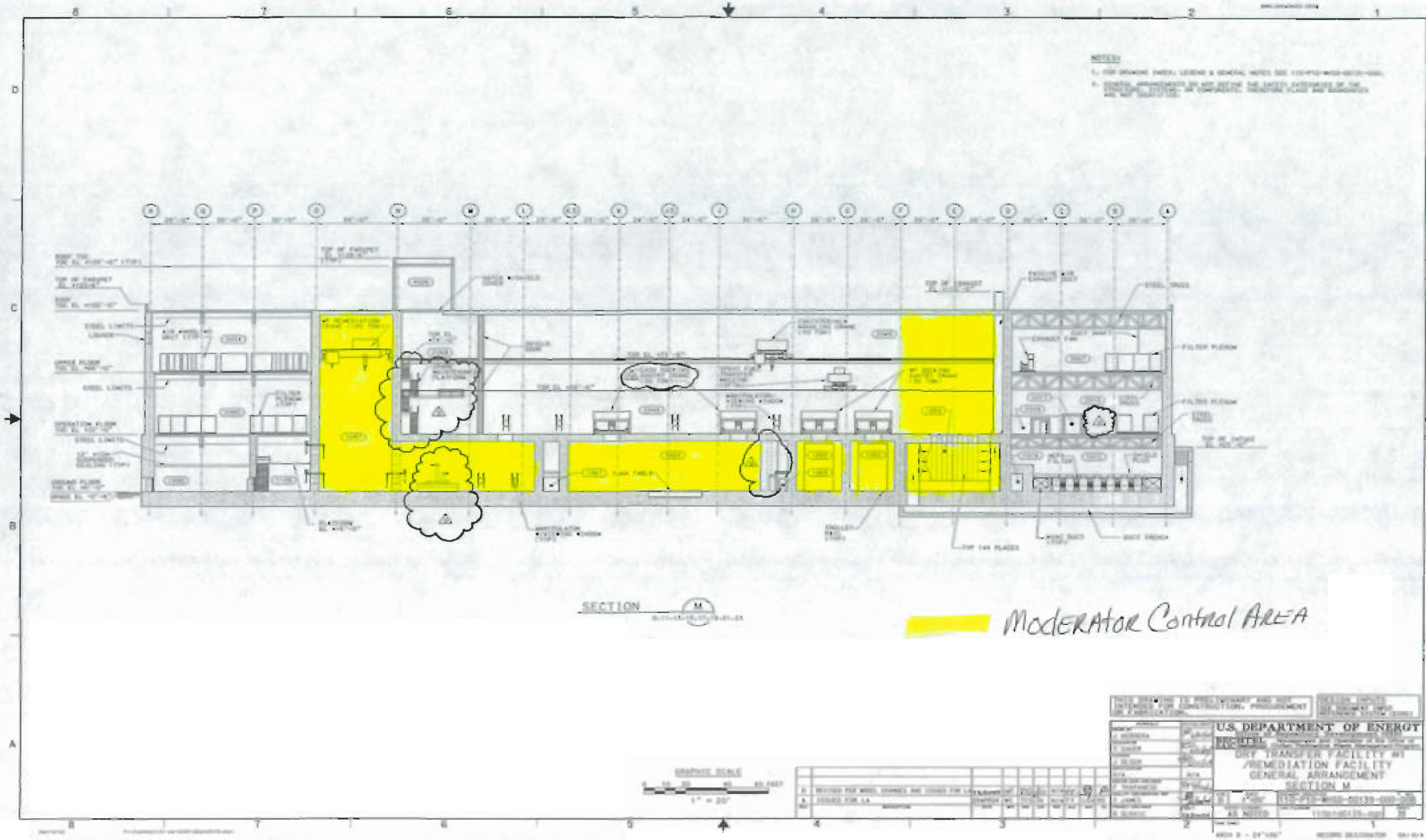

NOTES:
SECTION F
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
BECHTEL
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION F
AS NOTED

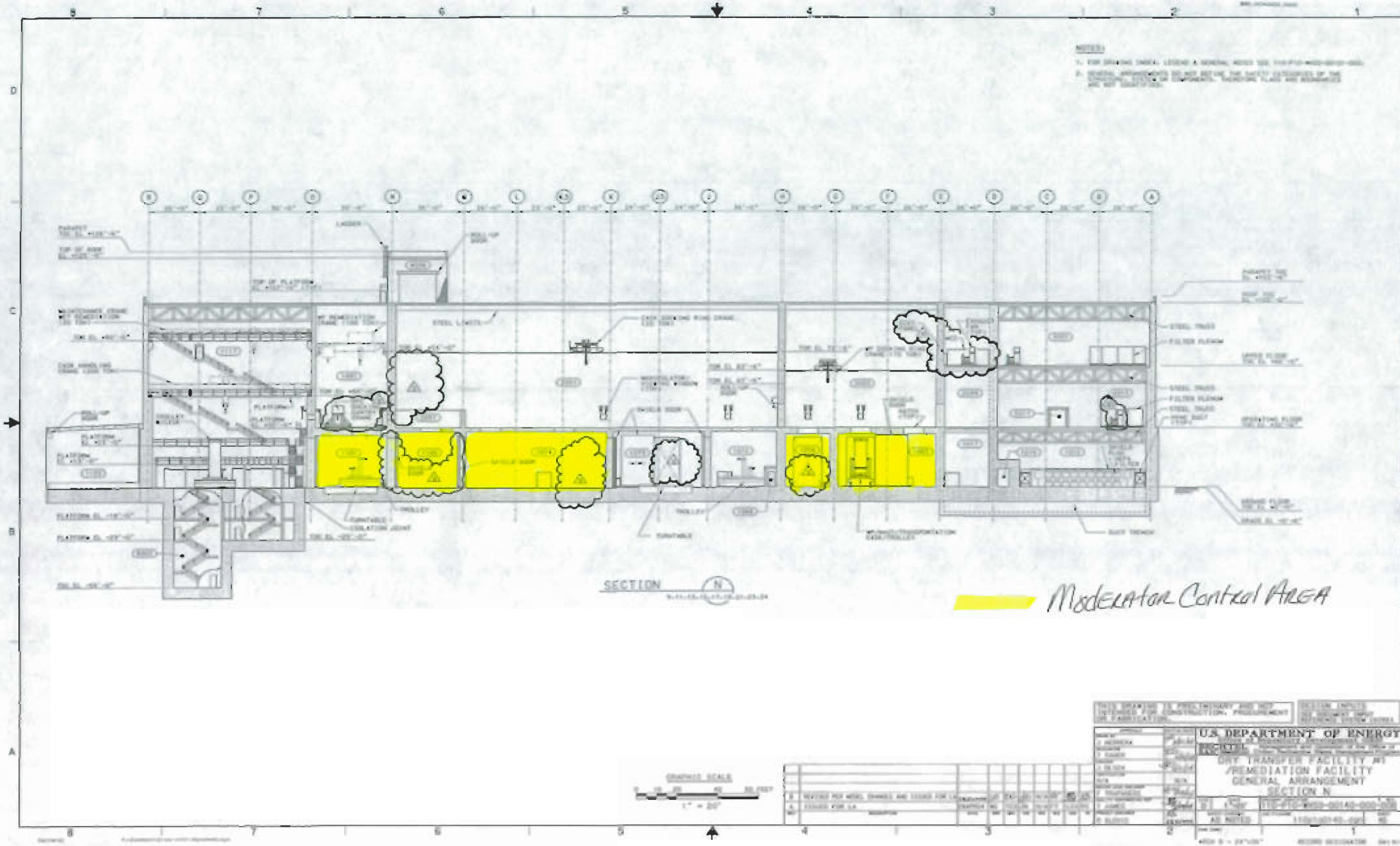

NOTES:
1. FOR DRAWING INDEX, LEGEND & GENERAL NOTES SEE 110-P10-WHS0-00101-000.
2. GENERAL ARRANGEMENTS DO NOT DEFINE THE SAFETY CATEGORIES OF THE STRUCTURE, SYSTEMS, OR COMPONENTS. THEREFORE FLAGS AND BOUNDARIES ARE NOT IDENTIFIED.
SECTION G
THIS DRAWING IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION, PROCUREMENT OR FABRICATION.
U.S. DEPARTMENT OF ENERGY
Office of Repository Development (ORD)
DRY TRANSFER FACILITY #1 /REMEDIATION FACILITY GENERAL ARRANGEMENT SECTION G
110-P10-WHS0-00134-000-00B
B REVISED PER MODEL CHANGES AND ISSUED FOR LA
A ISSUED FOR LA 29APR04
GRAPHIC SCALE 1" = 20'
ARCH D - 24"x36"

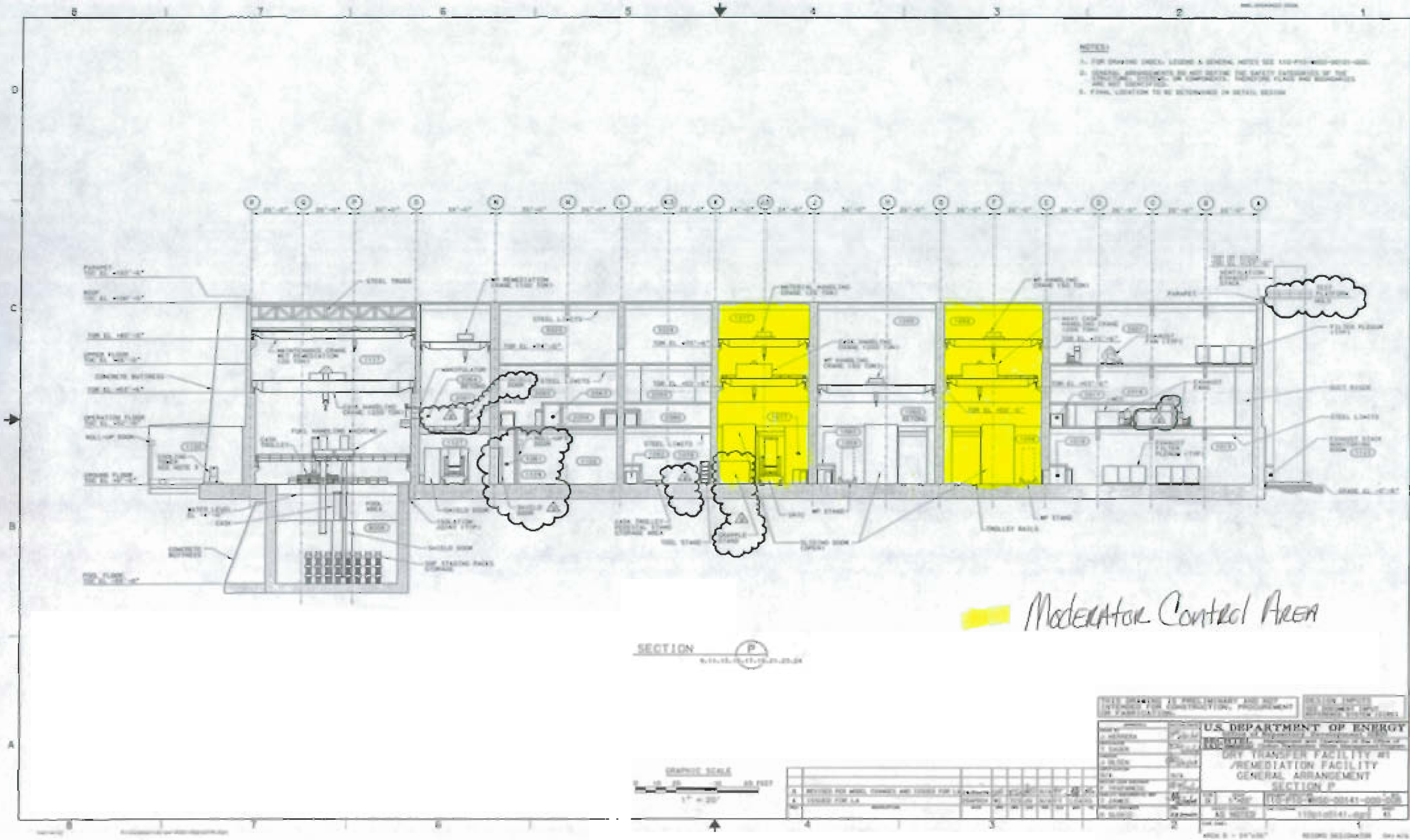

NOTES:
SECTION J
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION J

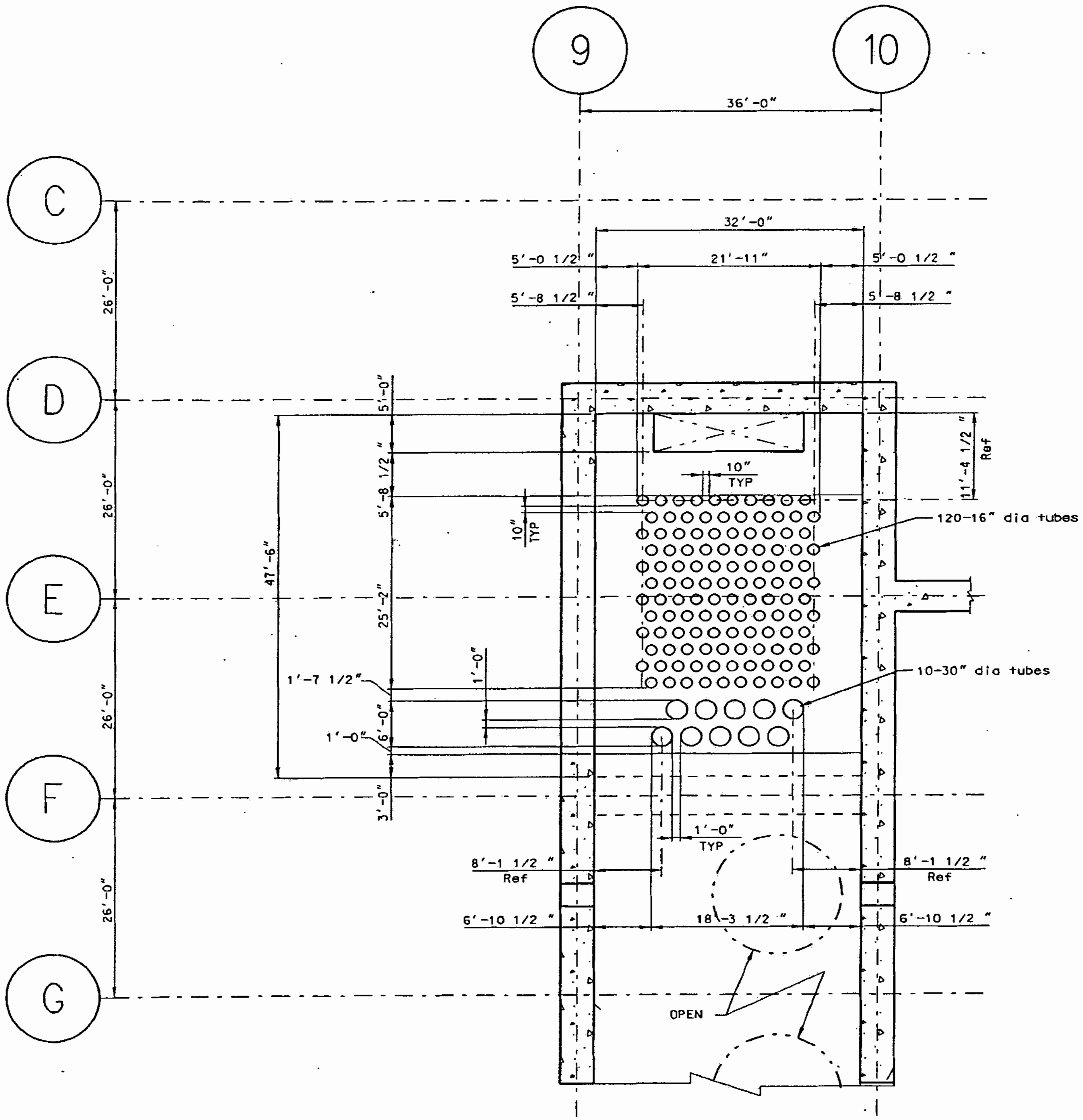

SECTION K
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION K

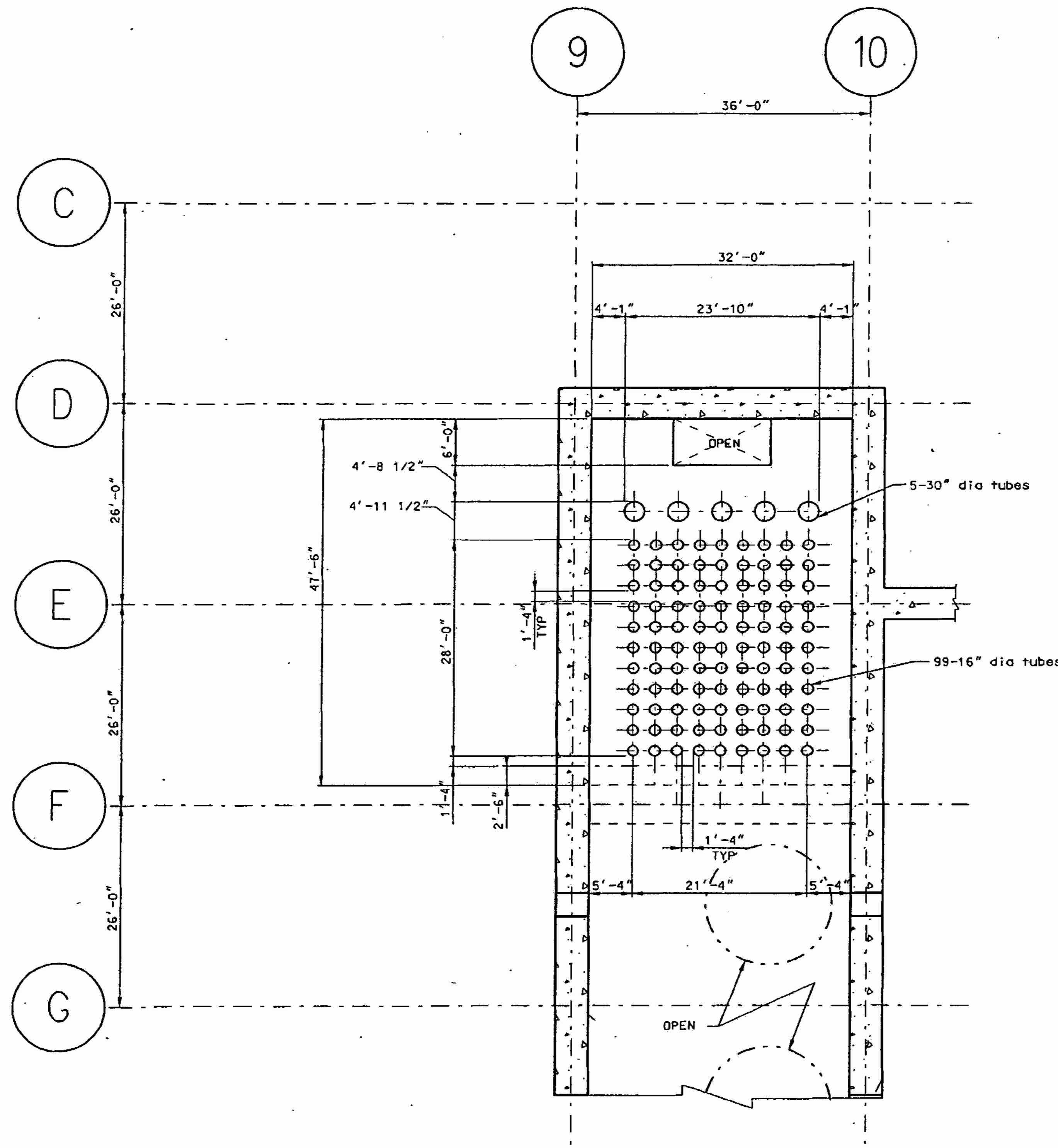

SECTION
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
BECHTEL
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION L


SECTION M
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION M


SECTION N
Moderator Control Area
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION N


Moderator Control Area
SECTION P
U.S. DEPARTMENT OF ENERGY
DRY TRANSFER FACILITY #1
/REMEDIATION FACILITY
GENERAL ARRANGEMENT
SECTION P
AS NOTED


9
10
36'-0"
C
D
E
F
G
26'-0"
26'-0"
26'-0"
26'-0"
32'-0"
5'-0 1/2"
21'-11"
5'-0 1/2"
5'-8 1/2"
5'-8 1/2"
5'-0"
5'-8 1/2"
25'-2"
6'-0"
3'-0"
47'-6"
11'-4 1/2" Ref
10" TYP
10" TYP
120-16" dia tubes
10-30" dia tubes
1'-7 1/2"
1'-0"
1'-0"
1'-0" TYP
8'-1 1/2" Ref
8'-1 1/2" Ref
6'-10 1/2"
6'-10 1/2"
18'-3 1/2"
OPEN


9
10
36'-0"
C
D
E
F
G
26'-0"
26'-0"
26'-0"
26'-0"
32'-0"
4'-1"
23'-10"
4'-1"
OPEN
5-30" dia tubes
99-16" dia tubes
4'-8 1/2"
4'-11 1/2"
6'-0"
28'-0"
47'-6"
1'-4" TYP
1'-4"
2'-6"
1'-4" TYP
5'-4"
21'-4"
5'-4"
OPEN