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1. PURPOSE

The objective of this calculation is to determine the structural response of the waste package (WP) swinging down from a horizontally suspended height. The WP used for that purpose is the 21-Pressurized Water Reactor (PWR) WP. The scope of this document is limited to reporting the calculation results in terms of stress intensities. This calculation is associated with the WP design and was performed by the Waste Package Design group in accordance with the *Technical Work Plan for: Waste Package Design Description for LA* (Ref. 13). AP-3.12Q, *Calculations* (Ref. 18) is used to perform the calculation and develop the document. The information provided by the sketches attached to this calculation is that of the potential design of the type of 21-PWR WP design considered in this calculation and provides the potential dimensions and materials for the 21-PWR WP design.

2. METHOD

The finite element calculation was performed by using the commercially available ANSYS Version (V) 5.6.2 (Computer Software Configuration Item [CSCI] 10364 V5.6.2; Ref. 5) and LS-DYNA V950.C (Software Tracking Number [STN] 10300-950-00; Ref. 7) finite element codes. The results of this calculation were provided in terms of maximum stress intensities in the outer shell (OS), inner shell (IS), and Shear Ring.

With regard to the development of this calculation, the control of electronic management of data was evaluated in accordance with AP-SV.1Q, *Control of the Electronic Management of Information* (Ref. 17). The evaluation (Addendum B of Ref. 13) determined that current work processes and procedures are adequate for the control of the electronic management of data for this activity.

3. ASSUMPTIONS

In the course of developing this document, the following assumptions are made regarding the structural calculation. The assumptions do not require confirmation.

3.1 Some of the temperature-dependent material properties, such as Poisson's Ratio, Coefficient of Thermal Expansion, and density, are not available or are negligible for SB-575 N06022 (Alloy 22), SA-516 K02700 (516 carbon steel [CS]), and SA-240 S31600 (316 stainless steel [SS]). The room-temperature (20 °C) material properties are assumed for these materials. The impact of using room-temperature material properties is anticipated to be small. The rationale for this assumption is that undetermined material properties of said materials will not significantly impact the results. This assumption is used in Section 5.2.

3.2 The Poisson's ratio of Alloy 22 is not available in literature. The Poisson's ratio of Alloy 625 (SB-443 N06625) is assumed for Alloy 22. The impact of this assumption is anticipated to be negligible. The rationale for this assumption is that the chemical compositions of Alloy 22 and Alloy 625 are similar (see Ref. 2, Table 1 and Ref. 10, p. 143, respectively). This assumption is used in Section 5.2.

3.3 Strain rate hardening material properties are not available for SB-575 N06022 (Alloy 22), SA-516 K02700 (516 carbon steel [CS]), and SA-240 S31600 (316 stainless steel [SS]). The effects of this phenomena are neglected. The impact of ignoring these properties is anticipated to be conservative. The rationale for this assumption is that strain rate hardening would make the material stronger. This assumption is used in Section 5.2.

3.4 Poisson's ratio is not available for 516 CS. Therefore, Poisson's ratio of cast carbon steel is assumed for 516 CS. The impact of this assumption is anticipated to be negligible. The rationale for this assumption is that the elastic constants of cast carbon steels are only slightly affected by changes in composition and structure (see Ref. 3). This assumption is used in Section 5.2.

3.5 The exact geometry of the loaded internals is simplified for the purpose of this calculation. The spent fuel was modeled as 21 separate solid rectangles made from SS304L, but the thermal shunts, fuel tubes, and dividers between the fuel assemblies were omitted. The density of the spent fuel was increased to account for the missing mass. However, the sideguides, cornerguides, and stiffeners were included to accurately represent the contact with the inner shell. The rationale for this assumption is to simplify the finite element representation (FER), thus reducing processing time and file size, without compromising the accuracy of the calculation. This assumption is used in Section 5.2 and Section 5.4.

3.6 The elongations of Alloy 22 and 316NG SS at elevated temperatures are not available from traditional sources. However, vendor data is available (Ref. 6 and Ref. 14). The percent difference between elongations at room temperature and elevated temperatures can be normalized and applied to the data available from accepted codes. The rationale for this assumption is that the relative change of typical elongations should be bounding for the relative change of minimum elongation. Even though the values are not from traditional sources, the values are conservative and create higher stress intensities for the same temperature. This assumption is used in Section 5.2.1.

3.7 The impact surface that the WP is to be dropped on is conservatively assumed to be perfectly rigid (unyielding). Such a material does not exist. LS-DYNA V950.C (Ref. 7) is able to simulate such a surface. The result will be that the stresses produced by this calculation will be a small percentage higher than those that would result if a realistic surface were used. The rationale is that this is a conservative assumption. This assumption is used in Section 5.4.

3.8 Three-stage deformation characteristics are not observed in the stress-strain curves for Alloy 22 or Type 316 stainless steel (Ref. 9). However, in order to capture the uniform strain of the material from the curves, the total elongation should be conservatively reduced by 10%. The rationale for this assumption is to truncate the last portion of the curve that has decreasing slope. This assumption is used in Section 5.2.2.

3.9 The uniform strain of A 516 Grade 70 CS is not available in literature. Therefore, it is conservatively assumed that the uniform strain is 50% of the elongation. The rationale for this assumption is the character of stress-strain curve for A 36 CS (see Refs. 8 and 12) that has similar chemical composition with A 516 Grade 70 CS (see Ref. 2, SA-516/SA-516M and SA-36/SA-36M). This assumption is used in Section 5.2.2.

3.10 For the purposes of analyzing the initial angular velocity of the waste package before impact, the WP will be assumed to be a solid cylinder. This is necessary to calculate the rotary moment of inertia. The impact of this assumption on the results is negligible. The rationale for this assumption is the overall cylindrical shape of the WP and the relatively solid packing of the contents. This assumption is used in Section 5.3.

4. USE OF COMPUTER SOFTWARE AND MODELS

4.1 SOFTWARE

The first finite element analysis (FEA) computer code used for this calculation is ANSYS V5.6.2 (Ref. 5), which is identified with the Software Tracking Number (STN) 10364 V5.6.2 and was obtained from Software Configuration Management in accordance with appropriate procedures. ANSYS V5.6.2 is a commercially available finite element analysis code and is appropriate for structural calculations of WPs as performed in this calculation. The calculations using the ANSYS V5.6.2 software were executed on a Hewlett-Packard (HP) UNIX workstation, Bechtel SAIC Company, LLC (BSC) tag number 700314. The ANSYS evaluations performed for these designs are fully within the range of the validation performed for the ANSYS V5.6.2 code. The code used to perform these calculations was obtained from the Software Configuration Secretariat in accordance with the appropriate procedures.

The second FEA code used is Livermore Software Technology Corporation (LSTC) LS-DYNA V950.C (Ref. 7). LS-DYNA V950.C was obtained from the Software Configuration Secretariat in accordance with the appropriate procedures and is identified by STN 10300-950-00. LS-DYNA V950.C is appropriate for its intended use. The LS-DYNA evaluation performed for this calculation is fully within the range of the validation perfromed for the LS-DYNA V950.C code. The calculations were executed on HP 9000 series UNIX workstations identified with YMP tag numbers 117161 and 114435 located in Las Vegas, NV.

The input and output files are defined in Section 8 of this document. They are located in Attachment II to this document.

4.2 SOFTWARE ROUTINES

None used.

4.3 MODELS

None used.

5. CALCULATION

5.1 MASS AND GEOMETRIC DIMENSIONS OF WASTE PACKAGE

This calculation was performed using mass and geometric dimensions of the 21-PWR waste package (see pp. I-1, I-15 and I-24):

Total mass of the loaded WP = 41,598 *kg*
Length = 5.129 *m*
Outer diameter of outer shell = 1.574 *m*
Outer diameter of trunnion collar sleeve = 1.654 *m*

5.2 MATERIAL PROPERTIES

Material properties used in these calculations are listed in this section. Some of the temperature-dependent and rate-dependent material properties are not available for Alloy 22, 316NG SS, and 516 CS. Therefore, room-temperature density and Poisson's ratio obtained under the static loading conditions are used for for Alloy 22, 316NG SS, and 516 CS (see Assumptions 3.1 and 3.3).

SB-575 N06022 (Alloy 22) (Outer shell, outer shell lids, upper and lower trunnion collar sleeves):

- Density = 8690 kg/m^3 (0.314 lb/in^3) (at room temperature) (Ref. 2, SB-575 Section 7.1)
- Yield strength = 310 *MPa* (45 *ksi*) (at room temperature) (Ref. 2, Table Y-1)
  Yield strength = 236 *MPa* (34.3 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table Y-1)
  Yield strength = 211 *MPa* (30.6 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table Y-1)
- Tensile strength = 690 *MPa* (100 *ksi*) (at room temperature) (Ref. 2, Table U)
  Tensile strength = 657 *MPa* (95.3 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table U)
  Tensile strength = 628 *MPa* (91.1 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table U)
- Elongation = 0.45 (at room temperature) (Ref. 2, SB-575 Table 3)
- Poisson's ratio = 0.278 (at room temperature) (Ref. 10, p. 143; see Assumption 3.2)
- Modulus of elasticity = 206 *GPa* (at room temperature) (Ref. 6, p. 14)
  Modulus of elasticity = 196 *GPa* (at 400 °F = 204 °C) (Ref. 6, p. 14)
  Modulus of elasticity = 190 *GPa* (at 600 °F = 316 °C) (Ref. 6, p. 14)

SA-240 S31600 (316NG SS, which is 316 SS with tightened control on carbon and nitrogen content and has the same material properties as 316 SS [see Ref. 15, page 931 and Ref. 2, Section II, SA-240 Table 1]) (Inner shell, inner shell lids, and inner shell lifting feature):

- Density = 7980 kg/m^3 (at room temperature) (Ref. 11, Table X1, p. 7)

- Yield strength = 207 *MPa* (30.0 *ksi*) (at room temperature) (Ref. 2, Table Y-1)
  Yield strength = 148 *MPa* (21.4 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table Y-1)
  Yield strength = 130 *MPa* (18.9 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table Y-1)

- Tensile strength = 517 *MPa* (75.0 *ksi*) (at room temperature) (Ref. 2, Table U)
  Tensile strength = 496 *MPa* (71.9 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table U)
  Tensile strength = 495 *MPa* (71.8 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table U)

- Elongation = 0.40 (at room temperature) (Ref. 2, SA-240 Table 2)

- Poisson's ratio = 0.298 (at room temperature) (Ref. 10, Figure 15, p. 755)

- Modulus of elasticity = 195 *GPa* (28.3 * 10^6 *psi*) (at room temperature) (Ref. 2, Table TM-1)
  Modulus of elasticity = 183 *GPa* (26.5 * 10^6 *psi*) (at 400 °F = 204 °C) (Ref. 2, Table TM-1)
  Modulus of elasticity = 174 *GPa* (25.3 * 10^6 *psi*) (at 600 °F = 316 °C) (Ref. 2, Table TM-1)

SA-516 K02700 (516 CS) (Sideguides, stiffeners, and baskets):

- Density = 7850 kg/m^3 (at room temperature) (Ref. 2, SA-20/SA20M, Section 14.1)

- Yield strength = 262 *MPa* (38 *ksi*) (at room temperature) (Ref. 2, Table Y-1)
  Yield strength = 224 *MPa* (32.5 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table Y-1)
  Yield strength = 201 *MPa* (29.1 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table Y-1)

- Tensile strength = 483 *MPa* (70 *ksi*) (at room temperature) (Ref. 2, Table U)
  Tensile strength = 483 *MPa* (70 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table U)
  Tensile strength = 483 *MPa* (70 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table U)

- Elongation = 0.21 (at room temperature) (Ref. 2, SA-240 Table 2)

- Poisson's ratio = 0.3 (at room temperature) (Ref. 3, p. 374) (see Assumption 3.4)

- Modulus of elasticity = 203 *GPa* (29.5 * 10^6 *psi*) (at room temperature) (Ref. 2, Table TM-1)
  Modulus of elasticity = 191 *GPa* (27.7 * 10^6 *psi*) (at 400 °F = 204 °C) (Ref. 2, Table TM-1)
  Modulus of elasticity = 184 *GPa* (26.7 * 10^6 *psi*) (at 600 °F = 316 °C) (Ref. 2, Table TM-1)

SA-240 S30400 (304 SS, see Assumption 3.5) (21-PWR Fuel):

- Yield strength = 207 *MPa* (38 *ksi*) (at room temperature) (Ref. 2, Table Y-1)
  Yield strength = 143 *MPa* (32.5 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table Y-1)
  Yield strength = 127 *MPa* (29.1 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table Y-1)

- Tensile strength = 517 *MPa* (70 *ksi*) (at room temperature) (Ref. 2, Table U)
  Tensile strength = 441 *MPa* (70 *ksi*) (at 400 °F = 204 °C) (Ref. 2, Table U)
  Tensile strength = 437 *MPa* (70 *ksi*) (at 600 °F = 316 °C) (Ref. 2, Table U)

- Elongation = 0.40 (at room temperature) (Ref. 2, SA-240 Table 2)

- Poisson's ratio = 0.290 (at room temperature) (Ref. 10, Figure 15, p. 755)

- Modulus of elasticity = 195 *GPa* (29.5 * 10^6 *psi*) (at room temperature) (Ref. 2, Table TM-1)
  Modulus of elasticity = 183 *GPa* (27.7 * 10^6 *psi*) (at 400 °F = 204 °C) (Ref. 2, Table TM-1)
  Modulus of elasticity = 174 *GPa* (26.7 * 10^6 *psi*) (at 600 °F = 316 °C) (Ref. 2, Table TM-1)

5.2.1 Calculations for Elevated-Temperature Material Properties

The values for elongation at elevated temperatures are not listed in conventional listings such as American Society for Testing and Materials (ASTM) Standards or American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. However, the elongation values at elevated temperatures are available from vendor data. This vendor data will be used to estimate elevated temperature elongation normalized to the room temperature values from accepted codes (see Assumption 3.6).

For Alloy 22, the vendor data shows a 13% increase between 600 °F and room temperature (Ref. 6).

Therefore the elongation values for Alloy 22 at elevated temperatures will be as follows:

Elongation $_{600\,°F}$ = 0.45 * 1.13 = 0.51

For SS 316, the vendor data shows a 30% decrease between 600 °F and room temperature (Ref. 14).

Therefore the elongation values for SS 316 at elevated temperatures will be as follows:

Elongation $_{600\,°F}$ = 0.40 * (1 – 0.30) = 0.28

Since the components made of SA-516 will not be analyzed for stresses, its elongation is not needed at elevated temperatures. The SA-516 components are only needed for their density.

5.2.2 Calculations for True Measures of Ductility

The material properties in Sections 5.2 and 5.2.1 refer to engineering stress and strain definitions:

$$s = \frac{P}{A_0} \text{ and } e = \frac{L - L_0}{L_0} \qquad \text{(Ref. 4)}$$

Where P stands for the force applied during static tensile test, L is the deformed-specimen length, and L_0 and A_0 are original length and cross-sectional area of specimen, respectively. It is generally accepted that the engineering stress-strain curve does not give a true indication of the deformation characteristics of a material during the plastic deformation since it is based entirely on the original dimensions of the specimen. Therefore, the LS-DYNA V950.C finite element code requires input in terms of true stress and strain definitions:

$$\sigma = \frac{P}{A} \text{ and } \varepsilon = \ln\left(\frac{L}{L_0}\right) \qquad \text{(Ref. 4)}$$

The relationships between the true stress and strain definitions and engineering stress and strain definitions can be readily derived based on constancy of volume ($A_O*L_O = A*L$) and strain homogeneity during plastic deformation:

$$\sigma = s * (1 + e) \text{ and } \varepsilon = \ln(1 + e) \qquad \text{(Ref. 4)}$$

These expressions are applicable only in the hardening region of stress-strain curve that is limited by the onset of necking.

The following parameters are used in the subsequent calculations:

$s_y \approx \sigma_y \equiv$ yield strength

$s_u \equiv$ engineering tensile strength

$\sigma_u \equiv$ true tensile strength

$e_y \approx \varepsilon_y \equiv$ strain corresponding to yield strength

$e_u \equiv$ engineering strain corresponding to tensile strength (engineering uniform strain)

$\varepsilon_u \equiv$ true strain corresponding to tensile strength (true uniform strain)

In absence of the uniform strain data in available literature, it needs to be estimated based on stress-strains curves and elongation (strain corresponding to rupture of the tensile specimen).

The stress-strain curves for Alloy 22, 316 SS and 316NG SS do not manifest three-stage deformation character (Ref. 9). Therefore, the elongation, reduced by 10% for the sake of conservativism, can be used in place of uniform strain (Assumption 3.8).

In the case of Alloy 22 ($e_u = 0.9 * elongation = 0.41$ at room temperature), the true measures of ductility are

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.41) = 0.34$

$\sigma_u = s_u * (1 + e_u) = 690 * (1 + 0.41) = 973\ MPa.$

<u>400 °F (204 °C) Alloy 22</u>

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.41) = 0.34$

$\sigma_u = s_u * (1 + e_u) = 657 * (1 + 0.41) = 926\ MPa$

<u>600 °F (316 °C) Alloy 22</u>

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.41) = 0.34$ (ASME values)

$\sigma_u = s_u * (1 + e_u) = 628 * (1 + 0.41) = 885\ MPa$ (ASME values)

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.45) = 0.37$ (vendor data)

$\sigma_u = s_u * (1 + e_u) = 628 * (1 + 0.45) = 911\ MPa$ (vendor data)

For 316NG SS at room temperature, $e_u = 0.9 * elongation = 0.36$, therefore:

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.36) = 0.31$

$\sigma_u = s_u * (1 + e_u) = 517 * (1 + 0.36) = 703\ MPa$

<u>400 °F (204 °C) SS 316NG</u>

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.36) = 0.31$

$\sigma_u = s_u * (1 + e_u) = 496 * (1 + 0.36) = 675\ MPa$

<u>600 °F (316 °C) SS 316NG</u>

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.36) = 0.31$ (ASME values)

$\sigma_u = s_u * (1 + e_u) = 495 * (1 + 0.36) = 673\ MPa$ (ASME values)

<u>600 °F (316 °C) SS 316NG</u>(cont'd)

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.25) = 0.22$ (vendor data)

$\sigma_u = s_u * (1 + e_u) = 495 * (1 + 0.25) = 619\ MPa$ (vendor data)

For 516 CS at room temperature, $e_u = 0.5 * elongation = 0.11$, therefore:

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.11) = 0.10$

$\sigma_u = s_u * (1 + e_u) = 483 * (1 + 0.11) = 536\ MPa$

<u>400 °F (204 °C) 516 CS</u>

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.11) = 0.10$

$\sigma_u = s_u * (1 + e_u) = 483 * (1 + 0.11) = 536\ MPa$

<u>600 °F (316 °C) 516 CS</u>

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.11) = 0.10$

$\sigma_u = s_u * (1 + e_u) = 483 * (1 + 0.11) = 536\ MPa$

For 304 SS at room temperature, $e_u = 0.75 * elongation = 0.30$, therefore:

$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.30) = 0.26$
$\sigma_u = s_u * (1 + e_u) = 517 * (1 + 0.30) = 672\ MPa$

400 °F (204 °C) 304 SS
$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.30) = 0.26$
$\sigma_u = s_u * (1 + e_u) = 441 * (1 + 0.30) = 573\ MPa$

600 °F (316 °C) 304 SS
$\varepsilon_u = \ln(1 + e_u) = \ln(1 + 0.30) = 0.26$
$\sigma_u = s_u * (1 + e_u) = 437 * (1 + 0.30) = 568\ MPa$

5.2.3 Calculations for Tangent Moduli

As previously discussed, the results of this simulation are required to include elastic and plastic deformations for Alloy 22, 516 CS, and 316NG SS. When the materials are driven into the plastic range, the slope of stress-strain curve continuously changes. Thus, a simplification for this curve is needed to incorporate plasticity into the FER. A standard approximation commonly used in engineering is to use a straight line that connects the yield point and the tensile strength point of the material. The parameters used in the subsequent calculations in addition to those defined in Section 5.2.2 are modulus of elasticity (E) and tangent modulus (E_1). The tangent (hardening) modulus represents the slope of the stress-strain curve in the plastic region. In the case of Alloy 22, the strain corresponding to the yield strength is:

$\varepsilon_{y,rt} = \sigma_y/E = 310 * 10^6 / 206 * 10^9 = 0.0015$ (see Section 5.2.1)

Hence, the tangent modulus at room temperature is:

$E_{1,rt} = (\sigma_{u,rt} - \sigma_{y,rt}) / (\varepsilon_{u,rt} - \varepsilon_{y,rt}) = (0.973 - 0.310)/(0.34 - 0.0015) = 2.0\ GPa$ (see Section 5.2, 5.2.1, and 5.2.2)

For Alloy 22 at 400 °F (204 °C)
$E_{1,400°F} = (\sigma_{u,400°F} - \sigma_{y,400°F}) / (\varepsilon_{u,400°F} - \sigma_{y,400°F}/E_{400°F}) = (0.926 - 0.236)/(0.34 - 236/196e3) = 2.0\ GPa$ (see Section 5.2, 5.2.1, and 5.2.2)

For Alloy 22 at 600 °F (316 °C, ASME values)
$E_{1,600°F} = (\sigma_{u,600°F} - \sigma_{y,600°F}) / (\varepsilon_{u,600°F} - \sigma_{y,600°F}/E_{600°F}) = (0.885 - 0.211)/(0.34 - 211/190e3) = 2.0\ GPa$ (see Section 5.2, 5.2.1, and 5.2.2)

For Alloy 22 at 600 °F (316 °C, vendor data)
$E_{1,600°F} = (\sigma_{u,600°F} - \sigma_{y,600°F}) / (\varepsilon_{u,600°F} - \sigma_{y,600°F}/E_{600°F}) = (0.911 - 0.211)/(0.37 - 211/190e3) = 1.9\ GPa$ (see Section 5.2, 5.2.1, and 5.2.2)

Similarly, for 316NG SS at room temperature:
$E_{t,rt} = (\sigma_{u,rt} - \sigma_{y,rt}) / (\varepsilon_{u,rt} - \sigma_{y,rt}/E_{rt})$ = (0.703 – 0.207)/(0.31 – 207/195e3) = 1.6 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

For 316NG SS at 400 °F (204 °C)
$E_{t,400°F} = (\sigma_{u,400°F} - \sigma_{y,400°F}) / (\varepsilon_{u,400°F} - \sigma_{y,400°F}/E_{400°F})$ = (0.675 – 0.148)/(0.31 – 148/183e3) = 1.7 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

For 316NG SS at 600 °F (316 °C, ASME values)
$E_{t,600°F} = (\sigma_{u,600°F} - \sigma_{y,600°F}) / (\varepsilon_{u,600°F} - \sigma_{y,600°F}/E_{600°F})$ = (0.673 – 0.130)/(0.31 – 130/174e3) = 1.8 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

For 316NG SS at 600 °F (316 °C, vendor data)
$E_{t,600°F} = (\sigma_{u,600°F} - \sigma_{y,600°F}) / (\varepsilon_{u,600°F} - \sigma_{y,600°F}/E_{600°F})$ = (0.619 – 0.130)/(0.22 – 130/174e3) = 2.2 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

Tangent Modulus of 516 CS at room temperature:

$E_{t,rt} = (\sigma_{u,rt} - \sigma_{y,rt}) / (\varepsilon_{u,rt} - \sigma_{y,rt}/E_{rt})$ = (0.536 – 0.262)/(0.10 – 262/203e3) = 2.8 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

516 CS at 400 °F (204 °C)
$E_{t,400°F} = (\sigma_{u,400°F} - \sigma_{y,400°F}) / (\varepsilon_{u,400°F} - \sigma_{y,400°F}/E_{400°F})$ = (0.536 – 0.224)/(0.10 – 224/191e3) = 3.2 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

516 CS at 600 °F (316 °C)
$E_{t,600°F} = (\sigma_{u,600°F} - \sigma_{y,600°F}) / (\varepsilon_{u,600°F} - \sigma_{y,600°F}/E_{600°F})$ = (0.536 – 0.201)/(0.10 – 201/184e3) = 3.4 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

Tangent Modulus of 304 SS at room temperature:

$E_{t,rt} = (\sigma_{u,rt} - \sigma_{y,rt}) / (\varepsilon_{u,rt} - \sigma_{y,rt}/E_{rt})$ = (0.672 – 0.207)/(0.26 – 207/195e3) = 1.8 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

304 SS at 400 °F (204 °C)
$E_{t,400°F} = (\sigma_{u,400°F} - \sigma_{y,400°F}) / (\varepsilon_{u,400°F} - \sigma_{y,400°F}/E_{400°F})$ = (0.573 – 0.143)/(0.26 – 143/183e3) = 1.7 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

304 SS at 600 °F (316 °C)
$E_{t,600°F} = (\sigma_{u,600°F} - \sigma_{y,600°F}) / (\varepsilon_{u,600°F} - \sigma_{y,600°F}/E_{600°F})$ = (0.568 – 0.127)/(0.26 – 127/174e3) = 1.7 *GPa* (see Section 5.2, 5.2.1, and 5.2.2)

5.3 INITIAL VELOCITY OF WASTE PACKAGE

To reduce the computer execution time while preserving all features of the problem relevant to the structural calculation, the WP is set in a position just before impact and given an appropriate initial velocity.

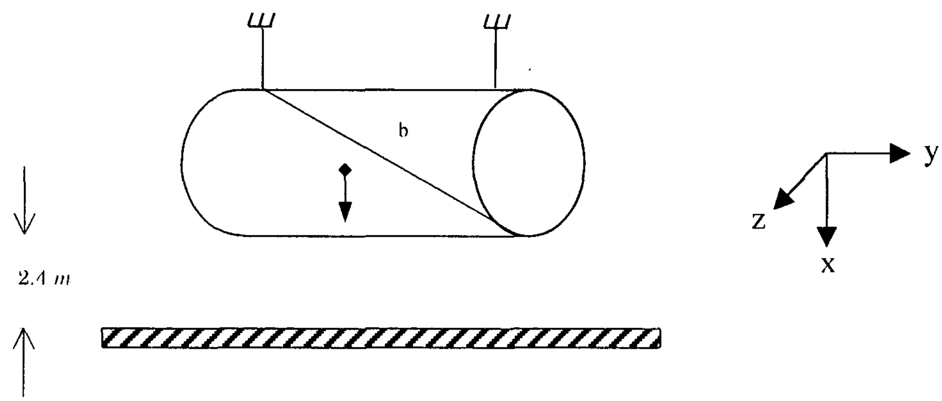

Figure 1. Swing-Down Initial Geometry

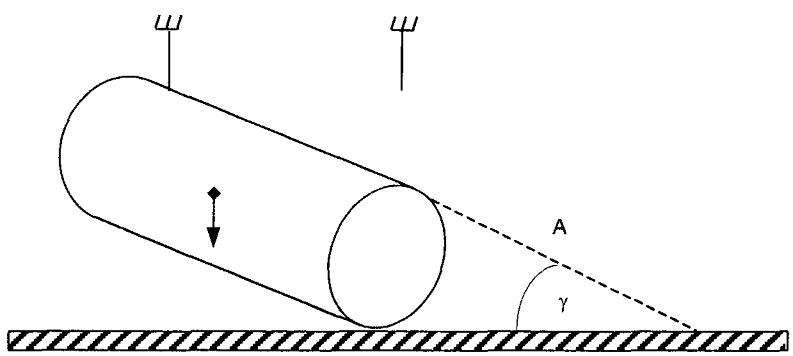

Figure 2. Geometry After Swing-Down

Using the following parameters:

g ≡ acceleration due to gravity = 9.81 m/s^2
S ≡ Drop Height = 2.4 *m* (Ref. 1)
b ≡ Distance between Trunnion and Corner of WP
$b = (1.654^2 + (5.129-.1725)^2)^{0.5} = 5.225\ m$

θ_1 ≡ Angle between b and top horizontal of WP
$\tan\theta_1 \equiv {}^{\text{opposite}}/_{\text{adjacent}} = {}^{1.654}/_{(5.129 - 0.1725)} = {}^{1.654}/_{4.957}$
$\therefore \theta_1 = 18.45°$

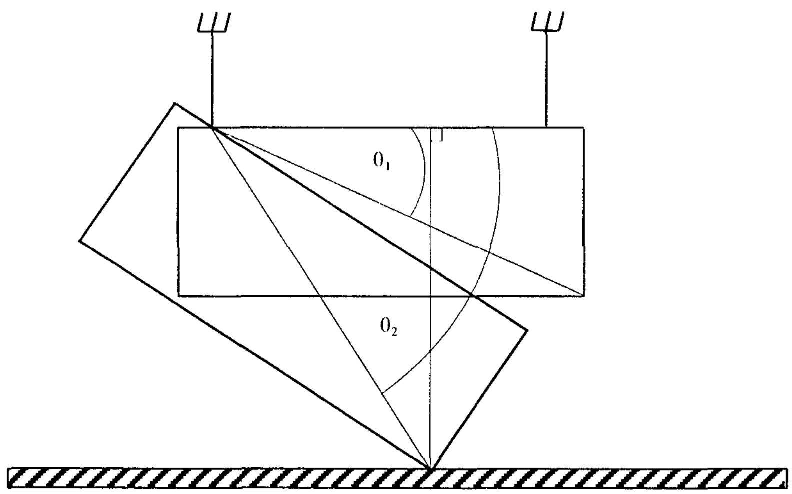

Figure 3. Overlaid Geometry

$\theta_2 \equiv$ Angle between b after swing-down and original top horizontal of WP
$\sin\theta_2 \equiv {}^{\text{opposite}}/_{\text{hypotenuse}} = {}^{4.054}/_{5.225}$
$\therefore \theta_2 = 50.89°$

$\gamma = \theta_2 - \theta_1 = 50.89° - 18.45° = 32.44°$
$\tan 32.44° = {}^{1.654}/_{A}$ (A from Figure 2)
$A = 2.602\ m$, ${}^{A}/_{2} = 1.301\ m$
${}^{\text{Length of WP}}/_{2} + {}^{A}/_{2} = 3.866\ m$

The final height of the center of mass over the surface is equal to
$\sin 32.44° = {}^{\text{opposite}}/_{\text{hypotenuse}}$
$3.866 * \sin 32.44° = \text{opposite}$
opposite = $2.074\ m$

The total change in height of the center of mass of the WP is equal to
$\Delta h = (2.4 + {}^{1.654}/_{2}) - 2.074 = 1.153\ m$
The initial angular velocity may be calculated using the energy method:
$mg\Delta h = \frac{1}{2} I_o \omega^2$

The rotary inertia (I) of a solid cylinder (Assumption 5.10) is known to equal to
$I_o = {}^{m}/_{48}(3d^2 + 4l^2)$
$I_o = {}^{41{,}598\ kg}/_{48}\ (3*(1.654\ m)^2 + 4*(5.129\ m)^2) = 98{,}304\ kg\text{-}m^2$

I_o is about the centroid of the WP, which is in the center of the WP. The parallel axis theorem may be used to find the rotary moment of inertia about the corner of the WP.

$I_1 = I_0 + Mc^2$
$c = ((^{\text{length of WP}}/_2)^2 + (^{\text{Diameter of WP}}/_2)^2)^{0.5} = (2.565^2 + 0.827^2)^{0.5} = 2.695\ m$
$I_1 = 98{,}304\ kg\text{-}m^2 + (41{,}598\ kg)*(2.695\ m)^2 = 400{,}431\ kg\text{-}m^2$

Now the initial angular velocity may be found.

$mg\Delta h = ½ I_1 \omega^2$
$(41{,}598\ kg)*(9.81\ m/s^2)*(1.153\ m) = ½(400{,}431\ kg\text{-}m^2)*\omega^2$
$\omega^2 = 2.35\ rad/s^2$
$\omega = 1.53\ rad/s$

5.4 FINITE ELEMENT REPRESENTATION

A full three-dimensional (3-D) FER of the WP was developed in ANSYS V5.4 using the dimensions provided in Attachment I. The internal structure of the WP was simplified. The internal components of the Inner Shell (thermal shunts, side guides, spent nuclear fuel, etc.) were represented using solid elements (Assumption 3.5). This significantly lowered the number of contacts within the FER while still maintaining the proper mass needed for the computer run. However, the sideguides and stiffeners between the spent nuclear fuel and the IS were accurately modeled using shell elements to accurately model the contacts in this region.

The target surface was conservatively assumed to be unyielding (Assumption 3.7). This was accomplished using the *RIGIDWALL command within LS-DYNA. This command creates an invisible rigid wall within LS-DYNA. All nodes are slaves to the RIGIDWALL, and the RIGIDWALL is immovable.

The mesh of the FER was appropriately generated and refined in the contact region according to standard engineering practice. Thus, the accuracy of the results of this calculation is deemed acceptable.

The initial drop height of the WP was reduced to 0.01 m before impact and the WP was given an initial angular velocity equal to 1.55 *rad/s*, which is conservative (see Section 5.3).

The FER was then used in LS-DYNA V950.C to perform the transient dynamic analysis for the 21-PWR Waste Package swing-down.

6. RESULTS

This document may be affected by technical product input information that requires confirmation. Any changes to the document that may occur as a result of completing the confirmation activities will be reflected in subsequent revisions. The status of the technical product input information quality may be confirmed by review of the DIRS database.

Attachment II includes the input files and results files that show execution of the programs occurred correctly. The stresses were reported via plots that have been made interactively using the postprocessor LSPOST. The stresses were recorded every 0.002 seconds after impact. The stresses in all components peaked between 0.002 and 0.030 seconds. However, the solution was allowed to reach 0.038 seconds to ensure that all stresses had climaxed.

The results file, d3hsp (Attachment II), lists the calculated masses used by LS-DYNA. The sum of the masses of the WP equals 42,550 *kg*, with the mass of the loaded WP 41,598 *kg* from Section 5.1. The percent difference in mass would then be ~ 2.3%. However, this difference is on the positive side, and thus considered to be conservative and negligible.

The following pages contain figures that show various parts at states of maximum stress. These start on the next page with Figure 4, which shows the maximum shear stress in the inner shell at room temperature.

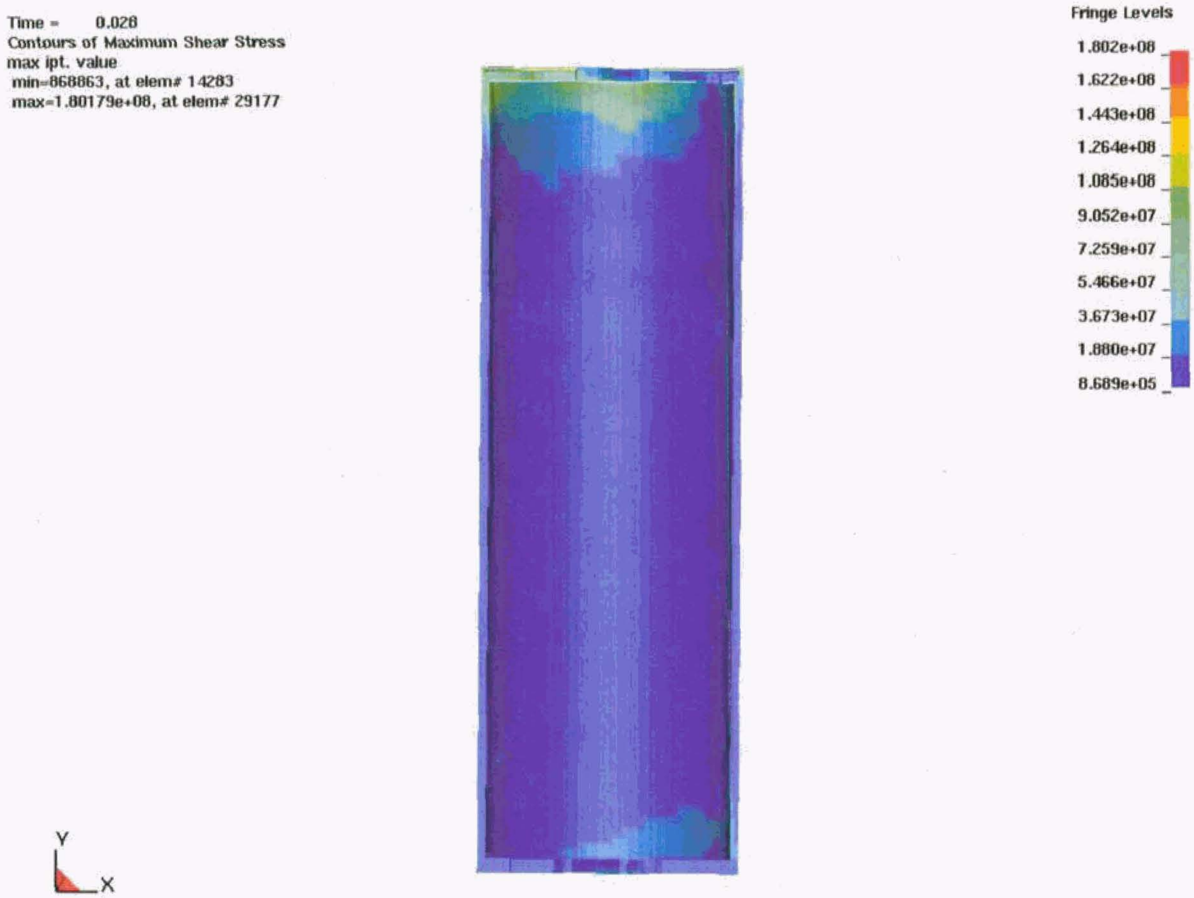

Figure 4. Inner Shell Stresses at Room Temperature

All of the stresses that are reported in the legends of the plots are Tresca Stresses or Maximum Shear Stresses. The units are Pascals. Figure 4 shows that the maximum stress intensity in inner shell is 360 MPa at 0.028 seconds.

Figure 5 may be found on the next page. It shows the maximum stress intensity in the same part, but at 400 degrees Fahrenheit.

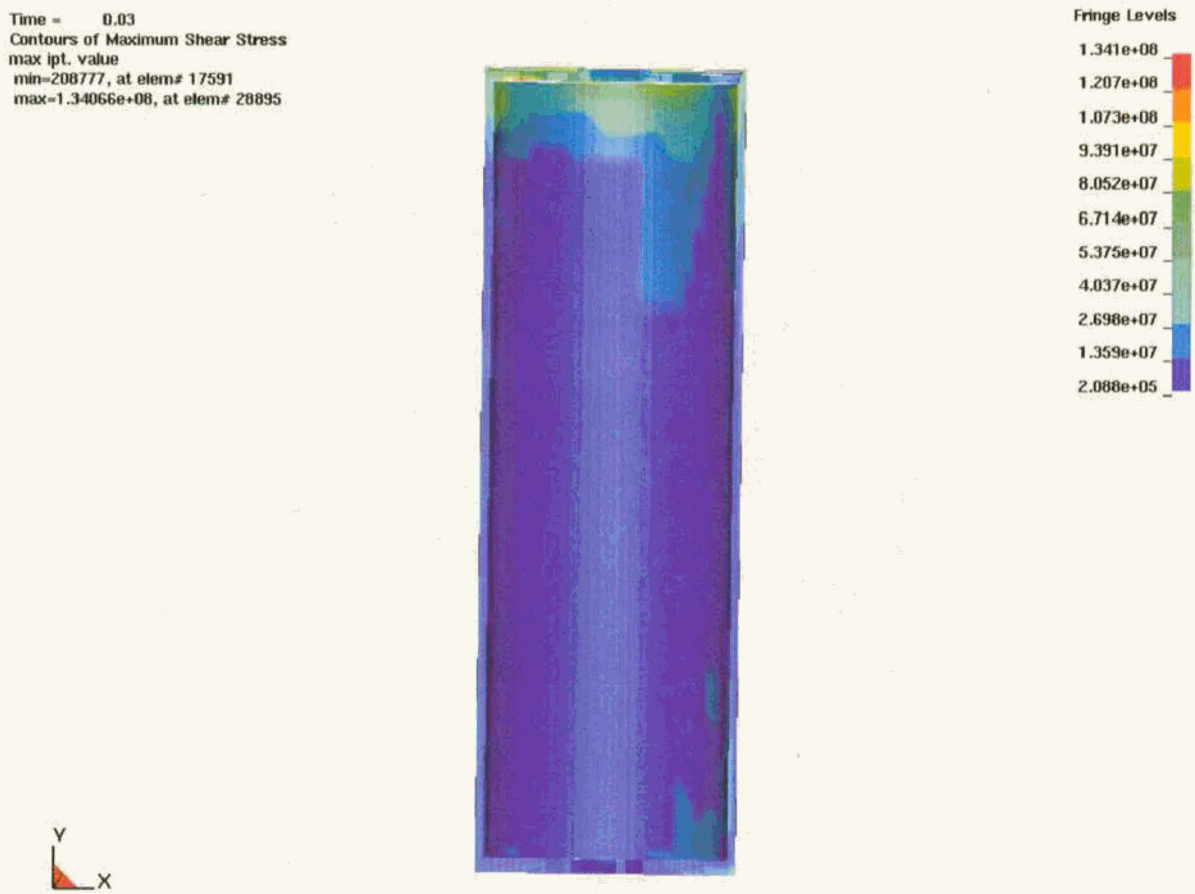

Figure 5. Inner Shell Stresses at 400 °F

Figure 5 shows that the maximum stress intensity in the inner shell is 268 MPa at 0.030 seconds. This is slightly lower than the room temperature value, which is to be expected.

Figure 6 may be found on the next page. It shows the maximum stress intensity in the same part, but at 600 degrees Fahrenheit.

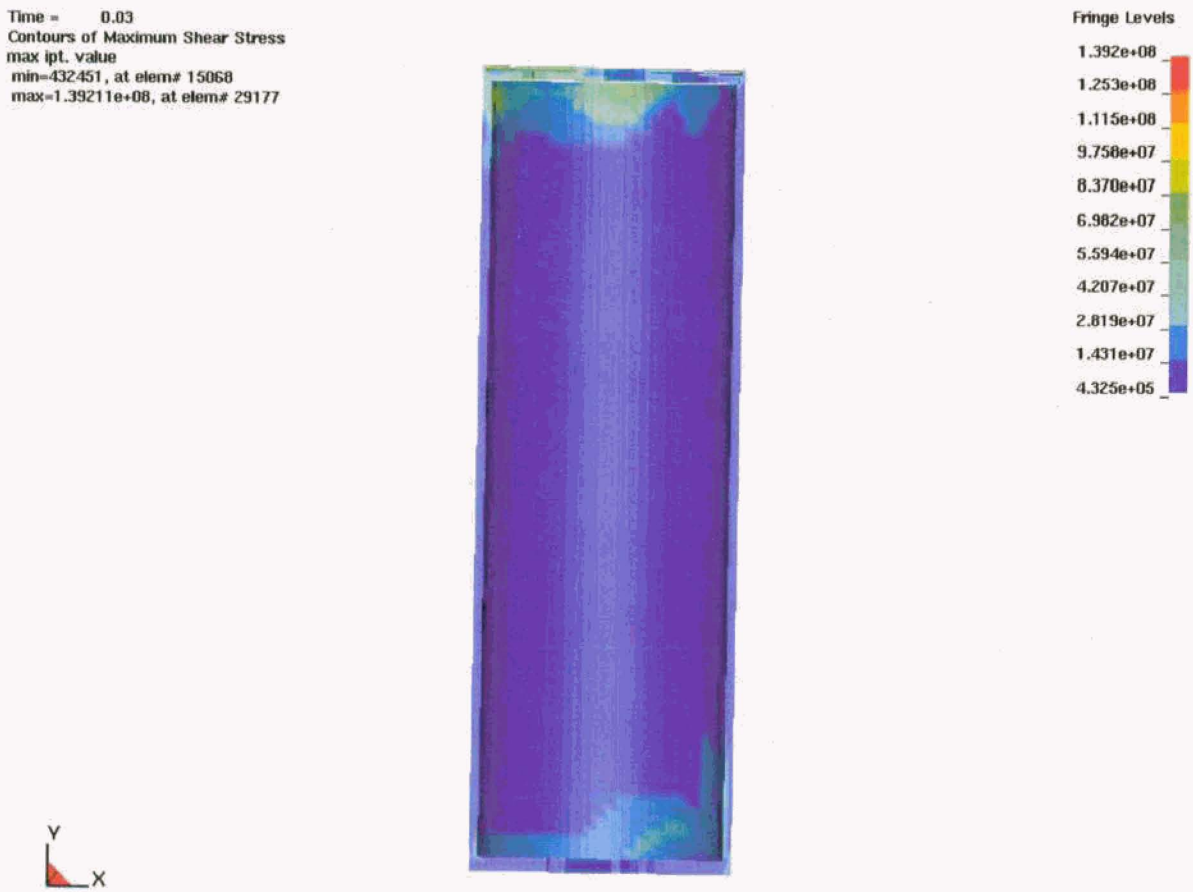

Figure 6. Inner Shell Stresses at 600 °F

Figure 6 shows that the maximum stress intensity in the inner shell is 278 MPa at 0.030 seconds. This is slightly higher than the 400 °F value.

Figure 7 may be found on the next page. It shows the maximum stress intensity in the inner shell at 600 degrees Fahrenheit using vendor data for elongation values.

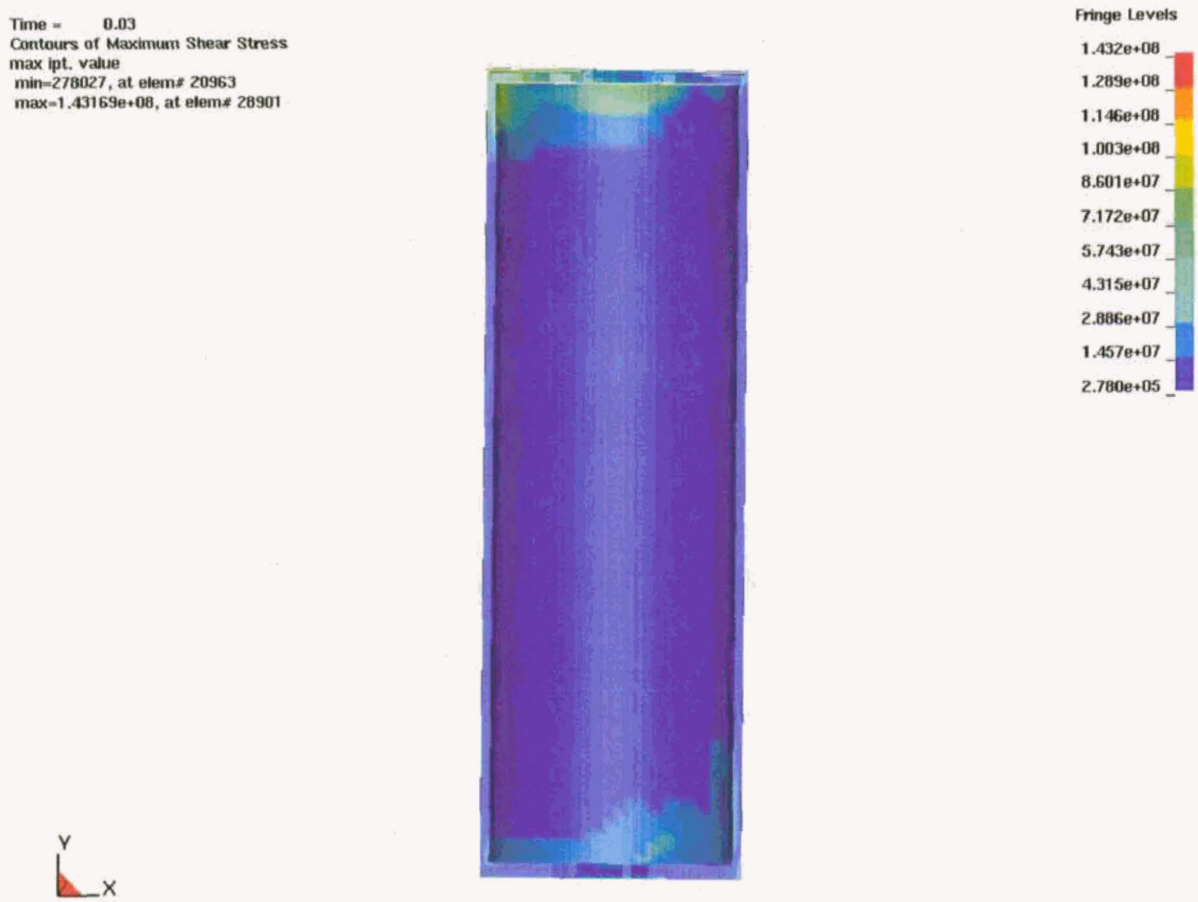

Figure 7. Inner Shell Stresses at 600 °F Using Vendor Elongation

Figure 7 shows that the maximum stress intensity in the inner shell is 286 MPa at 0.030 seconds. This is slightly higher than the 600 °F ASME value, but is to be expected considering the elongation values of 316NG SS at elevated temperatures.

Figure 8 may be found on the next page. It shows the maximum stress intensity in the outer shell at room temperature.

Figure 8. Outer Shell Stresses at Room Temperature

Figure 8 figure shows that the maximum stress intensity in the outer shell is 1,050 MPa at 0.002 seconds.

Figure 9 may be found on the next page. It shows the maximum stress intensity in the same part, but at 400 degrees Fahrenheit.

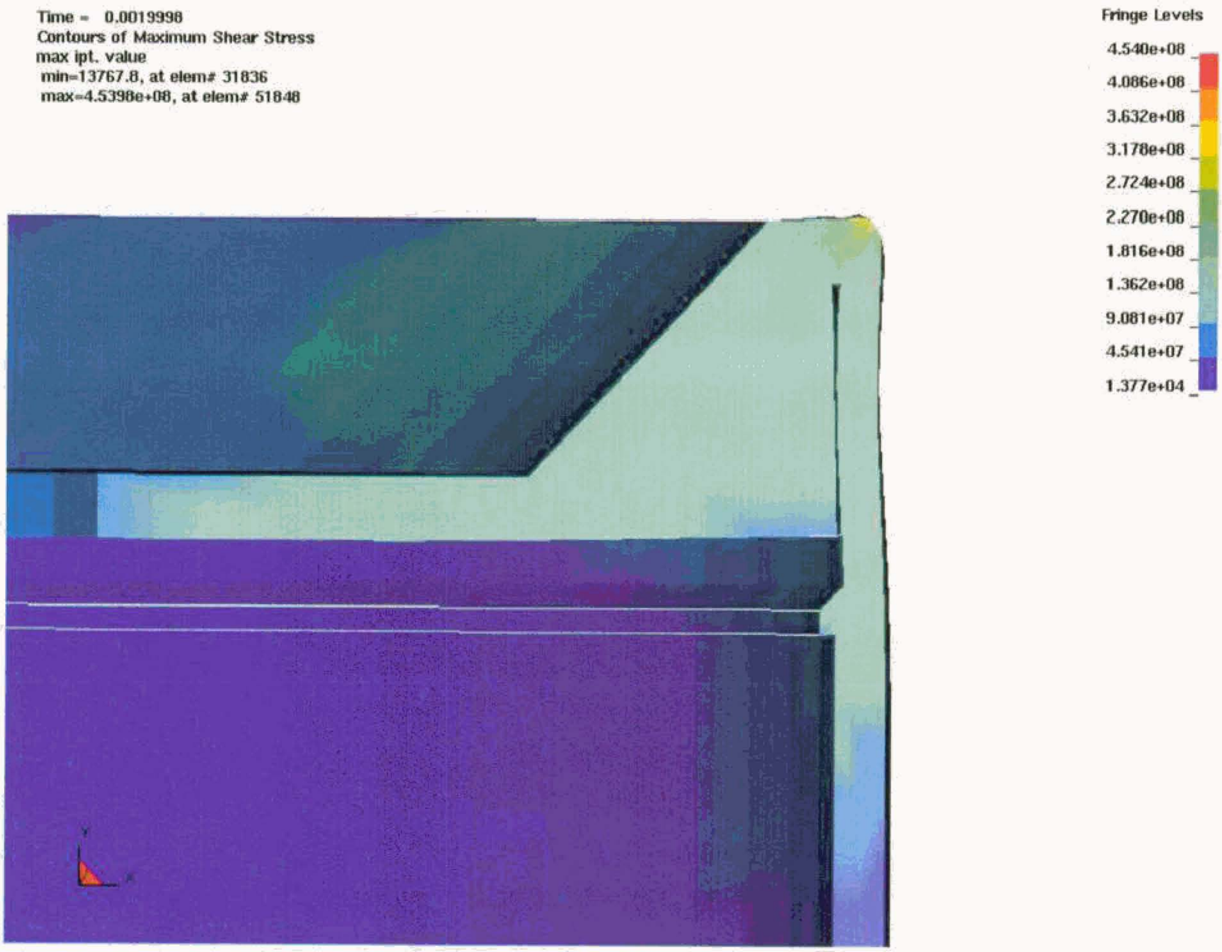

Figure 9. Outer Shell Stresses at 400 °F

Figure 9 shows that the maximum stress intensity in the outer shell is 908 MPa at 0.002 seconds. This is slightly lower than the room temperature value, which is to be expected.

Figure 10 may be found on the next page. It shows the maximum stress intensity in the same part, but at 600 degrees Fahrenheit.

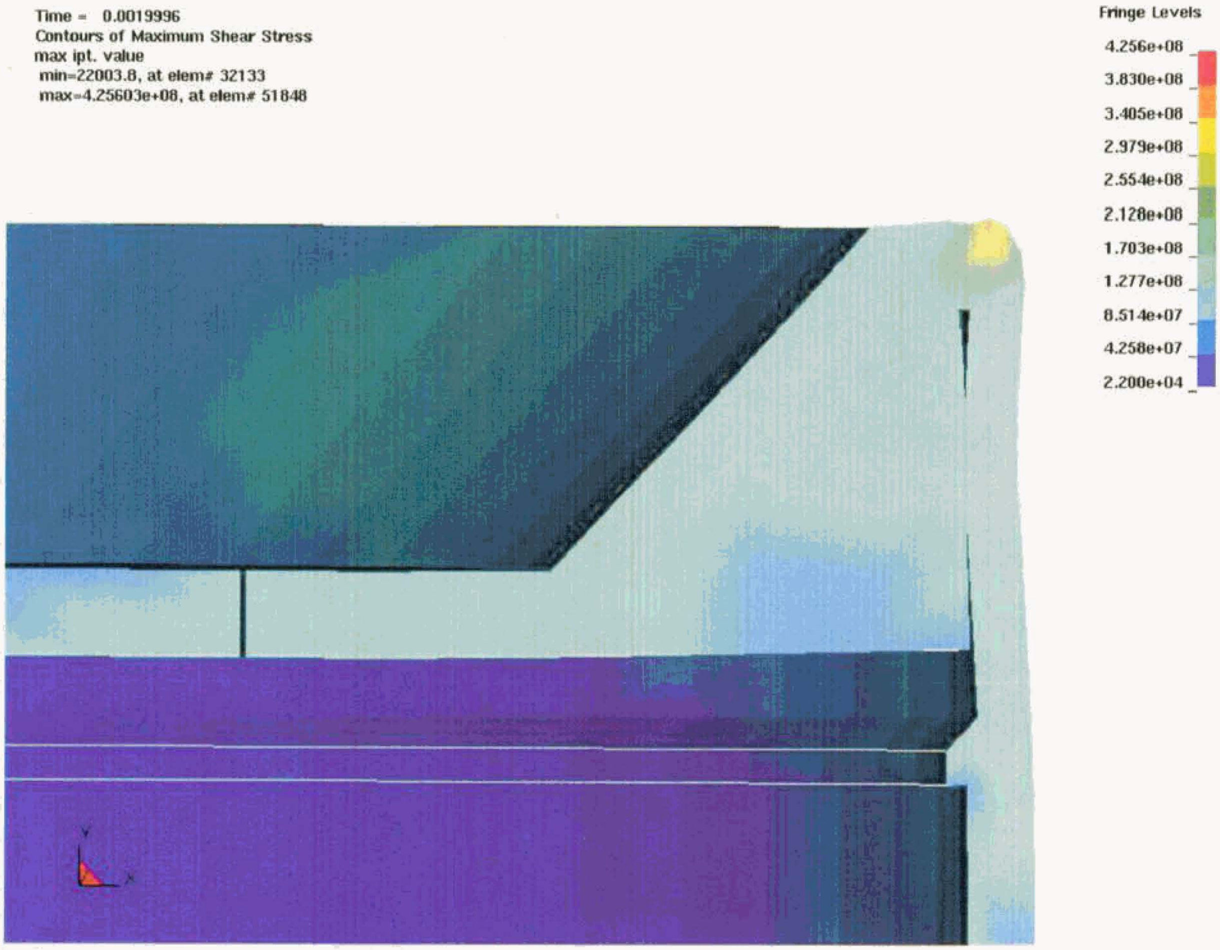

Figure 10. Outer Shell Maximum Stresses at 600 °F

Figure 10 shows that the maximum stress intensity in the outer shell is 851 MPa at 0.002 seconds. This is slightly lower than the 400 °F value, which is to be expected.

Figure 11 may be found on the next page. It shows the maximum stress intensity in the outer shell at 600 degrees Fahrenheit using vendor elongation data.

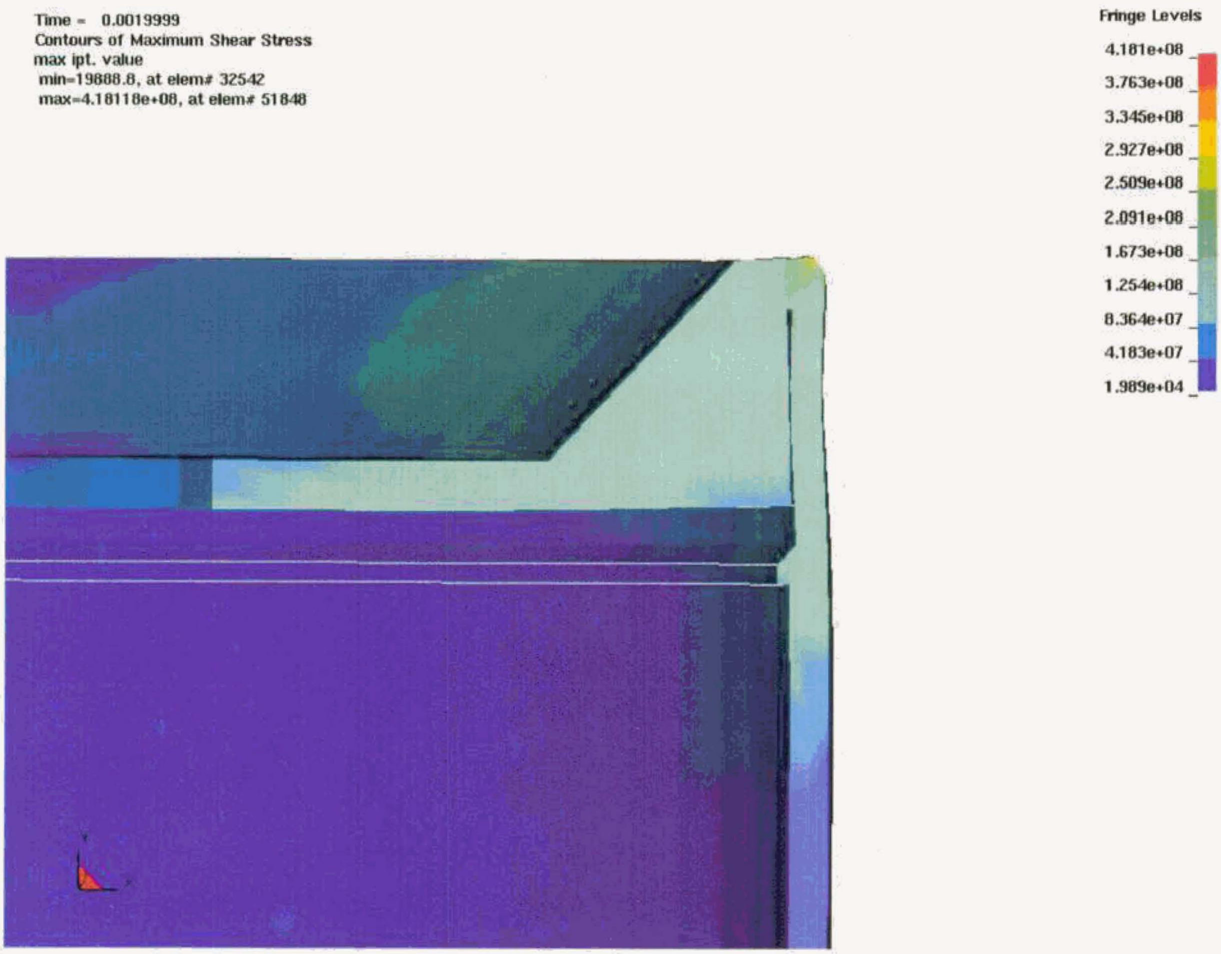

Figure 11. Outer Shell Maximum Stresses at 600 °F Using Vendor Elongation

Figure 11 shows that the maximum stress intensity in the upper trunnion collar is 836 MPa at 0.002 seconds. This is slightly higher than the 600 °F ASME value, which is to be expected due to the elongation values of Alloy 22 at elevated temperatures.

Figure 12 may be found on the next page. It shows the maximum stress intensity in the Shear Ring at room temperature.

Figure 12. Shear Ring Stresses at Room Temperature

Figure 12 shows that the maximum stress intensity in the Shear Ring is 347 MPa at 0.02 seconds.

Figure 13 may be found on the next page. It shows the maximum stress in the same part, but at 400 degrees Fahrenheit.

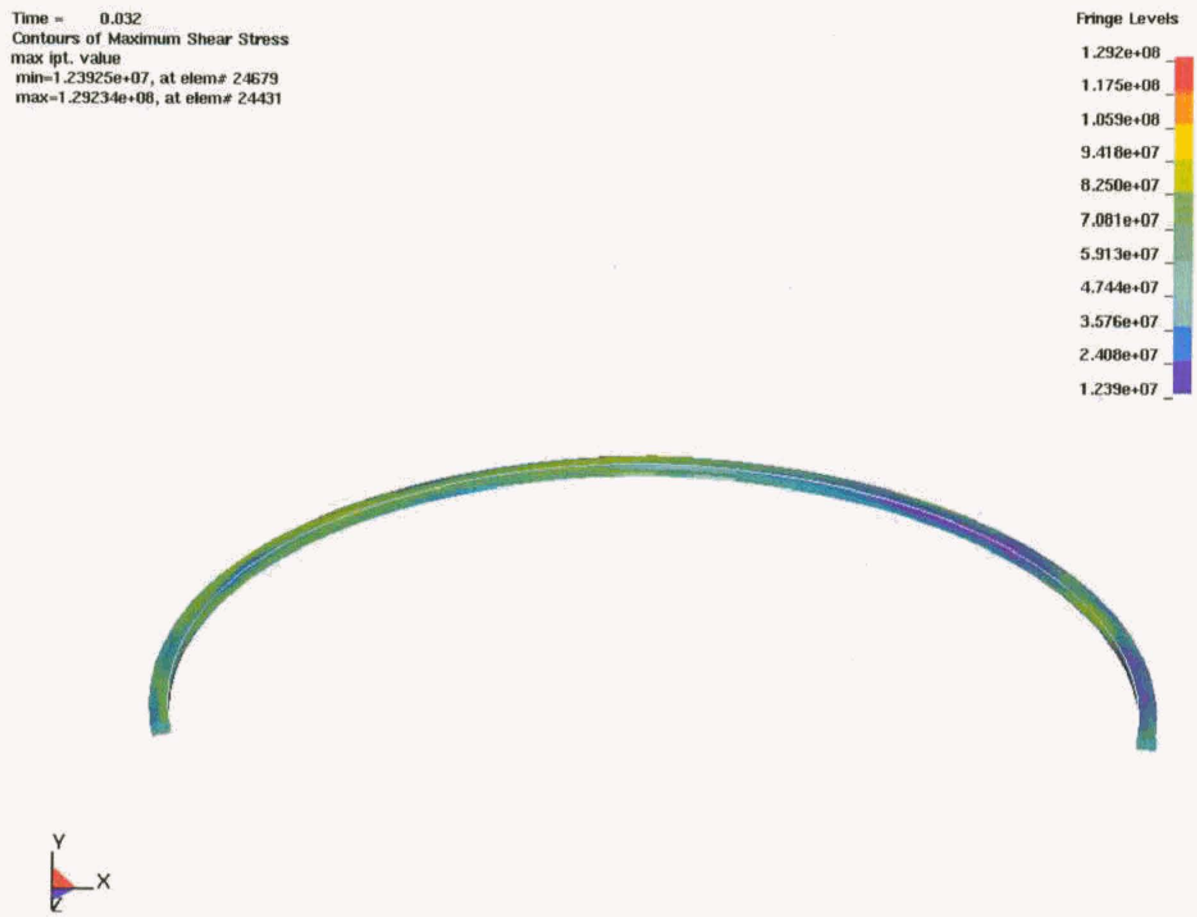

Figure 13. Shear Ring Stresses at 400 °F

Figure 13 shows that the maximum stress intensity in the Shear Ring is 258 MPa at 0.032 seconds. This is lower than the room temperature value.

Figure 14 may be found on the next page. It shows the maximum stress in the same part, but at 600 degrees Fahrenheit.

Figure 14. Shear Ring Stresses at 600 °F

Figure 14 shows that the maximum stress intensity in the Shear Ring is 264 MPa at 0.032 seconds. This is slightly higher than the 400 °F value.

Figure 15 may be found on the next page. It shows the maximum stress in the same part at 600 degrees Fahrenheit, but using vendor elongation data.

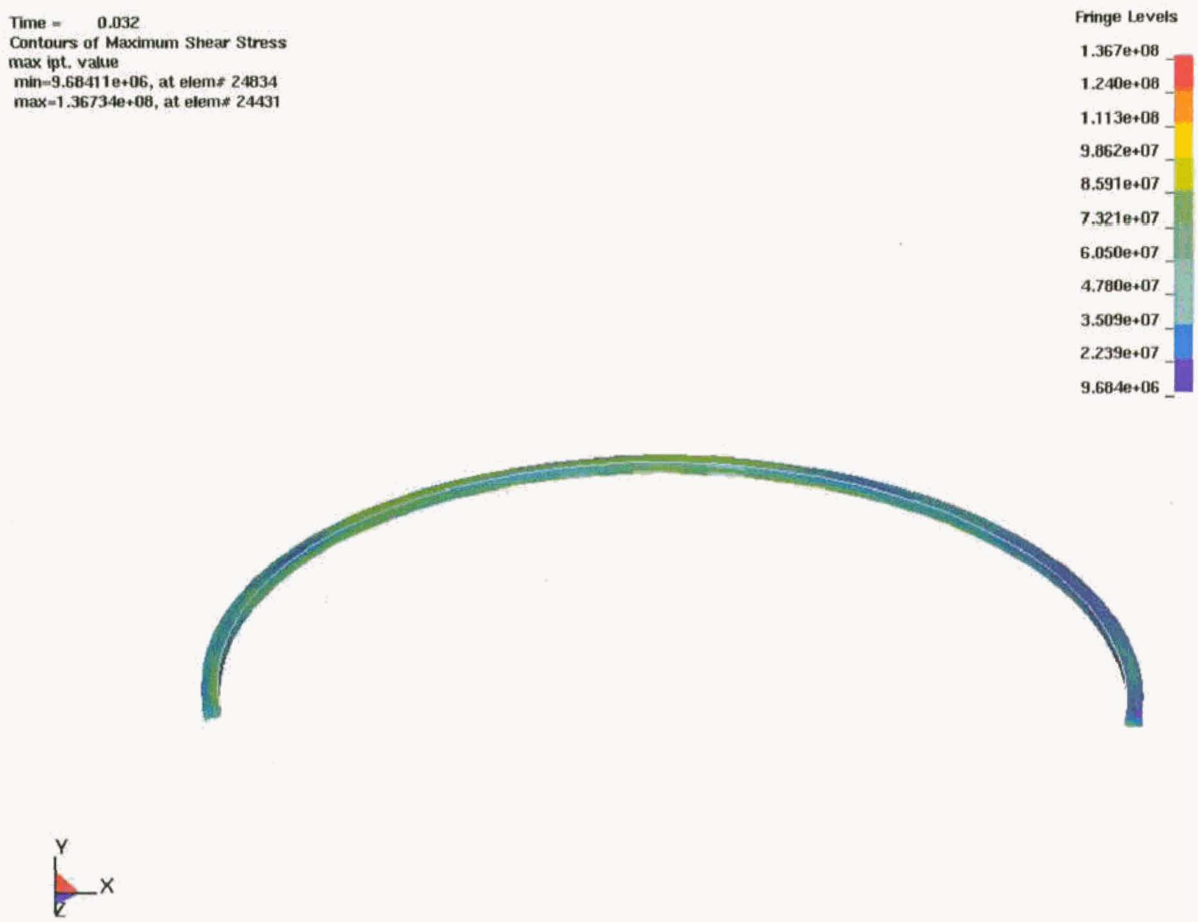

Figure 15. Shear Ring Stresses at 600 °F Using Vendor Elongation

Figure 15 shows that the maximum stress intensity in the Shear Ring is 273 MPa at 0.032 seconds. This is slightly higher than the 600 °F ASME value, which is to be expected due to 316NG SS elongation properties at elevated temperatures.

Table 6-1 provides a list maximum Stress Intensities sorted by Part, Temperature, and Elongation Value per Load Case.

Table 6-1. Maximum Stress Intensity by Load Case

Part	Temperature	Elongation Value	Max Stress Intensity	S_{int} / $S_{allowable}$
Inner Shell	70 °F	ASME	360 MPa	0.568
Outer Shell	70 °F	ASME	1,050 MPa	1.20
Shear Ring	70 °F	ASME	347 MPa	0.548
Inner Shell	400 °F	ASME	268 MPa	0.441
Outer Shell	400 °F	ASME	908 MPa	1.09
Shear Ring	400 °F	ASME	258 MPa	0.424
Inner Shell	600 °F	ASME	278 MPa	0.459
Outer Shell	600 °F	ASME	851 MPa	1.07
Shear Ring	600 °F	ASME	264 MPa	0.436
Inner Shell	600 °F	ASME - 30%	286 MPa	0.513
Outer Shell	600 °F	ASME + 10%	836 MPa	1.02
Shear Ring	600 °F	ASME - 30%	273 MPa	0.490

Note: $S_{allowable}$ is equal to 90% of σ_u.

Even though Table 6-1 shows that the Outer Shell has a ratio of $S_{int}/S_{allowable}$ equal to 1.20, this does not mean that the OS fails completely through the thickness. Figure 16 on the next page shows a plot of the Max Shear Stress in the elements through the thickness of the OS where the maximum stress occurs. If the ratio of $S_{int}/S_{allowable}$ does not exceed 1, then the OS does not fail completely through the thickness.

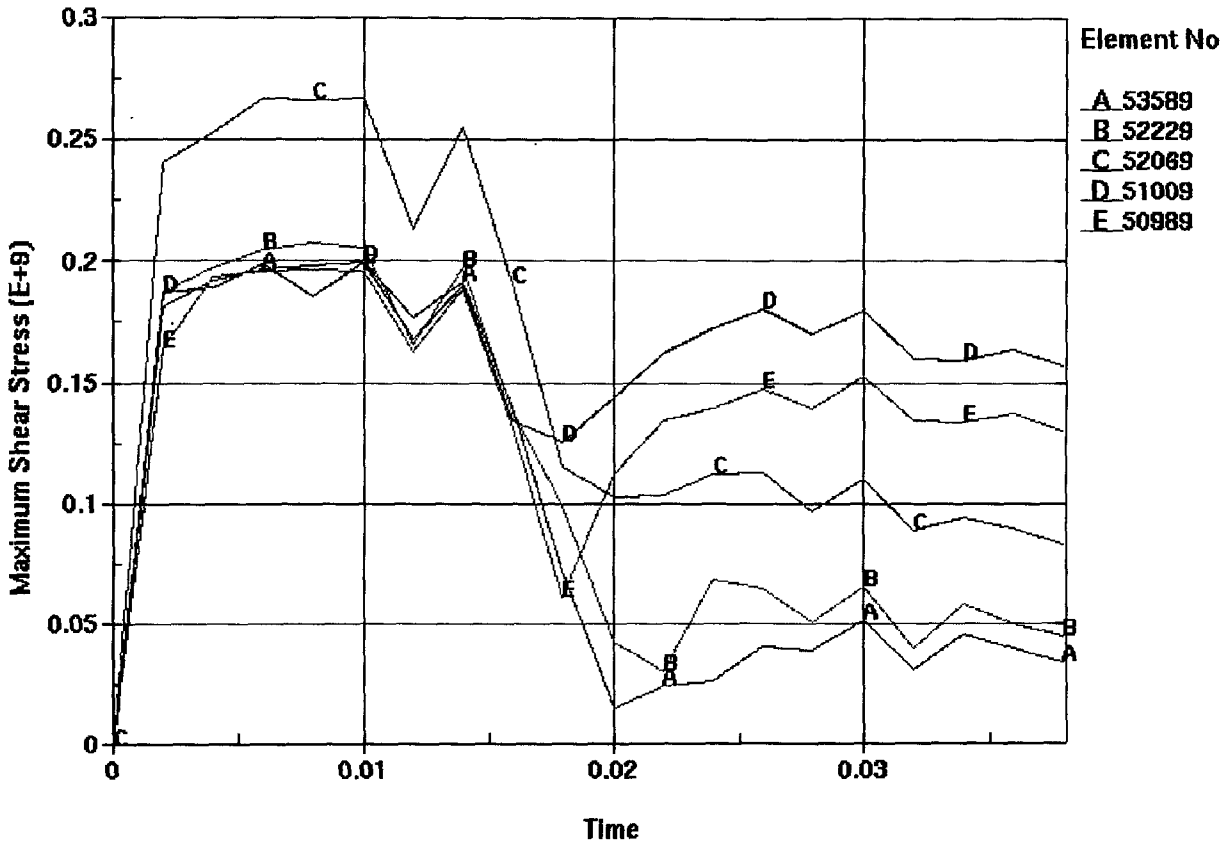

Figure 16. Max Shear Stress of Elements Surrounding Peak, Temp. 1

Figure 16 shows that element 52069 has a Maximum Shear Stress of approximately 270 MPa, which is equal to a Stress Intensity of 540 MPa. The ratio of $S_{int}/S_{allowable}$ is equal to 0.616, which is less than unity. Room temperature was the worst case for the OS. Therefore, the other temperature cases do not need to be investigated.

7. REFERENCES

1. CRWMS M&O 2000. *Uncanistered Spent Nuclear Fuel Disposal Container System Description Document.* SDD-UDC-SE-000001 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000822.0004.

2. ASME (American Society of Mechanical Engineers) 1998. *1998 ASME Boiler and Pressure Vessel Code.* 1998 Edition, Including Addenda. New York, New York: American Society of Mechanical Engineers. TIC: 247429.

3. ASM International 1990. *Properties and Selection: Irons, Steels, and High-Performance Alloys.* Volume 1 of *Metals Handbook.* 10th Edition. Materials Park, Ohio: ASM International. TIC: 245666.

4. Dieter, G.E. 1976. *Mechanical Metallurgy.* 2nd Edition. Materials Science and Engineering Series. New York, New York: McGraw-Hill Book Company. TIC: 247879.

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11. ASTM G 1-90 (Reapproved 1999). 1990. *Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens.* West Conshohocken, Pennsylvania: American Society for Testing and Materials. TIC: 238771.

12. Bowles, J.E. 1980. *Structural Steel Design.* New York, New York: McGraw-Hill. TIC: 249182.

13. CRWMS M&O 2000. *Technical Work Plan for: Waste Package Design Description for LA.* TWP-EBS-MD-000004 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001107.0304.

14. Allegheny Ludlum. 1987. Technical Data Blue Sheet for Stainless Steels Chromium-Nickel-Molybdenum, Types 316, 316L, 317, and 317L. Pittsburgh, Pennsylvania: Allegheny Ludlum Corporation. TIC: 240370.

15. ASM International 1987. *Corrosion.* Volume 13 of Metals Handbook. 9th Edition. Metals Park, Ohio: ASM International. TIC: 209807.

7.1 PROCEDURE REFERENCES

16. AP-SI.1Q, Rev. 3. *Software Management.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20010405.0012.

17. AP-SV.1Q, Rev. 0, ICN 2. *Control of the Electronic Management of Information.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL. 20000831.0065.

18. AP-3.12Q, Rev. 0, ICN 4. *Calculations.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20010404.0008.

8. ATTACHMENTS

Attachment I (25 pages): Design sketches (*21-PWR Waste Package Concept for License Application* [SK-0219 REV 01, 25 sheets])

Attachment II (on compact disc): contains electronic files (see Table 8-1 for a complete list). The *.k files are input files for LS-DYNA at the three temperatures and they call the *.inc files. The d3hsp files are the LS-DYNA output files at the three temperatures. The file *.inp is used in ANSYS to create the *.inc files.

Table 8-1 provides a list of attachments submitted in the form of electronic files (compact disc) in Attachment II.

Table 8-1. List of Attachments Submitted in the Form of Electronic Files in Attachment II

Description	Date	Time	Size
d3hspt1	02/07/2001	1:56 PM	26,625 KB
d3hspt2	02/07/2001	1:52 PM	26,608 KB
d3hspt3	02/07/2001	1:58 PM	26,598 KB
d3hspt3v	02/07/2001	1:54 PM	26,598 KB
elist.inc	02/07/2001	1:52 PM	5,439 KB
nlist.inc	02/07/2001	1:52 PM	5,563 KB
sd.inp	02/07/2001	1:56 PM	37KB
sdt1.k	02/07/2001	1:56 PM	3 KB
sdt2.k	02/07/2001	1:52 PM	3 KB
sdt3.k	02/07/2001	1:58 PM	3 KB
sdt3v.k	02/07/2001	1:54 PM	3 KB

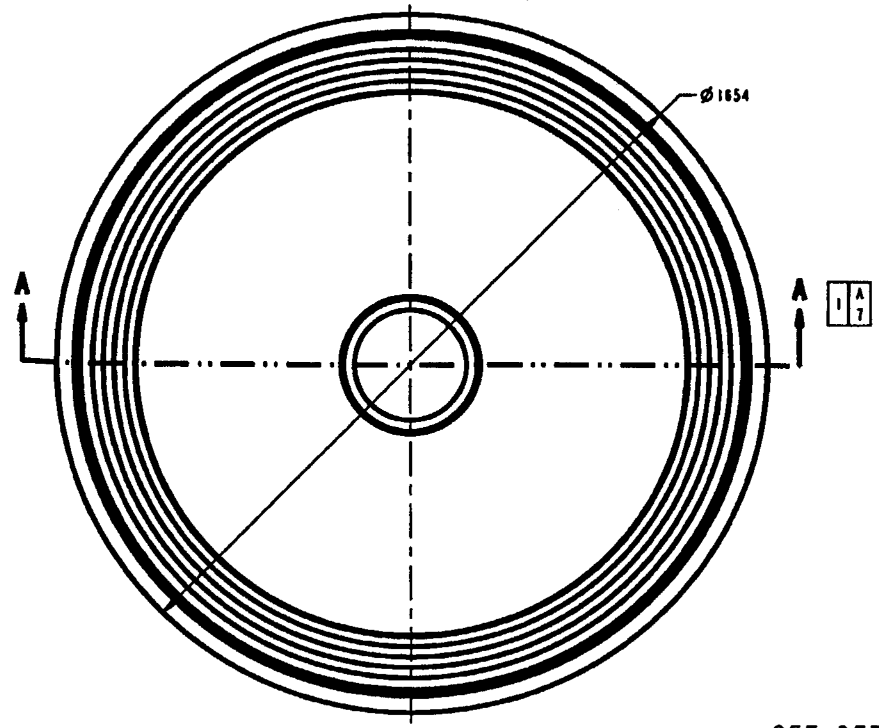
NOTE: The file sizes may vary with operating system.

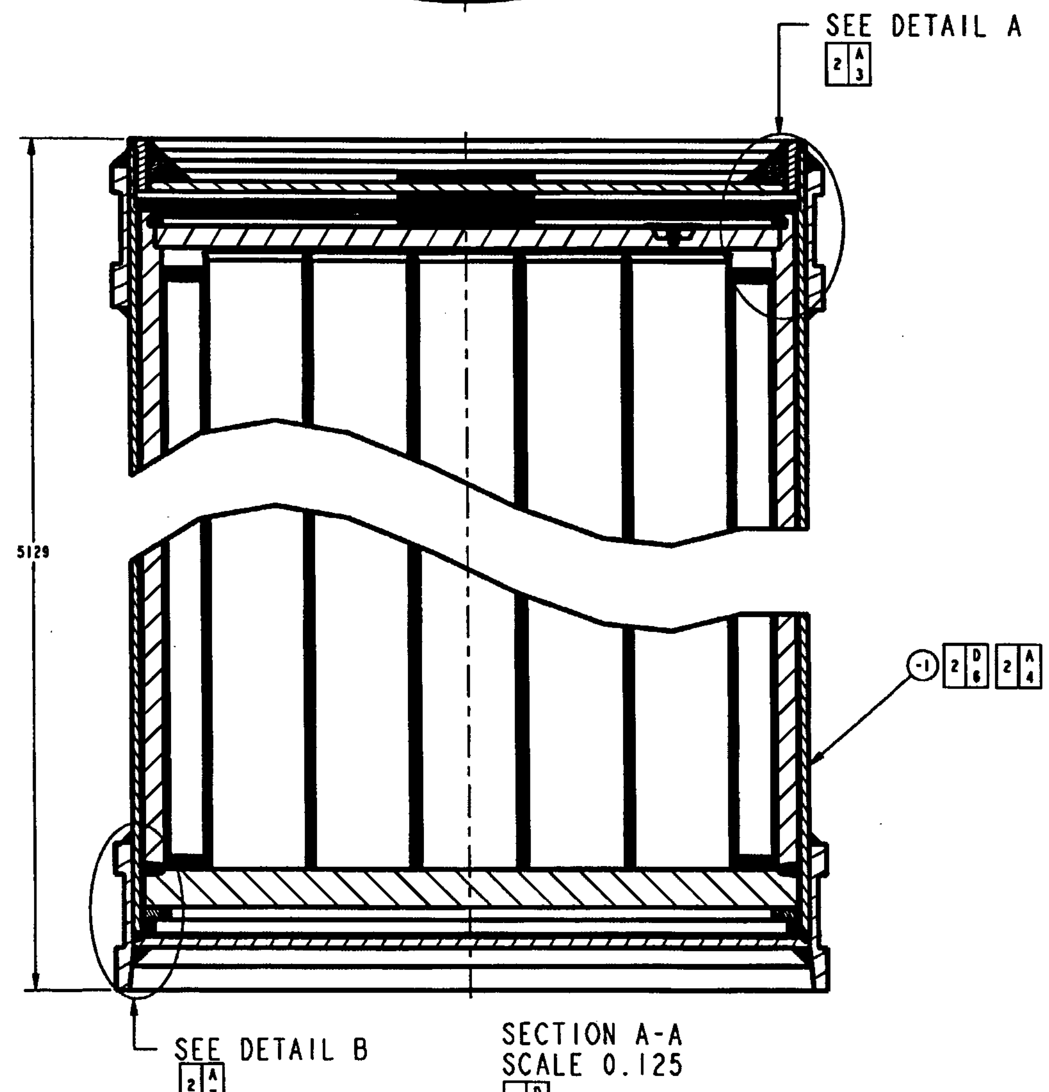
ALL SHEETS ARE THE SAME REVISION STATUS

SKETCH NUMBER	SHEET	REVISION
SK-0219	1 OF 25	01

REVISION HISTORY

ZONE	REV	DESCRIPTION	DATE	APPROVED
-	01	5129 WAS 5080 IN ZONES B8-1 AND B8-3	02/22/01	SMB
C4-2	01	172 WASTE PACKAGE TOP END TO INNER SHELL TOP LID WAS 200	02/22/01	SMB
C4-2	01	30.08 EXTENDED LID TO CLOSURE LID GAP WAS 30	02/22/01	SMB
C4-2	01	7 CLOSURE LID TO INNER SHELL GAP WAS 35	02/22/01	SMB
B6-2	01	100 OUTER SHELL BOTTOM LID TO LOWER TRUNNION COLLAR SLEEVE WAS ADDED TO DETAIL B	02/22/01	SMB
D2-2	01	ADDED 4 GAP	02/22/01	SMB
A2-5	01	DETAIL BB WAS ADDED	02/22/01	SMB
-	01	ITEM 14 WAS ITEM 13 IN ZONES D3-6, C5-12, B8-13, C6-18, AND C8-24	02/22/01	SMB
A6-5	01	ADDED DETAIL BB CALLOUT	02/22/01	SMB
A2-6	01	DETAIL CC WAS ADDED	02/22/01	SMB
D3-24	-	CONTINUED ON SHEET 24	02/22/01	SMB





SECTION A-A
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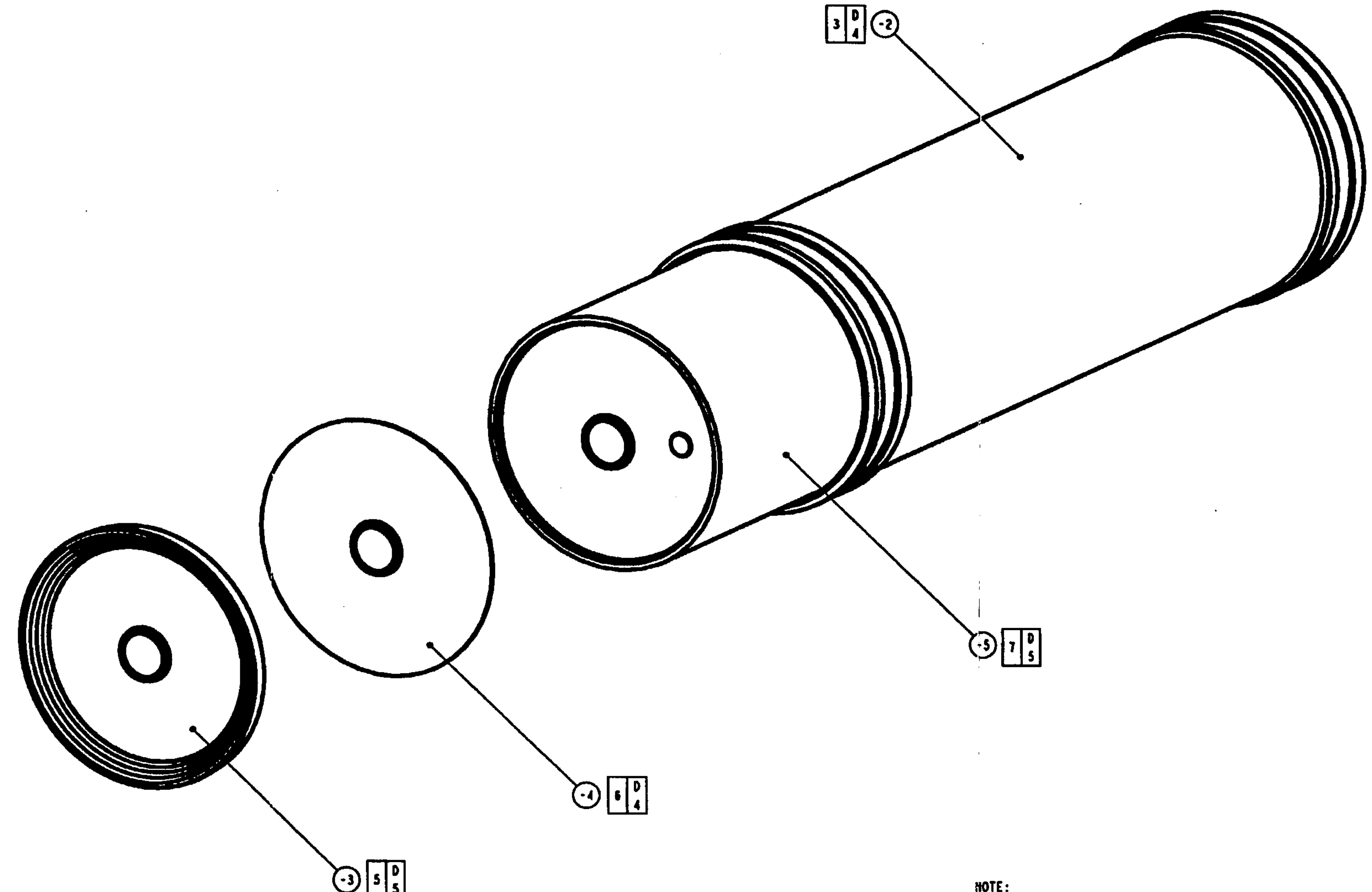
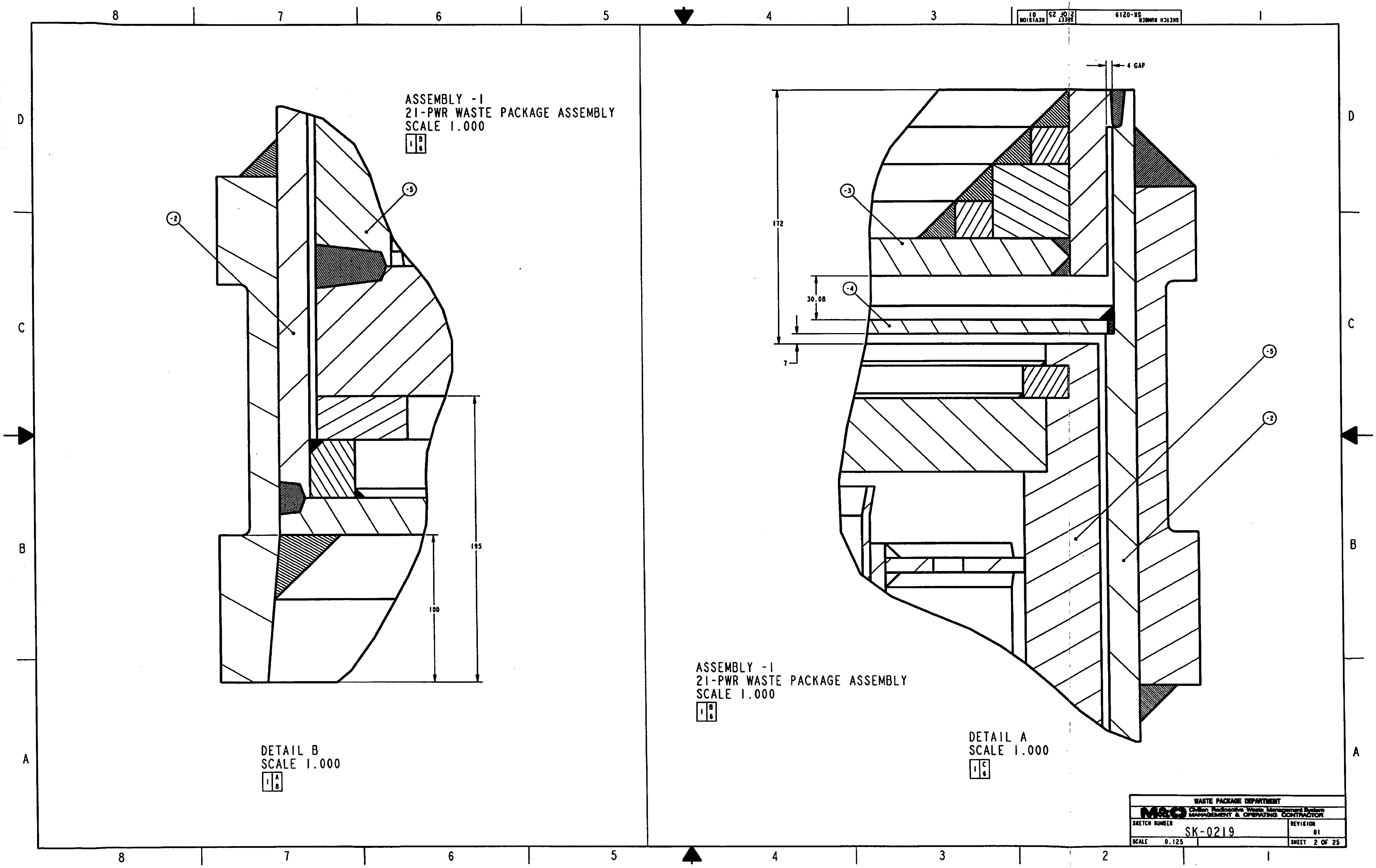


NOTE:
FOR COMPONENT LIST SEE SHEET 24
FOR WELD LIST SEE SHEET 25
FOR REFERENCE NOTE LIST SEE SHEET 25

"FOR INFORMATION ONLY"	APPROVALS	INITIAL/DATE	WASTE PACKAGE DEPARTMENT
THIRD ANGLE PROJECTION	SKETCHED BY BRYAN HARKINS	BH 02/22/01	M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR
	STRUCTURAL LEAD SCOTT BENNETT	SMB 02/22/01	TITLE 21-PWR WASTE PACKAGE CONCEPT FOR LICENSE APPLICATION
DIMENSIONS ARE IN MILLIMETERS AND DEGREES UNLESS OTHERWISE NOTED	MANUFACTURING MGR JERRY COGAR	JDC 2/22/01	SKETCH NUMBER SK-0219 — REVISION 01
DO NOT SCALE FROM SKETCH	DESIGN GROUP MGR MICHAEL ANDERSON	MA 2/22/01	SCALE 0.125 — SHEET 1 OF 25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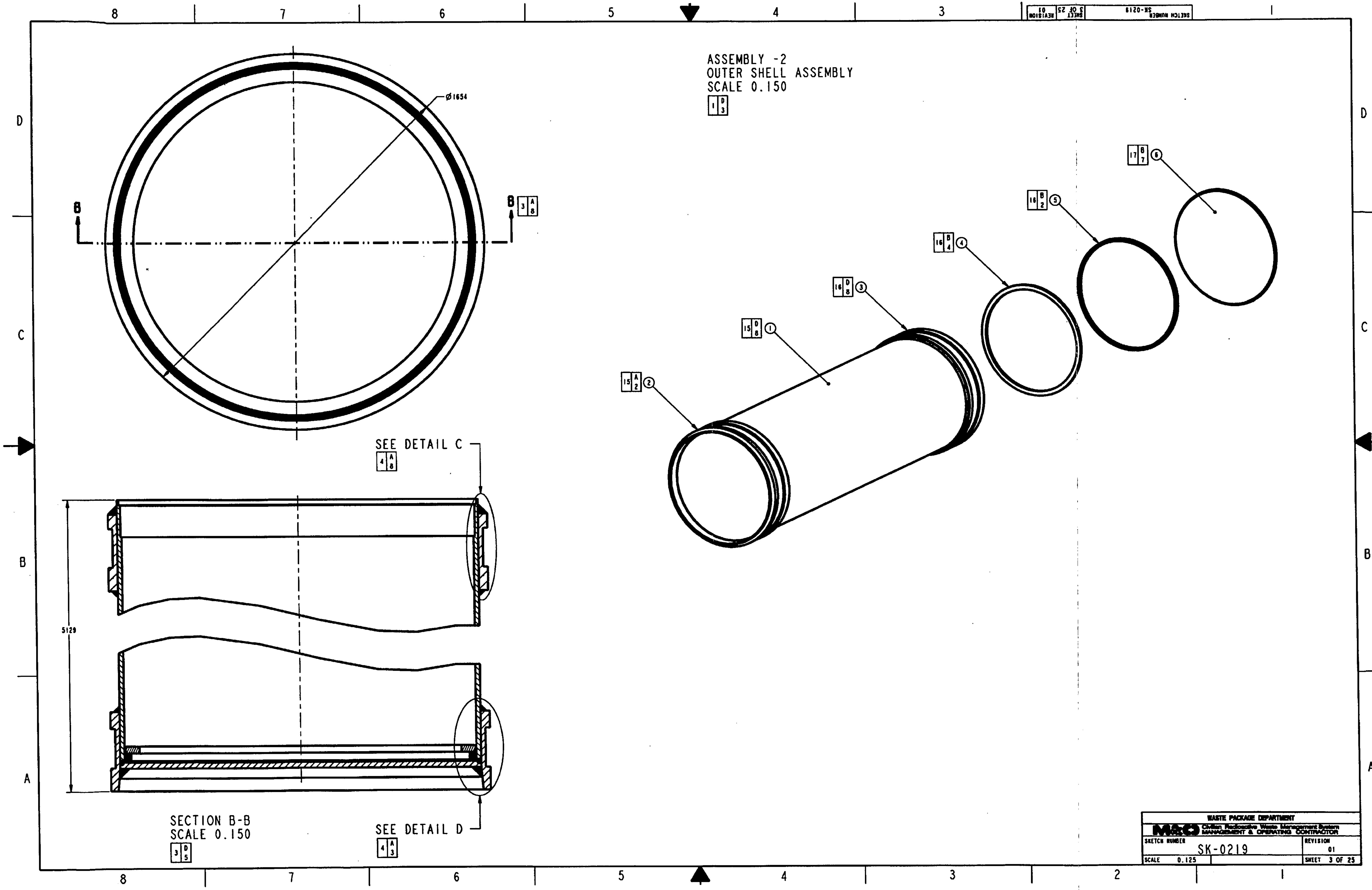
-3
30.08
-4
7
-5
-2
ASSEMBLY -1
21-PWR WASTE PACKAGE ASSEMBLY
SCALE 1.000
DETAIL A
SCALE 1.000
WASTE PACKAGE DEPARTMENT
M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER SK-0219
REVISION 01
SCALE 0.125
SHEET 2 OF 25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OUTER SHELL ASSEMBLY
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B
B
SEE DETAIL C
SEE DETAIL D
5129
SECTION B-B
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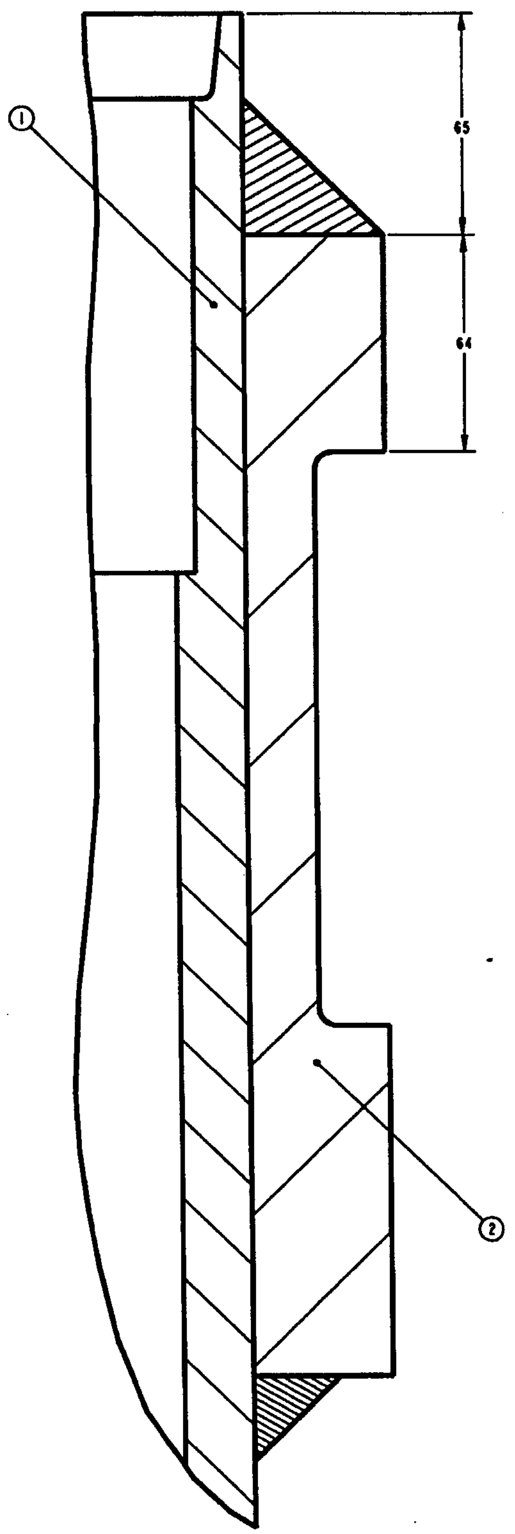
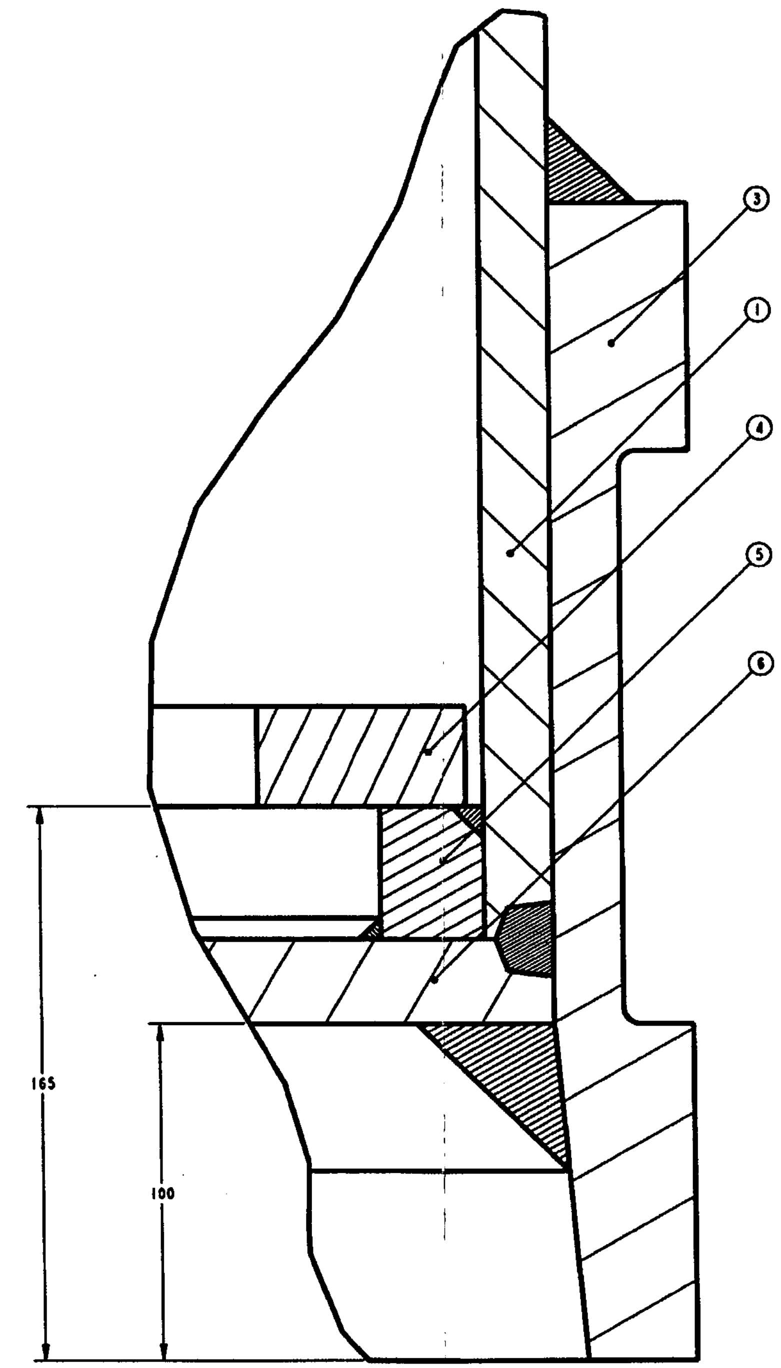
WASTE PACKAGE DEPARTMENT
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 3 OF 25



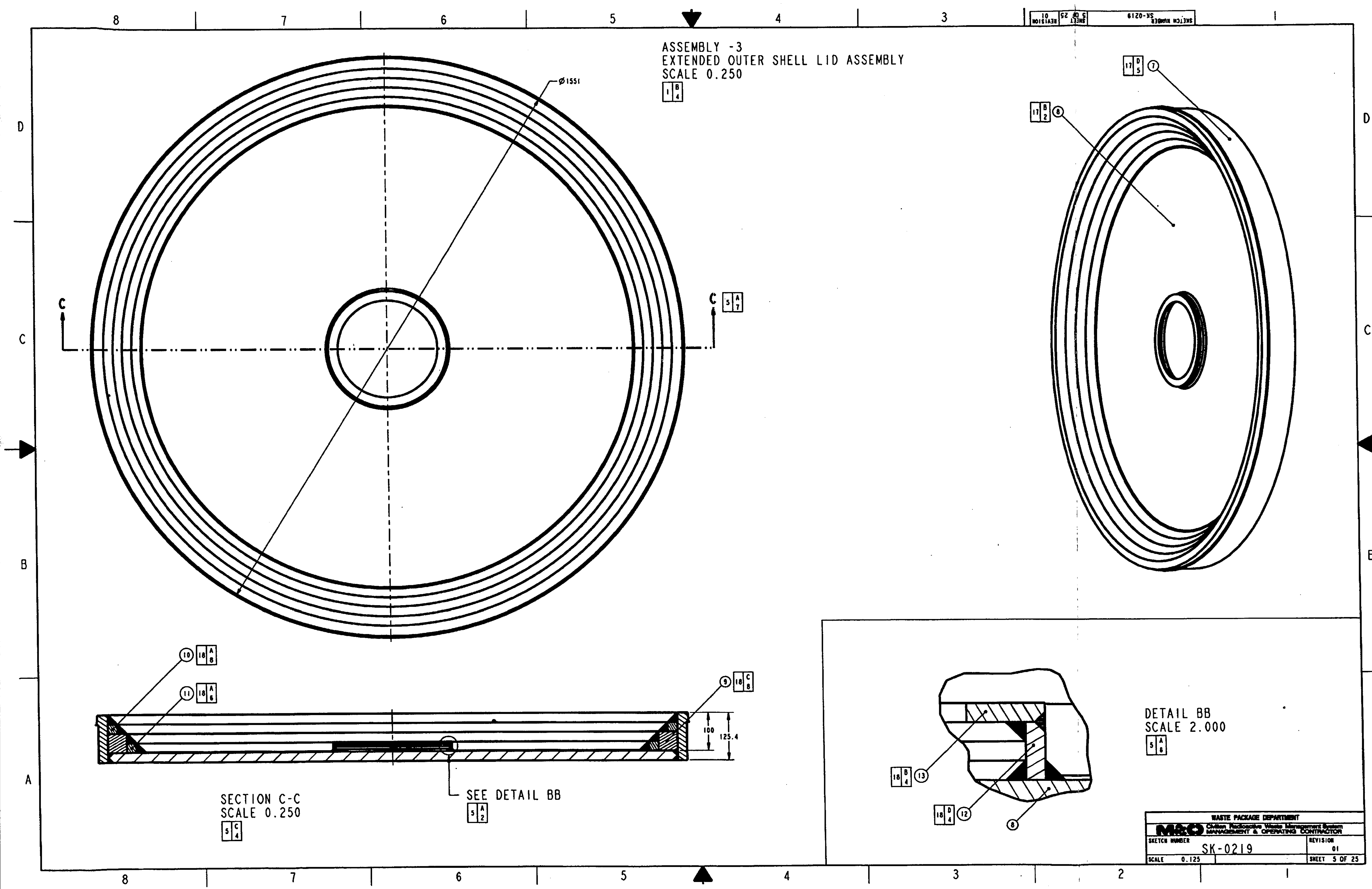
DETAIL C
SCALE 1.000

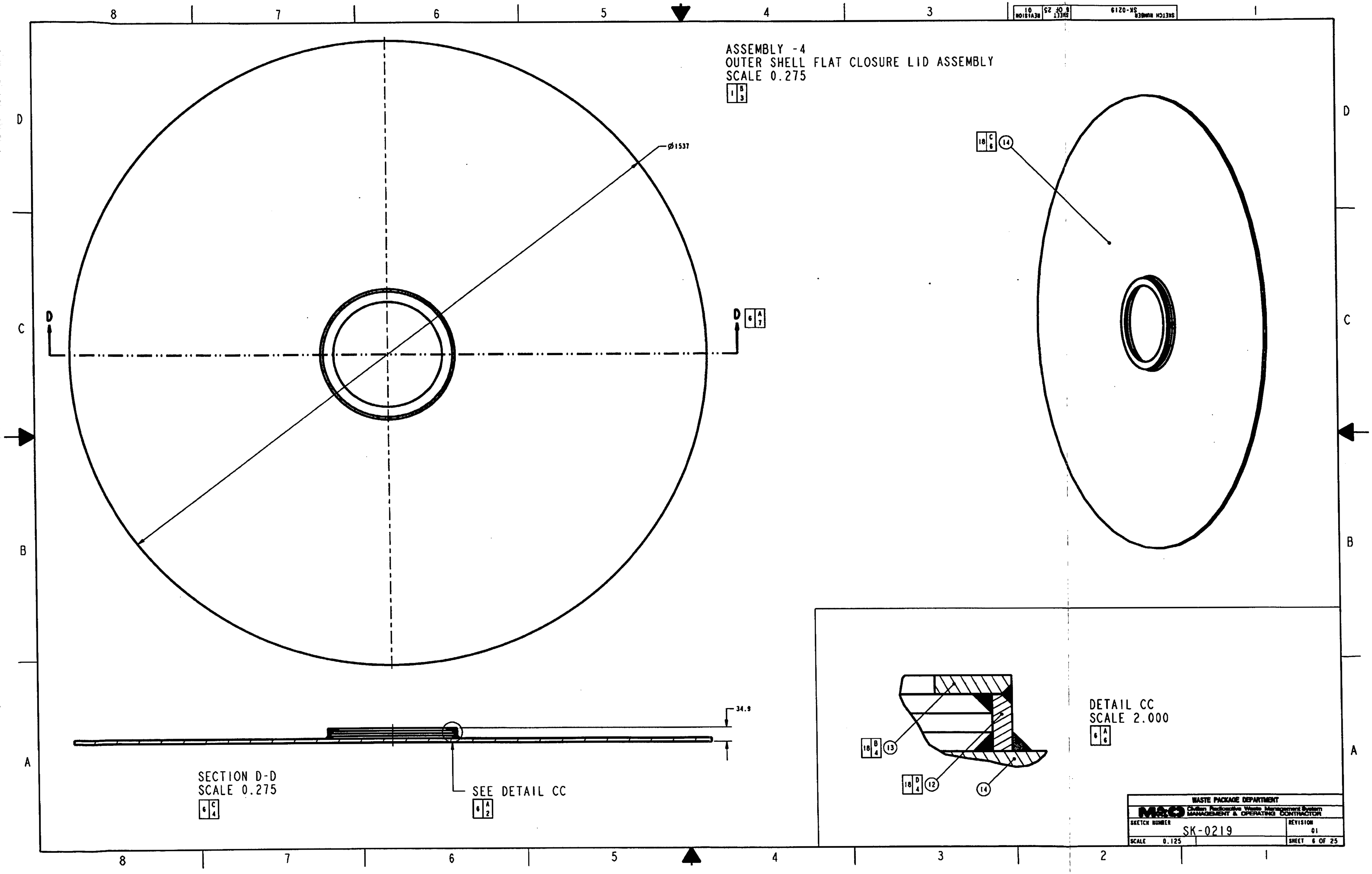


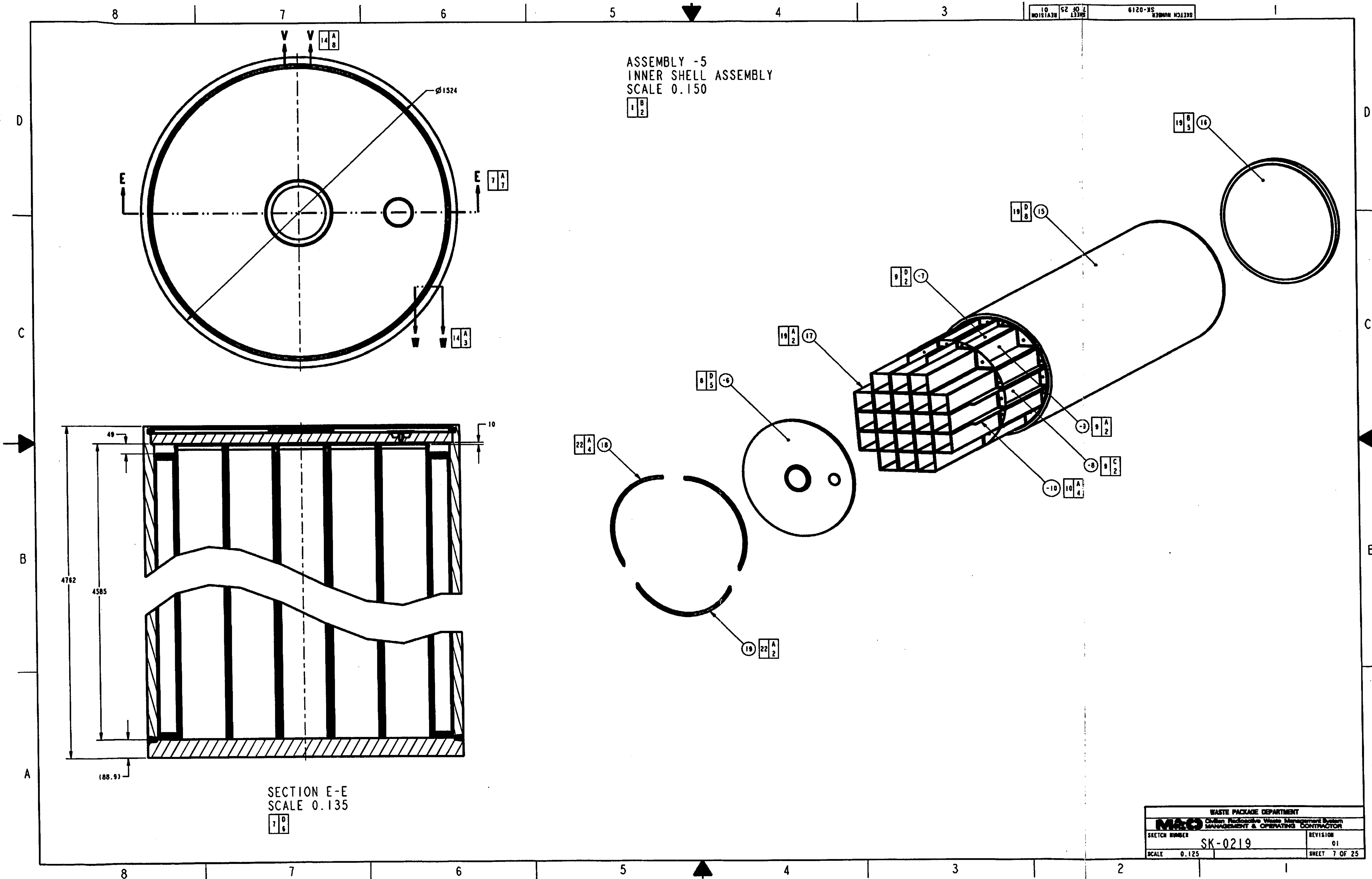
DETAIL D
SCALE 1.000

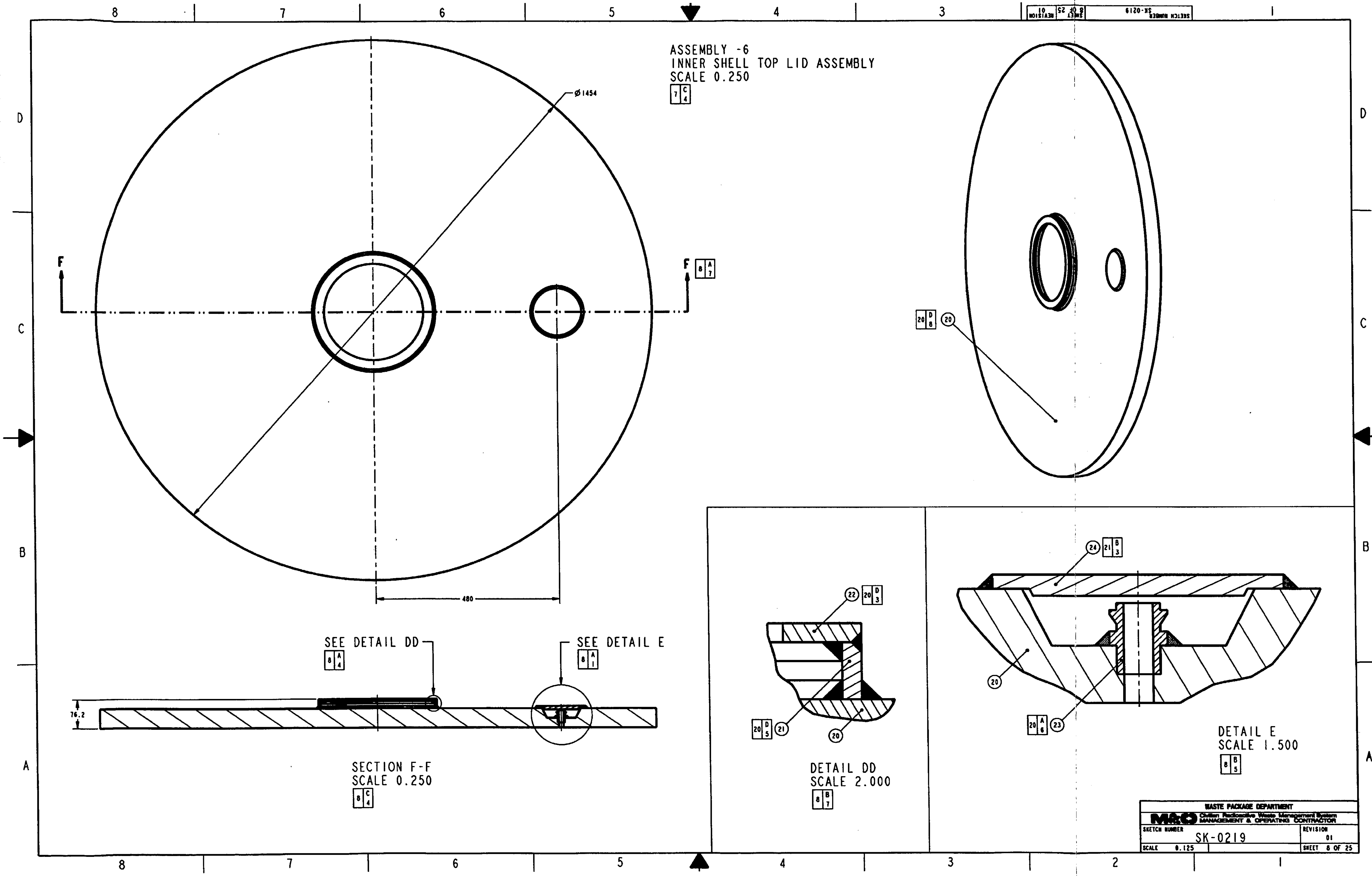
WASTE PACKAGE DEPARTMENT
M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR

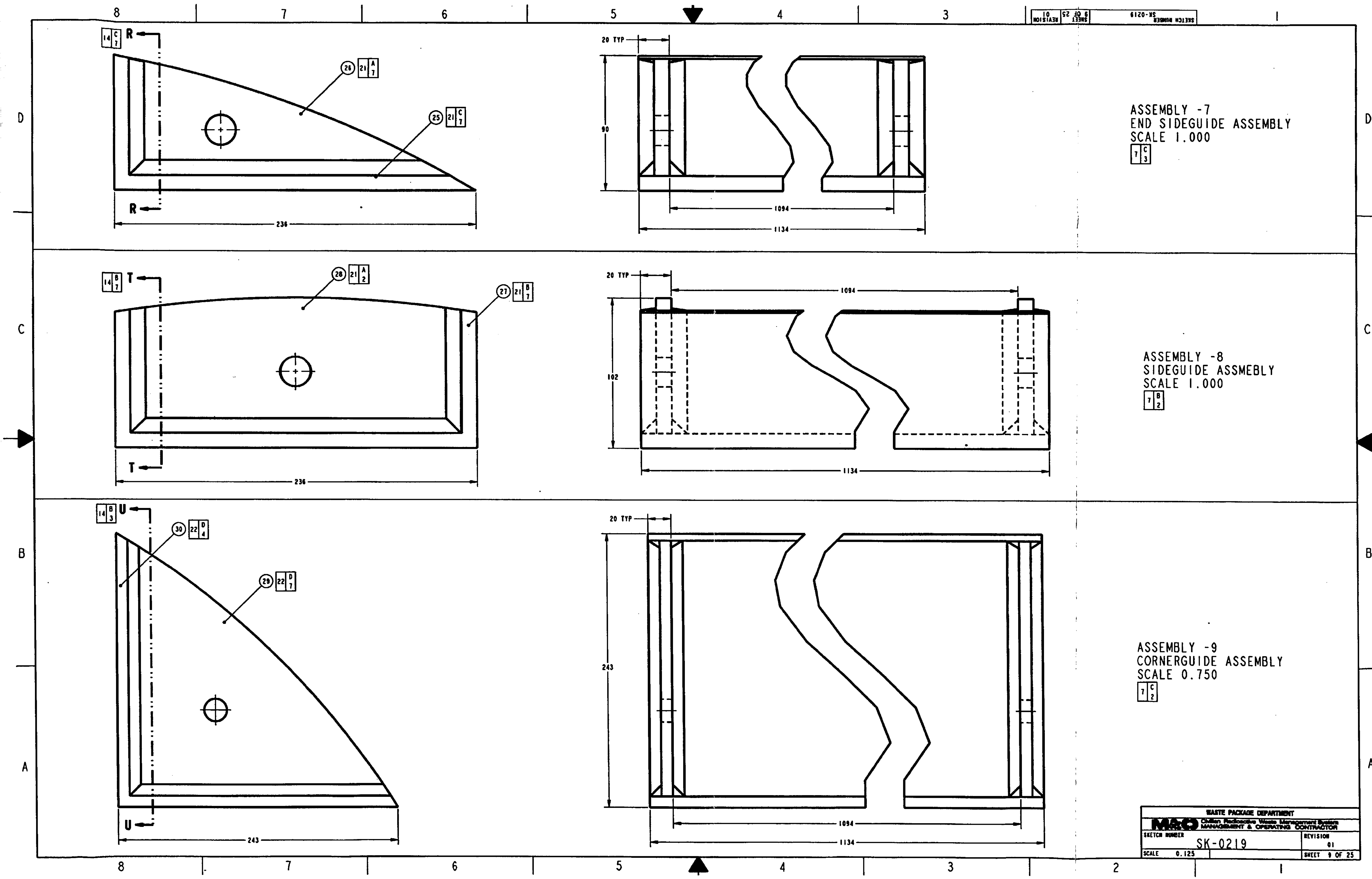
SKETCH NUMBER	REVISION
SK-0219	01
SCALE 0.125	SHEET 4 OF 25

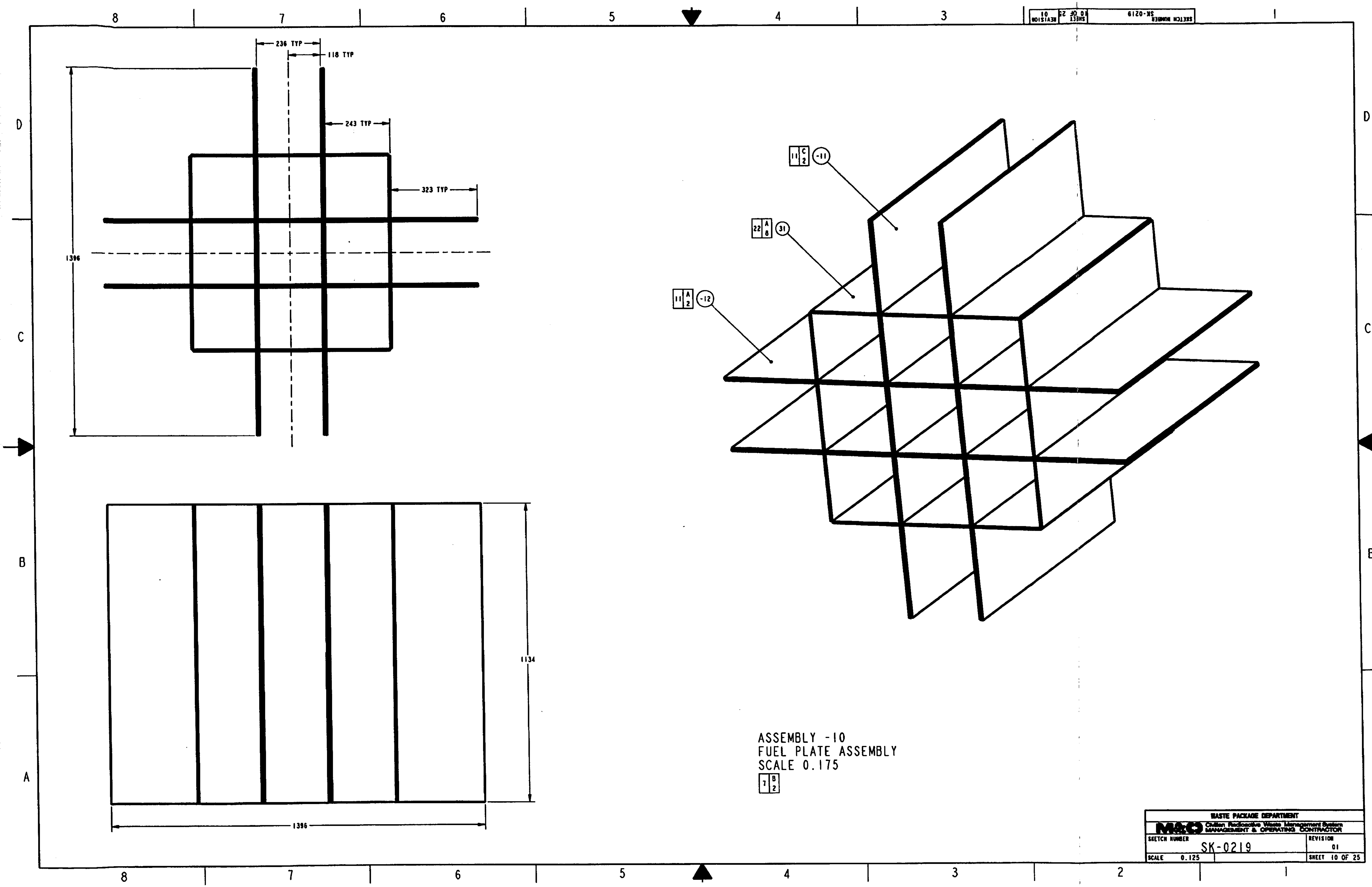

ASSEMBLY -3
EXTENDED OUTER SHELL LID ASSEMBLY
SCALE 0.250
Ø1551
C
C
SECTION C-C
SCALE 0.250
SEE DETAIL BB
100
125.4
DETAIL BB
SCALE 2.000
WASTE PACKAGE DEPARTMENT
M&O
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 5 OF 25

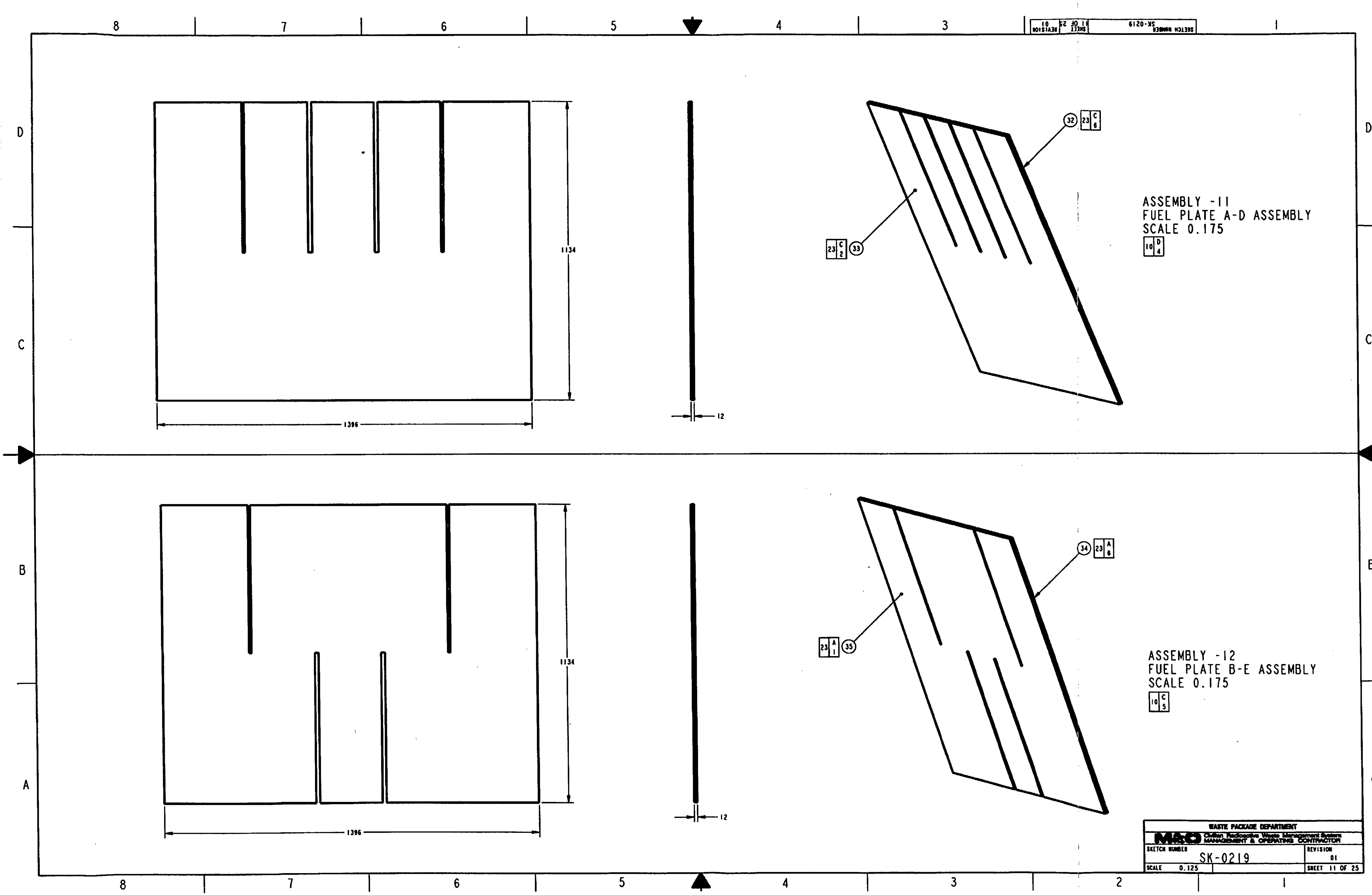

ASSEMBLY -4
OUTER SHELL FLAT CLOSURE LID ASSEMBLY
SCALE 0.275
Ø1537
34.9
SECTION D-D
SCALE 0.275
SEE DETAIL CC
DETAIL CC
SCALE 2.000
WASTE PACKAGE DEPARTMENT
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 6 OF 25

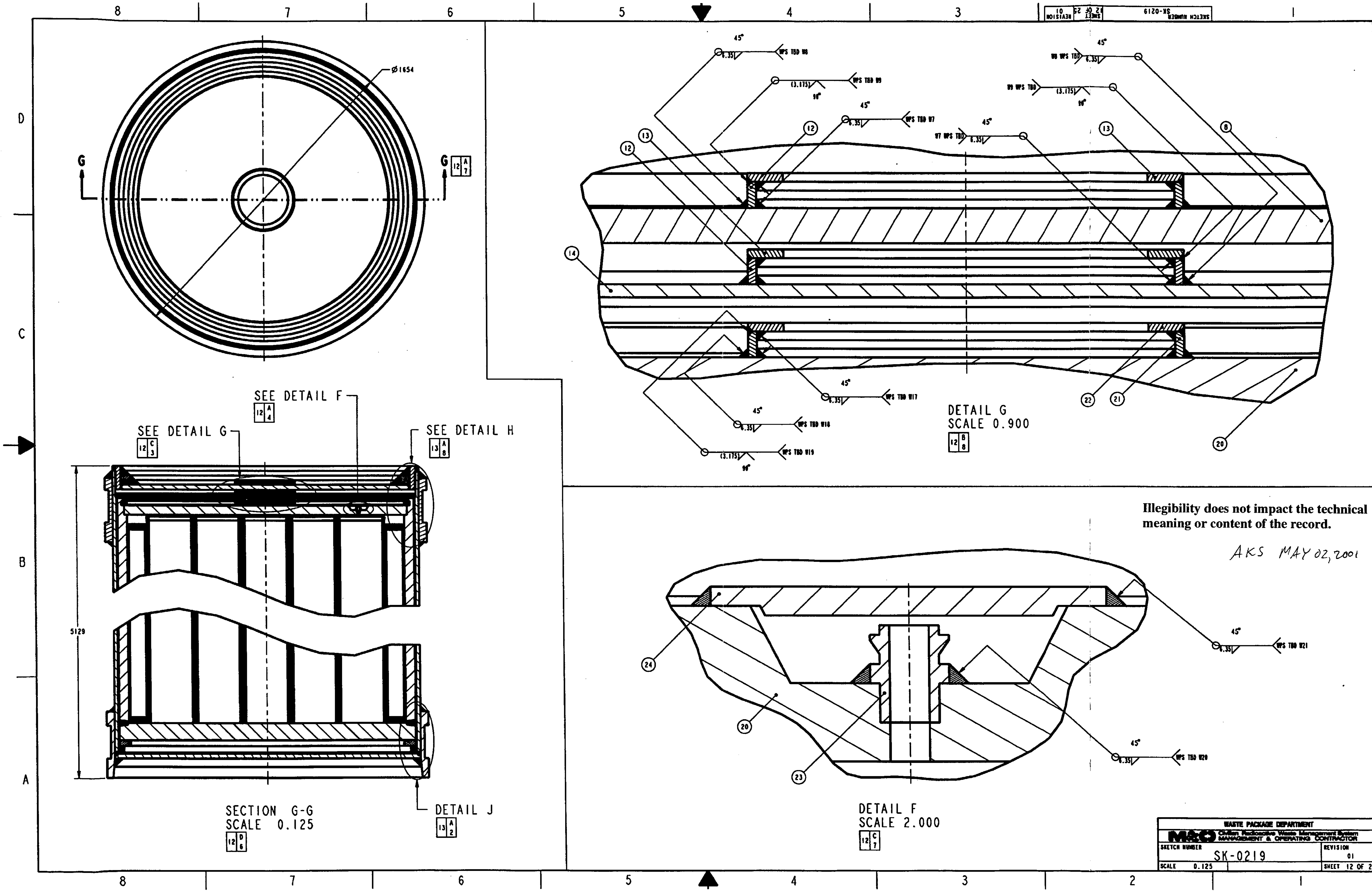

ASSEMBLY -5
INNER SHELL ASSEMBLY
SCALE 0.150
Ø1524
SECTION E-E
SCALE 0.135
4762
4585
49
10
(88.9)
WASTE PACKAGE DEPARTMENT
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 7 OF 25


ASSEMBLY -6
INNER SHELL TOP LID ASSEMBLY
SCALE 0.250
Ø1454
480
F
F
76.2
SEE DETAIL DD
SEE DETAIL E
SECTION F-F
SCALE 0.250
DETAIL DD
SCALE 2.000
DETAIL E
SCALE 1.500
WASTE PACKAGE DEPARTMENT
M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER SK-0219
REVISION 01
SCALE 0.125
SHEET 8 OF 25


ASSEMBLY -7
END SIDEGUIDE ASSEMBLY
SCALE 1.000
ASSEMBLY -8
SIDEGUIDE ASSMEBLY
SCALE 1.000
ASSEMBLY -9
CORNERGUIDE ASSEMBLY
SCALE 0.750
20 TYP
90
102
243
236
1094
1134
R
T
U
WASTE PACKAGE DEPARTMENT
M&O
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 9 OF 25

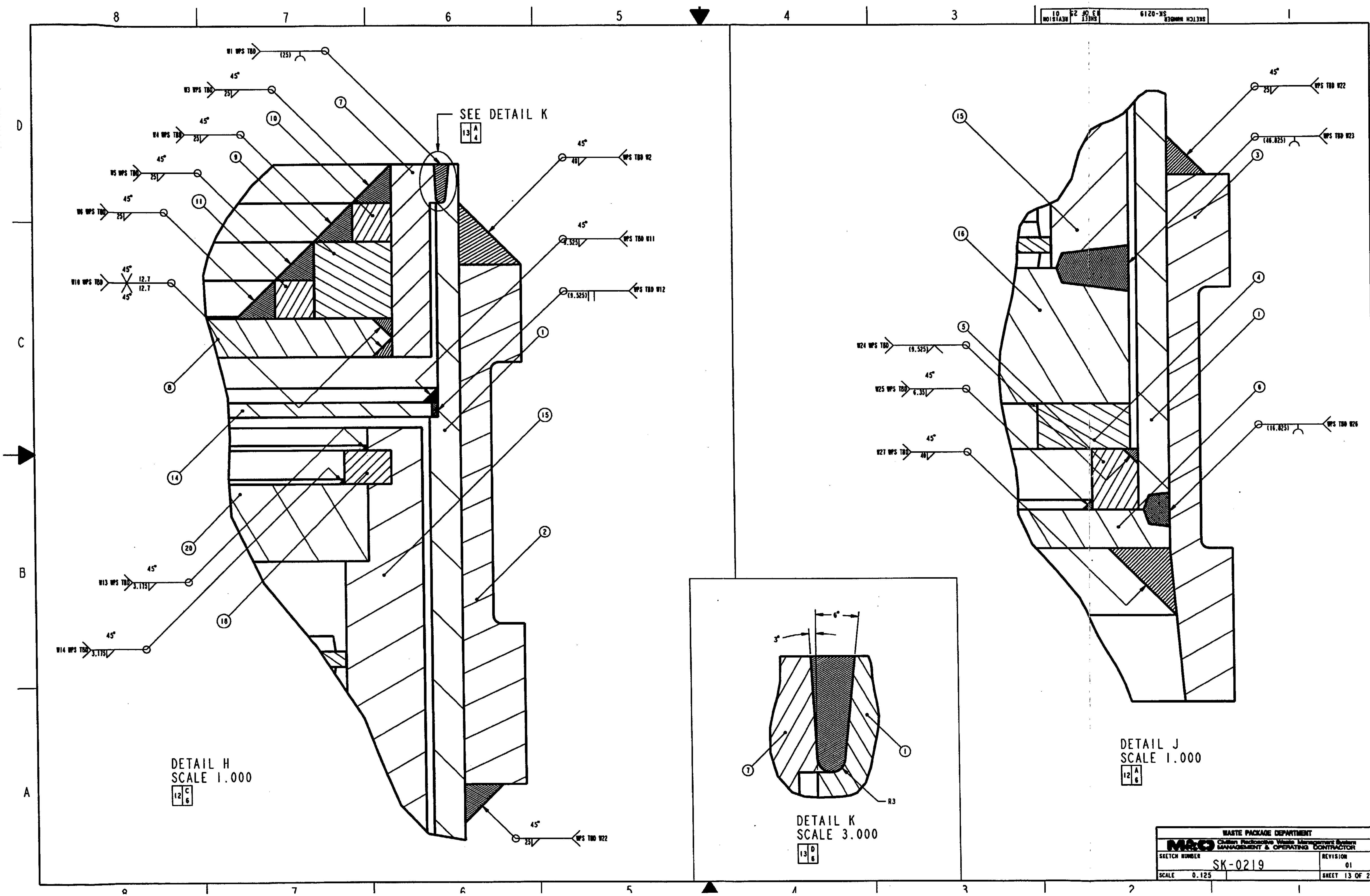

236 TYP
118 TYP
243 TYP
323 TYP
1396
1134
1396
-11
31
-12
ASSEMBLY -10
FUEL PLATE ASSEMBLY
SCALE 0.175
WASTE PACKAGE DEPARTMENT
M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER SK-0219
REVISION 01
SCALE 0.125
SHEET 10 OF 25


ASSEMBLY -11
FUEL PLATE A-D ASSEMBLY
SCALE 0.175
1134
1396
12
32
33
ASSEMBLY -12
FUEL PLATE B-E ASSEMBLY
SCALE 0.175
1134
1396
12
34
35
WASTE PACKAGE DEPARTMENT
M&O
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 11 OF 25



Illegibility does not impact the technical meaning or content of the record.

AKS MAY 02, 2001


SEE DETAIL K
DETAIL H
SCALE 1.000
DETAIL K
SCALE 3.000
R3
DETAIL J
SCALE 1.000
WASTE PACKAGE DEPARTMENT
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 13 OF 25

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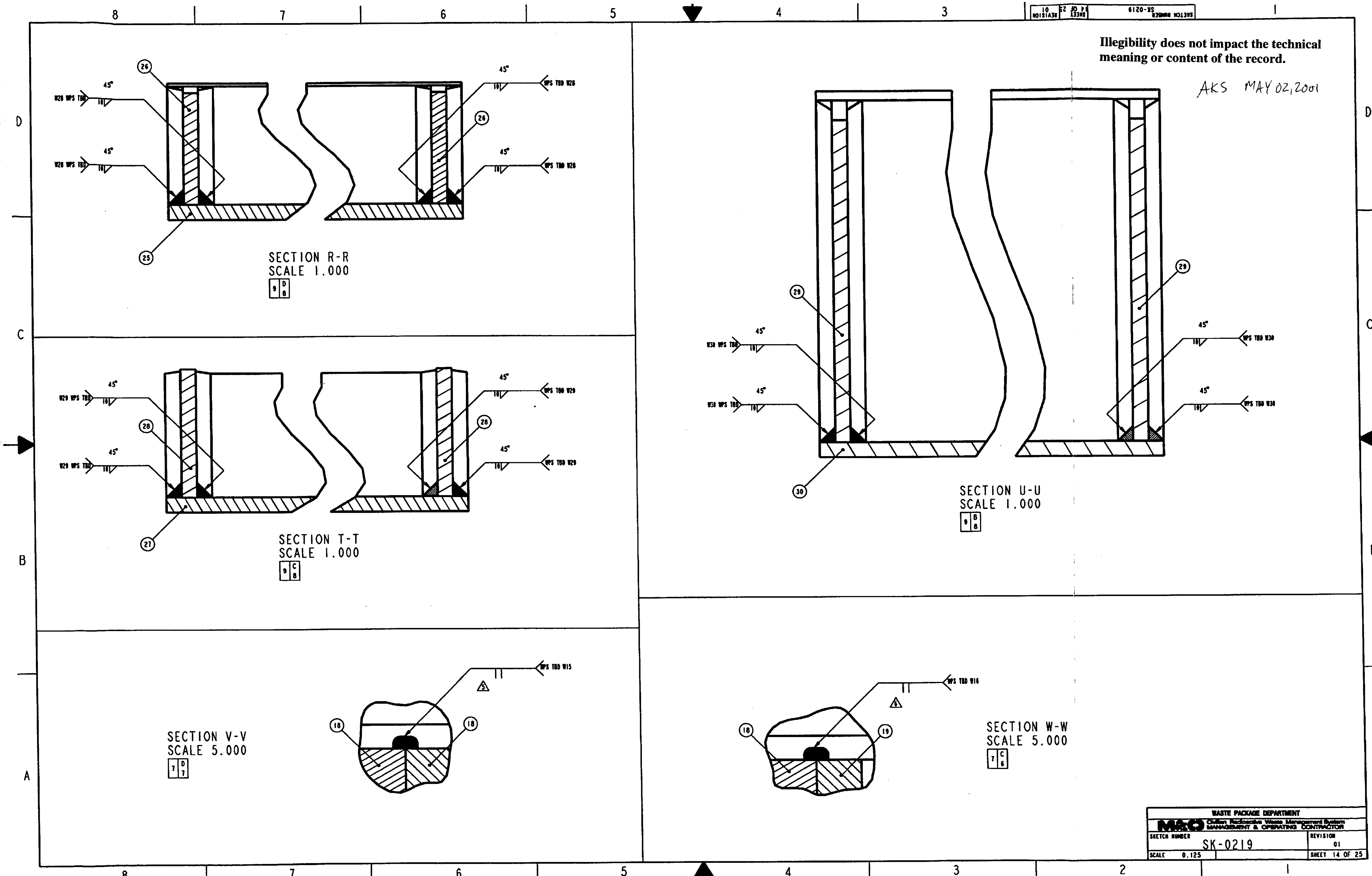
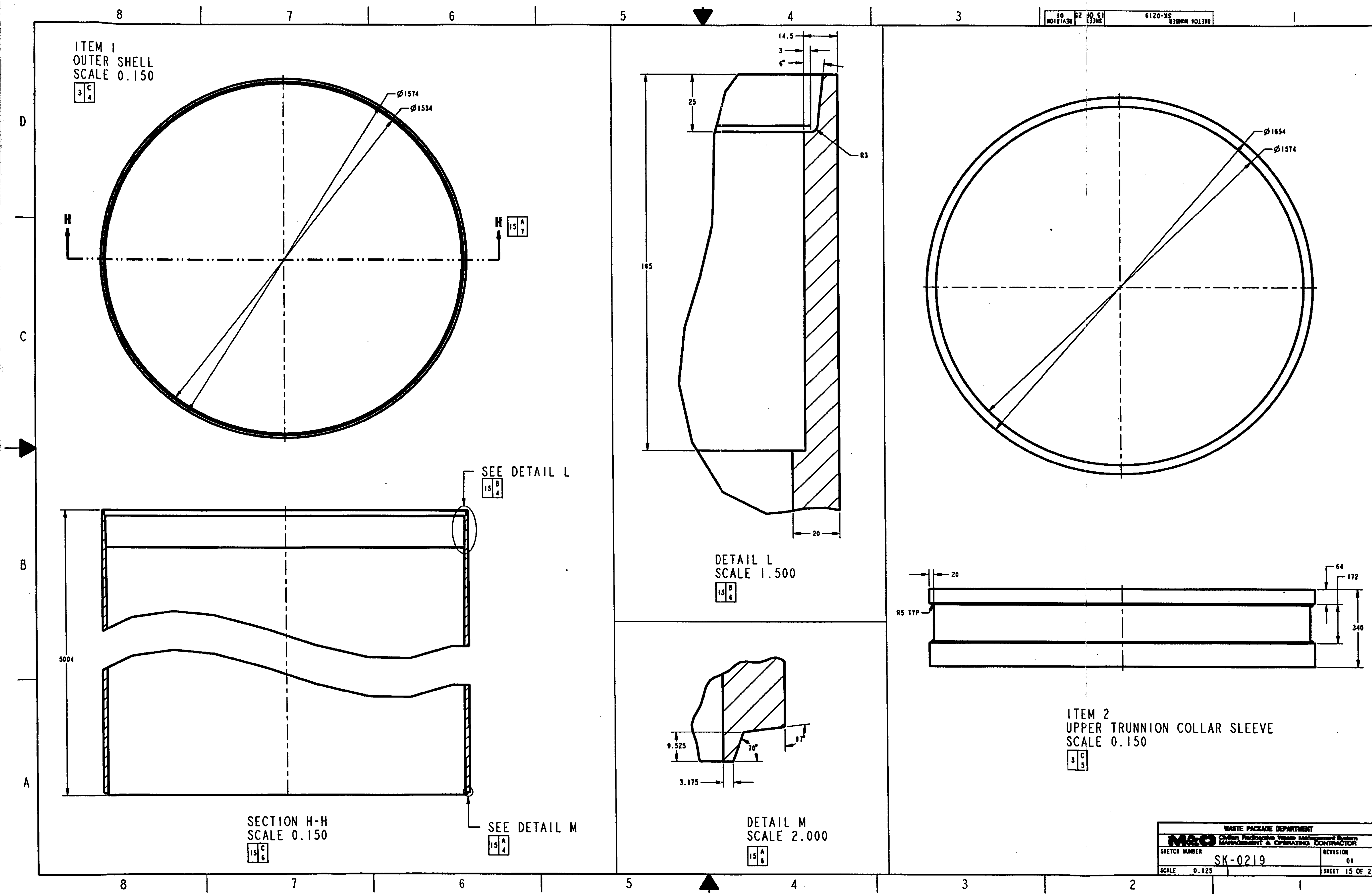
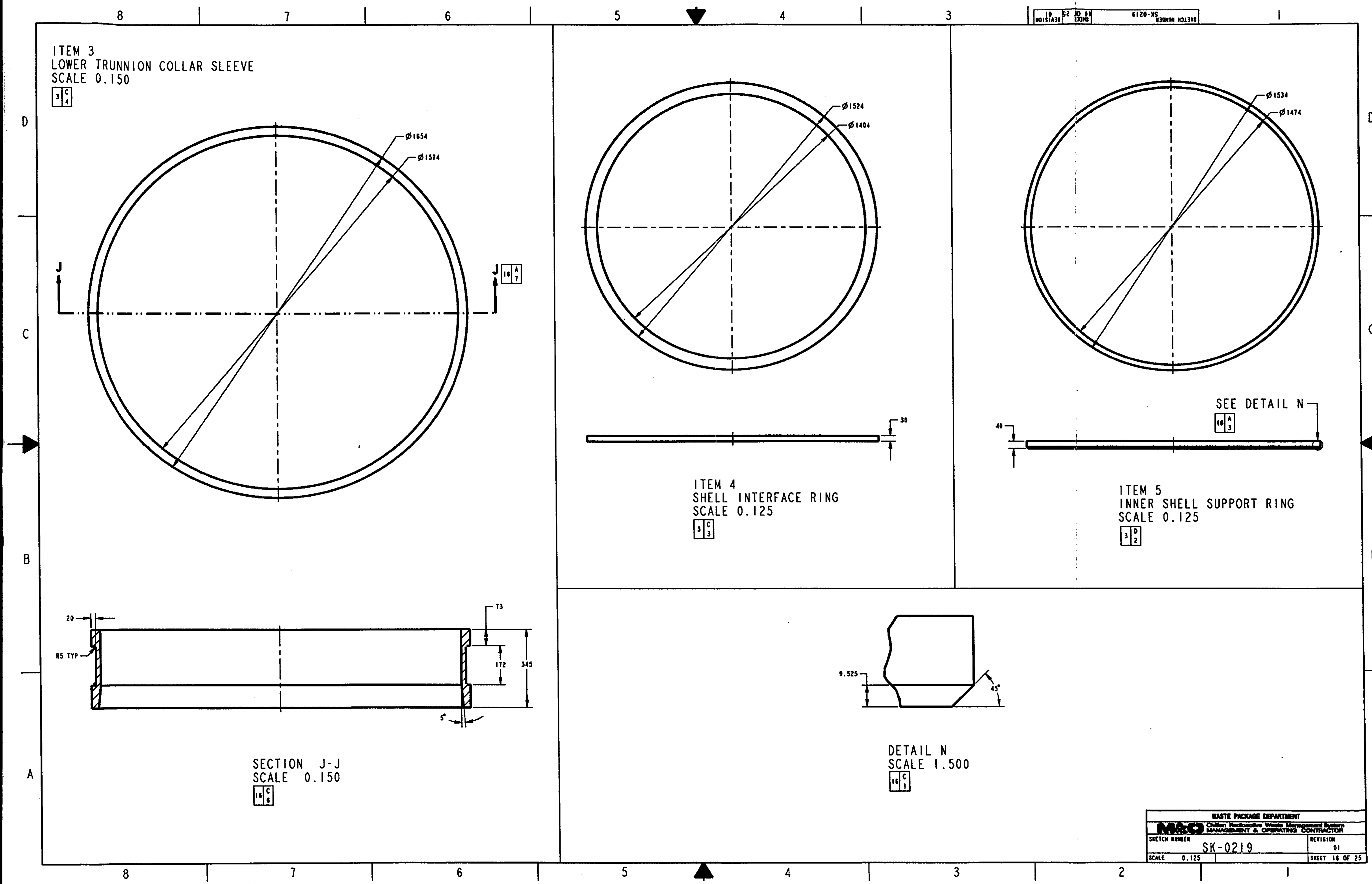
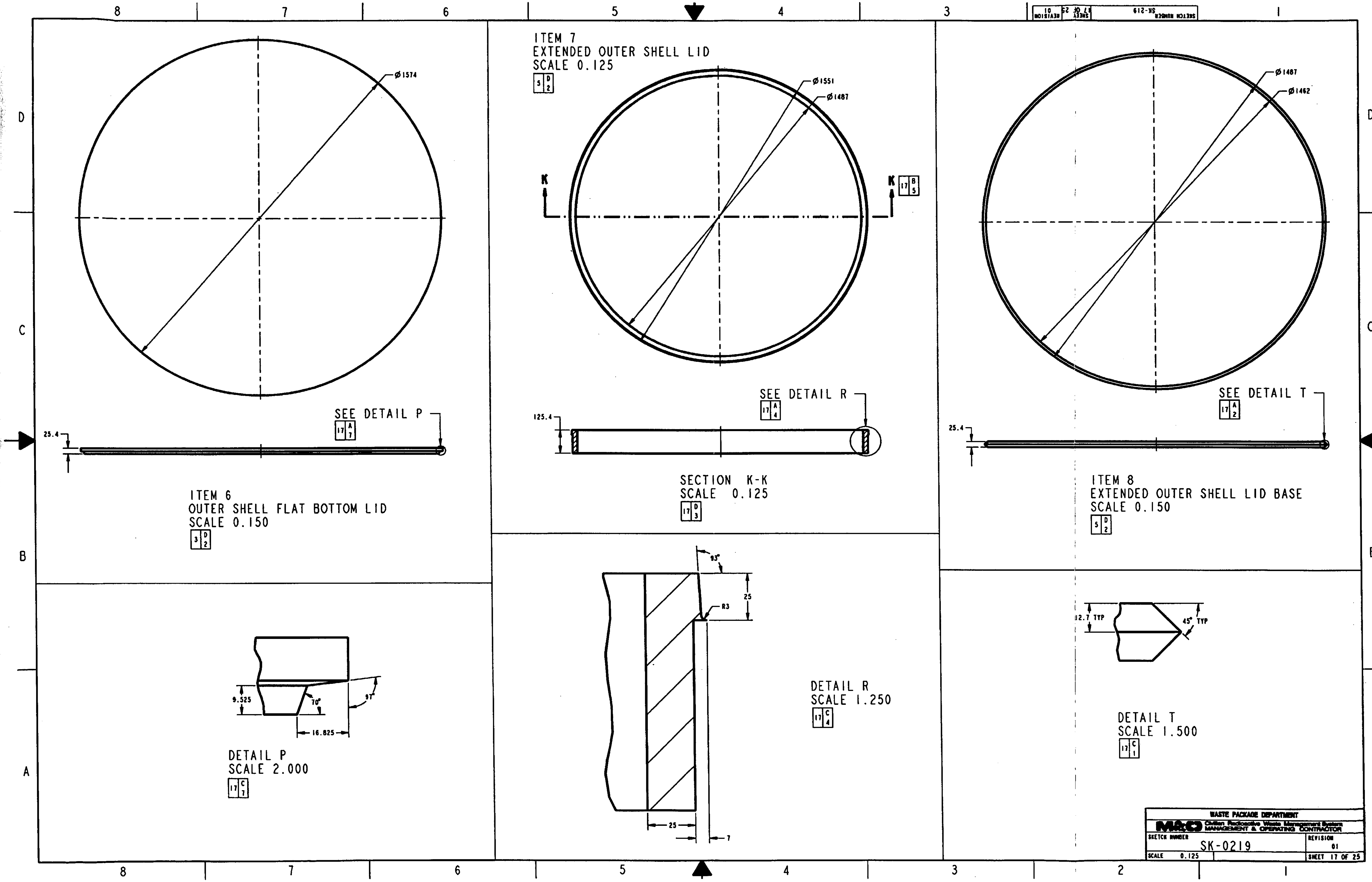
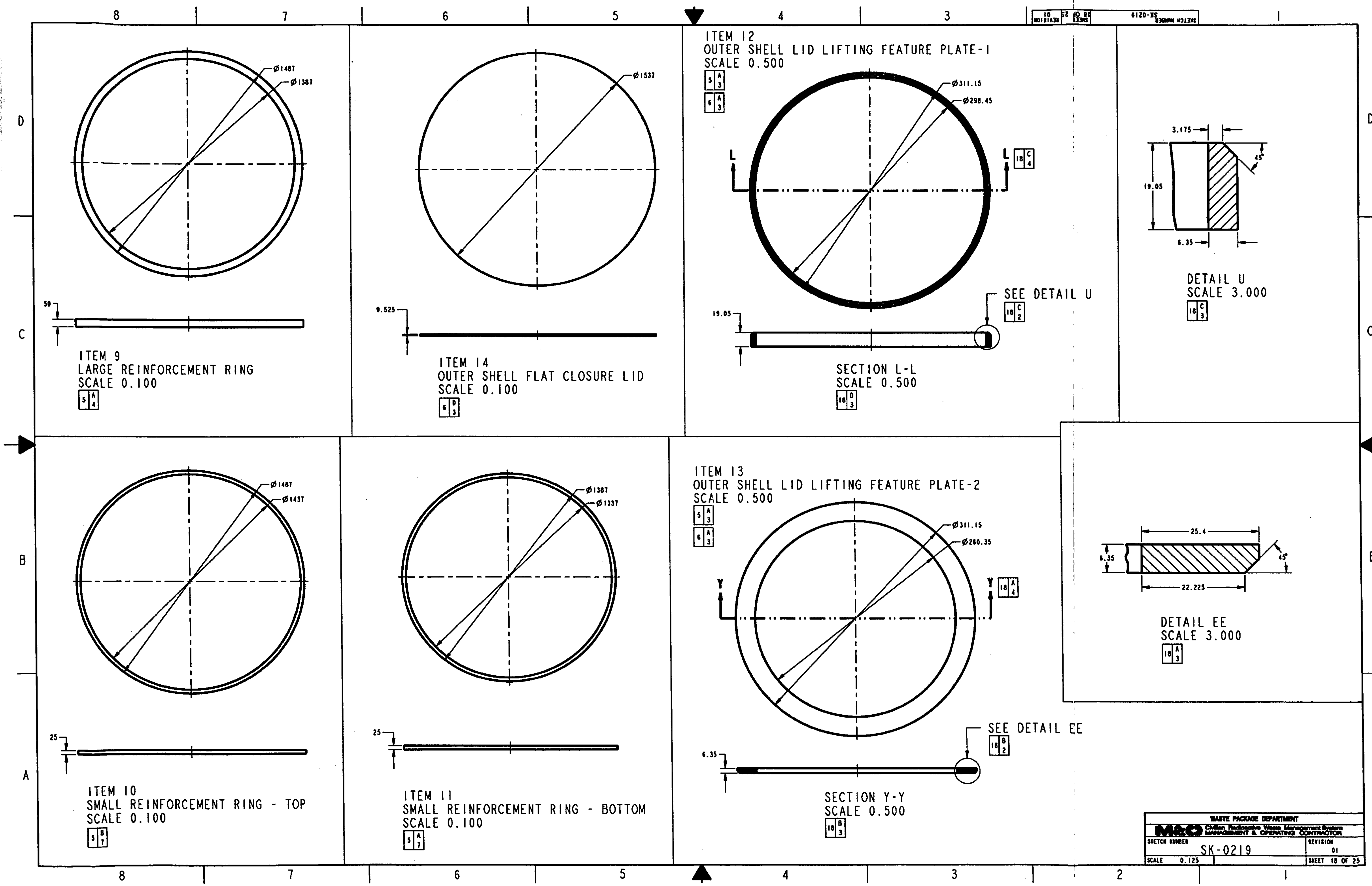
AKS MAY 02, 2001

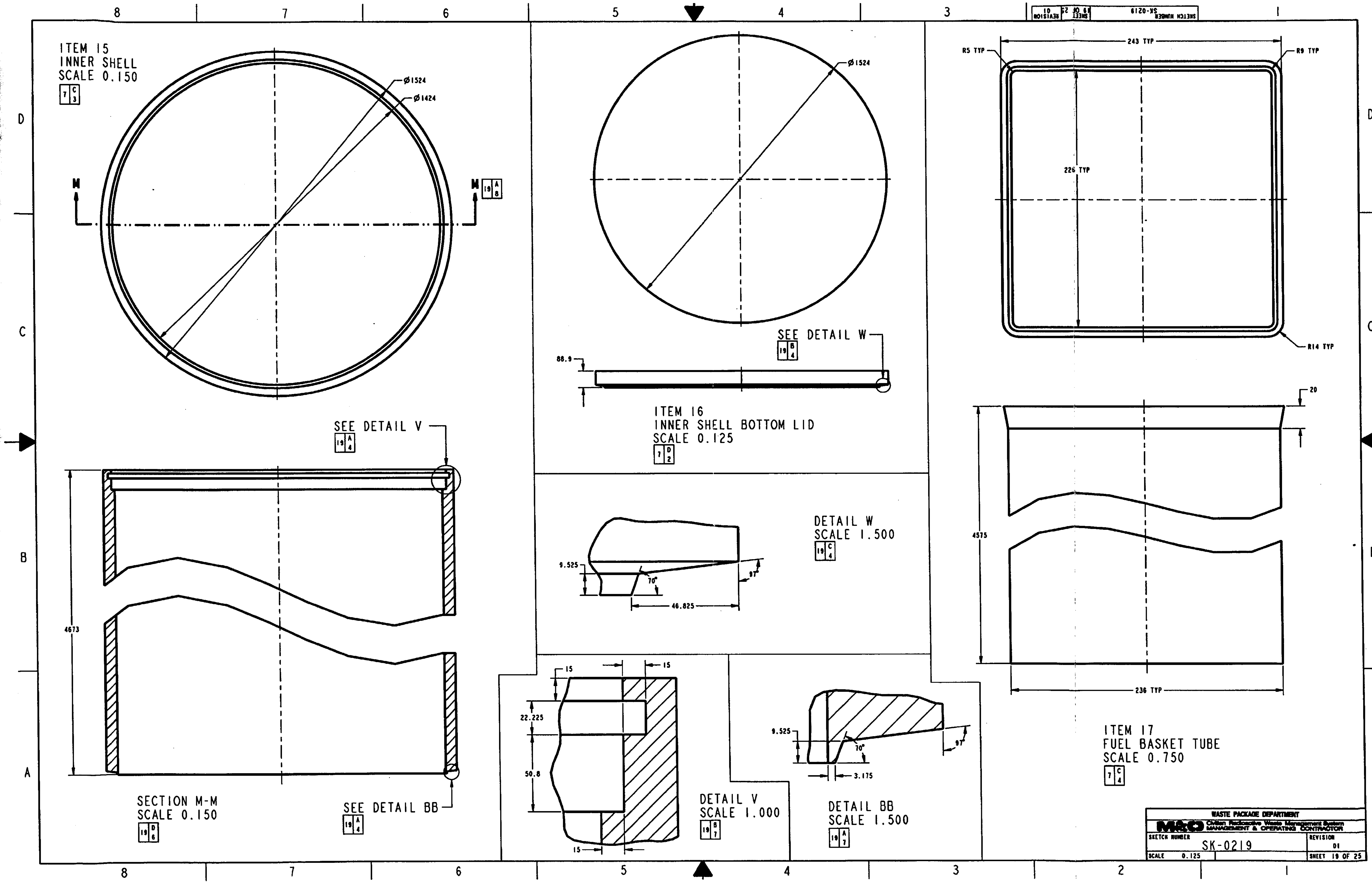


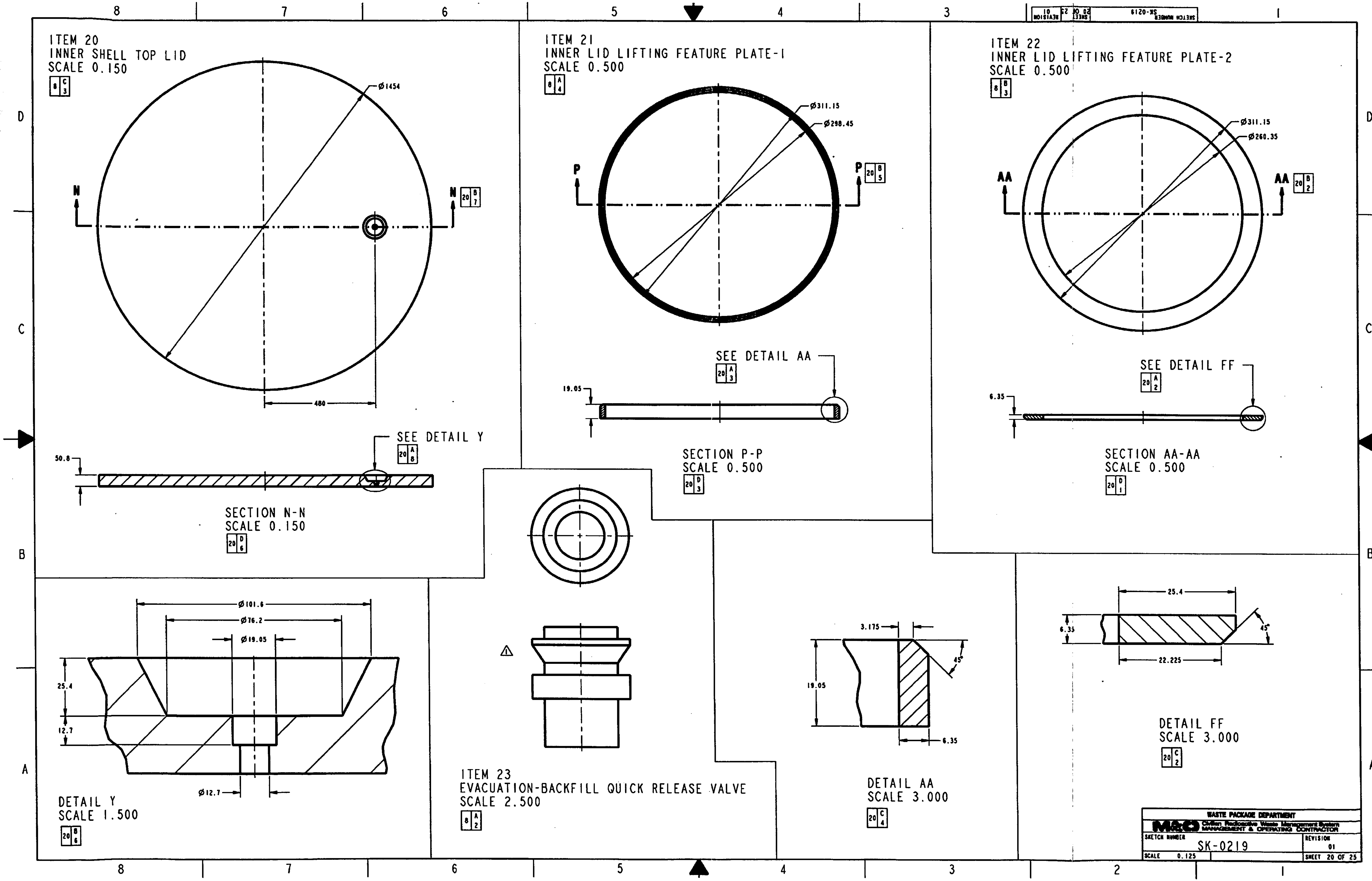

ITEM 1
OUTER SHELL
SCALE 0.150
Ø1574
Ø1534
H
H
SEE DETAIL L
SECTION H-H
SCALE 0.150
SEE DETAIL M
5004
14.5
3
6°
25
165
R3
20
DETAIL L
SCALE 1.500
9.525
70°
97°
3.175
DETAIL M
SCALE 2.000
Ø1654
Ø1574
20
64
172
R5 TYP
340
ITEM 2
UPPER TRUNNION COLLAR SLEEVE
SCALE 0.150
WASTE PACKAGE DEPARTMENT
M&O
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 15 OF 25

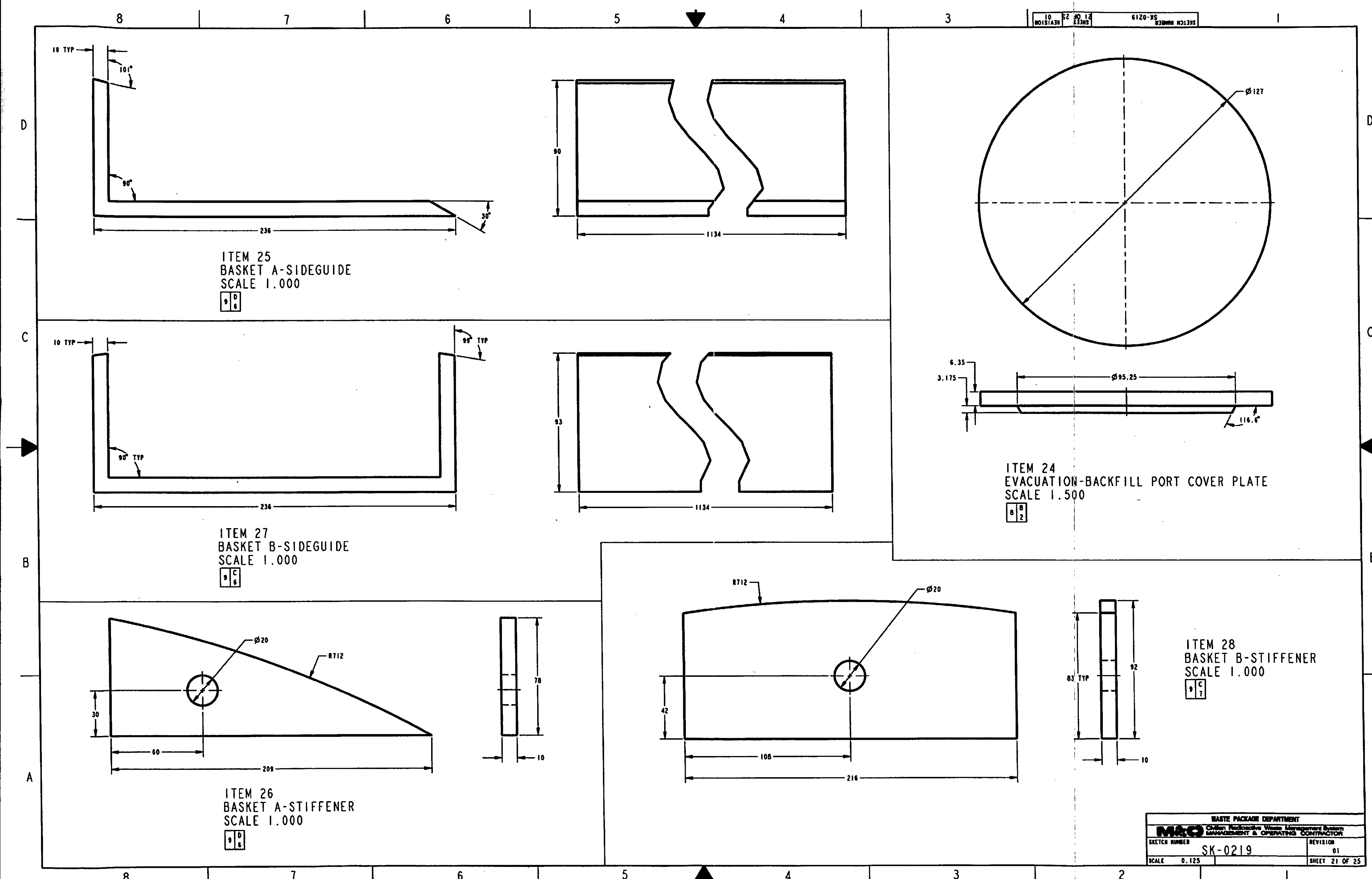

ITEM 3
LOWER TRUNNION COLLAR SLEEVE
SCALE 0.150
Ø1654
Ø1574
J
J
SECTION J-J
SCALE 0.150
20
R5 TYP
73
172
345
5°
ITEM 4
SHELL INTERFACE RING
SCALE 0.125
Ø1524
Ø1404
30
ITEM 5
INNER SHELL SUPPORT RING
SCALE 0.125
Ø1534
Ø1474
SEE DETAIL N
40
DETAIL N
SCALE 1.500
9.525
45°
WASTE PACKAGE DEPARTMENT
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 16 OF 25

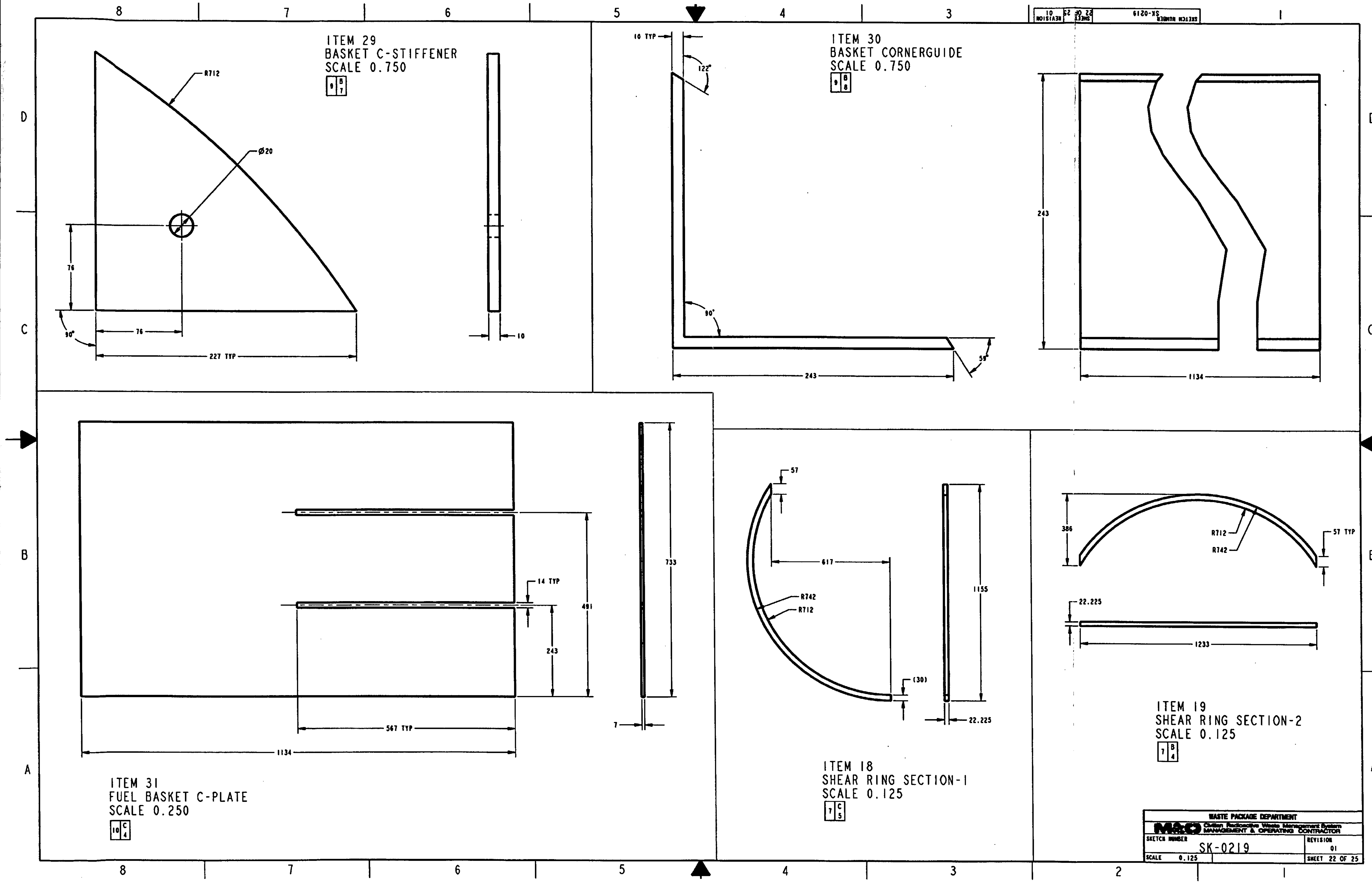

ITEM 6
OUTER SHELL FLAT BOTTOM LID
SCALE 0.150
Ø1574
25.4
SEE DETAIL P
ITEM 7
EXTENDED OUTER SHELL LID
SCALE 0.125
Ø1551
Ø1487
K
125.4
SEE DETAIL R
SECTION K-K
SCALE 0.125
ITEM 8
EXTENDED OUTER SHELL LID BASE
SCALE 0.150
Ø1487
Ø1462
25.4
SEE DETAIL T
DETAIL P
SCALE 2.000
9.525
70°
97°
16.825
DETAIL R
SCALE 1.250
93°
25
R3
25
7
DETAIL T
SCALE 1.500
12.7 TYP
45° TYP
WASTE PACKAGE DEPARTMENT
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 17 OF 25

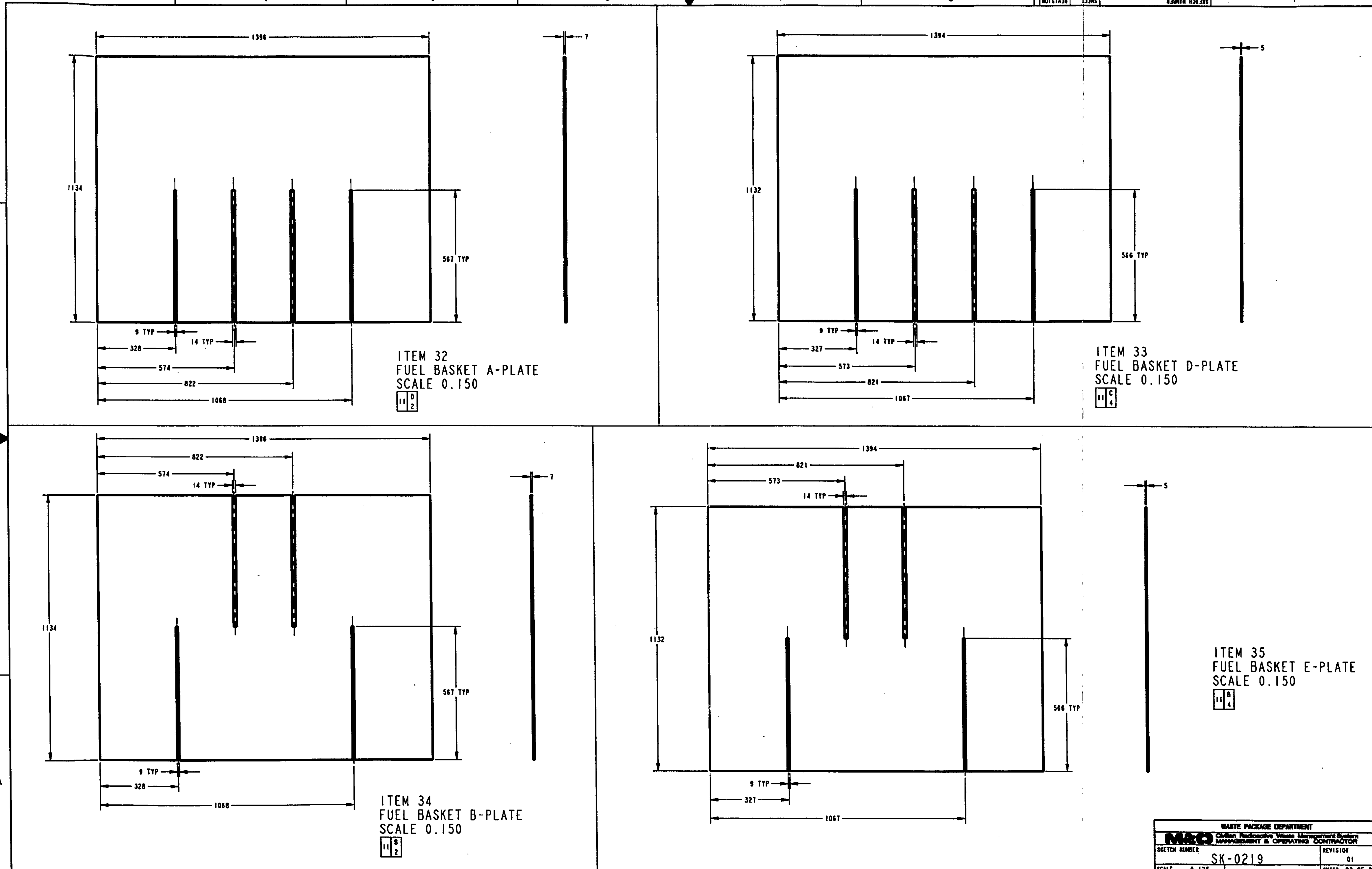

ITEM 9
LARGE REINFORCEMENT RING
SCALE 0.100
Ø1487
Ø1387
50
ITEM 14
OUTER SHELL FLAT CLOSURE LID
SCALE 0.100
Ø1537
9.525
ITEM 12
OUTER SHELL LID LIFTING FEATURE PLATE-1
SCALE 0.500
Ø311.15
Ø298.45
19.05
SEE DETAIL U
SECTION L-L
SCALE 0.500
DETAIL U
SCALE 3.000
3.175
19.05
6.35
45°
ITEM 10
SMALL REINFORCEMENT RING - TOP
SCALE 0.100
Ø1487
Ø1437
25
ITEM 11
SMALL REINFORCEMENT RING - BOTTOM
SCALE 0.100
Ø1387
Ø1337
25
ITEM 13
OUTER SHELL LID LIFTING FEATURE PLATE-2
SCALE 0.500
Ø311.15
Ø260.35
6.35
SEE DETAIL EE
SECTION Y-Y
SCALE 0.500
DETAIL EE
SCALE 3.000
25.4
22.225
6.35
45°
WASTE PACKAGE DEPARTMENT
M&O
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER SK-0219
REVISION 01
SCALE 0.125
SHEET 18 OF 25


ITEM 15
INNER SHELL
SCALE 0.150
Ø1524
Ø1424
M
M
SEE DETAIL V
4673
SECTION M-M
SCALE 0.150
SEE DETAIL BB
Ø1524
SEE DETAIL W
88.9
ITEM 16
INNER SHELL BOTTOM LID
SCALE 0.125
DETAIL W
SCALE 1.500
9.525
70°
97°
46.825
15
15
22.225
50.8
15
DETAIL V
SCALE 1.000
9.525
70°
97°
3.175
DETAIL BB
SCALE 1.500
243 TYP
R5 TYP
R9 TYP
226 TYP
R14 TYP
20
4575
236 TYP
ITEM 17
FUEL BASKET TUBE
SCALE 0.750
WASTE PACKAGE DEPARTMENT
M&O
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 19 OF 25


ITEM 20
INNER SHELL TOP LID
SCALE 0.150
Ø1454
480
SECTION N-N
SCALE 0.150
SEE DETAIL Y
50.8
ITEM 21
INNER LID LIFTING FEATURE PLATE-1
SCALE 0.500
Ø311.15
Ø298.45
SEE DETAIL AA
19.05
SECTION P-P
SCALE 0.500
ITEM 22
INNER LID LIFTING FEATURE PLATE-2
SCALE 0.500
Ø311.15
Ø260.35
SEE DETAIL FF
6.35
SECTION AA-AA
SCALE 0.500
Ø101.6
Ø76.2
Ø19.05
25.4
12.7
Ø12.7
DETAIL Y
SCALE 1.500
ITEM 23
EVACUATION-BACKFILL QUICK RELEASE VALVE
SCALE 2.500
3.175
19.05
45°
6.35
DETAIL AA
SCALE 3.000
25.4
6.35
45°
22.225
DETAIL FF
SCALE 3.000
WASTE PACKAGE DEPARTMENT
M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER SK-0219
REVISION 01
SCALE 0.125
SHEET 20 OF 25


ITEM 25
BASKET A-SIDEGUIDE
SCALE 1.000
10 TYP
101°
90°
30°
236
90
1134
ITEM 27
BASKET B-SIDEGUIDE
SCALE 1.000
10 TYP
95° TYP
90° TYP
236
93
1134
ITEM 24
EVACUATION-BACKFILL PORT COVER PLATE
SCALE 1.500
Ø127
6.35
3.175
Ø95.25
116.6°
ITEM 26
BASKET A-STIFFENER
SCALE 1.000
Ø20
R712
30
60
209
78
10
ITEM 28
BASKET B-STIFFENER
SCALE 1.000
R712
Ø20
42
108
216
83 TYP
92
10
WASTE PACKAGE DEPARTMENT
M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER SK-0219
REVISION 01
SCALE 0.125
SHEET 21 OF 25


ITEM 29
BASKET C-STIFFENER
SCALE 0.750
R712
Ø20
76
90°
76
227 TYP
10
ITEM 30
BASKET CORNERGUIDE
SCALE 0.750
10 TYP
122°
90°
59°
243
243
1134
ITEM 31
FUEL BASKET C-PLATE
SCALE 0.250
14 TYP
733
491
243
567 TYP
1134
7
ITEM 18
SHEAR RING SECTION-1
SCALE 0.125
57
617
R742
R712
(30)
1155
22.225
ITEM 19
SHEAR RING SECTION-2
SCALE 0.125
386
R712
R742
57 TYP
22.225
1233
WASTE PACKAGE DEPARTMENT
Civilian Radioactive Waste Management System
MANAGEMENT & OPERATING CONTRACTOR
SKETCH NUMBER
SK-0219
REVISION
01
SCALE 0.125
SHEET 22 OF 25



ITEM 32
FUEL BASKET A-PLATE
SCALE 0.150

ITEM 33
FUEL BASKET D-PLATE
SCALE 0.150

ITEM 34
FUEL BASKET B-PLATE
SCALE 0.150

ITEM 35
FUEL BASKET E-PLATE
SCALE 0.150

WASTE PACKAGE DEPARTMENT	
M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR	
SKETCH NUMBER SK-0219	REVISION 01
SCALE 0.125	SHEET 23 OF 25

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△2 COMPONENT LIST

ITEM NUMBER	ASSEMBLY	SUBASSEMBLY	SUBASSEMBLY	SUBASSEMBLY	COMPONENT NAME	MATERIAL	THICKNESS	MASS (kg)	QTY RQD
-1	21-PWR WASTE PACKAGE ASSEMBLY	-	-	-	-	-	-	25333	1
		-	-	-	-	-	-	△3 25357	△3 1
-2	-	OUTER SHELL ASSEMBLY	-	-	-	-	-	5728	1
1	-	-	-	-	OUTER SHELL	SB-575 N06022	20	4194	1
2	-	-	-	-	UPPER TRUNNION COLLAR SLEEVE	SB-575 N06022	40	446	1
3	-	-	-	-	LOWER TRUNNION COLLAR SLEEVE	SB-575 N06022	40	436	1
4	-	-	-	-	SHELL INTERFACE RING	SA-240 S31600	30	66	1
5	-	-	-	-	INNER SHELL SUPPORT RING	SB-575 N06022	40	47	1
6	-	-	-	-	OUTER SHELL FLAT BOTTOM LID	SB-575 N06022	25.4	423	1
-3	-	EXTENDED OUTER SHELL LID ASSEMBLY	-	-	-	-	-	713	1
7	-	-	-	-	EXTENDED OUTER SHELL LID	SB-575 N06022	25	133	1
8	-	-	-	-	EXTENDED OUTER SHELL LID BASE	SB-575 N06022	25.4	377	1
9	-	-	-	-	LARGE REINFORCEMENT RING	SB-575 N06022	50	98	1
10	-	-	-	-	SMALL REINFORCEMENT RING - TOP	SB-575 N06022	25	25	1
11	-	-	-	-	SMALL REINFORCEMENT RING - BOTTOM	SB-575 N06022	25	23	1
12	-	-	-	-	OUTER SHELL LID LIFTING FEATURE PLATE-1	SB-575 N06022	6.35	0.96	1
13	-	-	-	-	OUTER SHELL LID LIFTING FEATURE PLATE-2	SB-575 N06022	6.35	1.2	1
-4	-	OUTER SHELL FLAT CLOSURE LID ASSEMBLY	-	-	-	-	-	156	1
14	-	-	-	-	OUTER SHELL FLAT CLOSURE LID	SB-575 N06022	9.525	154	1
12	-	-	-	-	OUTER SHELL LID LIFTING FEATURE PLATE-1	SB-575 N06022	6.35	0.96	1
13	-	-	-	-	OUTER SHELL LID LIFTING FEATURE PLATE-2	SB-575 N06022	6.35	1.2	1
-5	-	INNER SHELL ASSEMBLY	-	-	-	-	-	18725	1
	-		-	-	-	-	-	△3 18748	△3 1
15	-	-	-	-	INNER SHELL	SA-240 S31600	50	8554	1
16	-	-	-	-	INNER SHELL BOTTOM LID	SA-240 S31600	88.9	1274	1
17	-	-	-	-	FUEL BASKET TUBE	SA-516 K02700	5	164	21
18	-	-	-	-	SHEAR RING SECTION-1	SA-240 S31600	22.225	8.2	2
19	-	-	-	-	SHEAR RING SECTION-2	SA-240 S31600	22.225	7.8	1
-6	-	-	INNER SHELL TOP LID ASSEMBLY	-	-	-	-	675	1
20	-	-	-	-	INNER SHELL TOP LID	SA-240 S31600	50.8	672	1
21	-	-	-	-	INNER LID LIFTING FEATURE PLATE-1	SA-240 S31600	6.35	0.89	1
22	-	-	-	-	INNER LID LIFTING FEATURE PLATE-2	SA-240 S31600	6.35	1.1	1
23	-	-	-	-	EVACUATION-BACKFILL QUICK RELEASE VALVE	SA-240 S31600	12.7	0.06	1
24	-	-	-	-	EVACUATION-BACKFILL PORT COVER PLATE	SA-240 S31600	6.35	0.82	1
-7	-	-	END SIDEGUIDE ASSEMBLY	-	-	-	-	29	32
25	-	-	-	-	BASKET A-SIDEGUIDE	SA-516 K02700	10	27	32
26	-	-	-	-	BASKET A-STIFFENER	SA-516 K02700	10	0.72	64
-8	-	-	SIDEGUIDE ASSEMBLY	-	-	-	-	39	16
27	-	-	-	-	BASKET B-SIDEGUIDE	SA-516 K02700	10	36	16
28	-	-	-	-	BASKET B-STIFFENER	SA-516 K02700	10	1.5	32
-9	-	-	CORNERGUIDE ASSEMBLY	-	-	-	-	47	16
29	-	-	-	-	BASKET C-STIFFENER	SA-516 K02700	10	2.3	32
30	-	-	-	-	BASKET CORNERGUIDE	SA-516 K02700	10	42	16
-10	-	-	FUEL PLATE ASSEMBLY	-	-	-	-	599	4
	-	-		-	-	-	-	△3 605	△3 4
31	-	-	-	-	FUEL BASKET C-PLATE	NEUTRONIT A 978	7	44	16
	-	-	-	-		△3 SA-516 K02700	△3 7	△3 45	△3 16
-11	-	-	-	FUEL PLATE A-D ASSEMBLY	-	-	-	106	8
	-	-	-		-	-	-	△3 107	△3 8
32	-	-	-	-	FUEL BASKET A-PLATE	NEUTRONIT A 978	7	85	8
	-	-	-	-		△3 SA-516 K02700	△3 7	△3 86	△3 8
33	-	-	-	-	FUEL BASKET D-PLATE	SB-209 A96061 T4	5	21	8
-12	-	-	-	FUEL PLATE B-E ASSEMBLY	-	-	-	106	8
	-	-	-		-	-	-	△3 107	△3 8
34	-	-	-	-	FUEL BASKET B-PLATE	NEUTRONIT A 978	7	85	8
	-	-	-	-		△3 SA-516 K02700	△3 7	△3 86	△3 8
35	-	-	-	-	FUEL BASKET E-PLATE	SB-209 A96061 T4	5	21	8
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	TOTAL CARBON STEEL WELDS	SFA-5.18 K10726	-	34	-
-	-	-	-	-	TOTAL ALLOY 22 WELDS	SFA-5.14 N06022	-	182	-
-	-	-	-	-	TOTAL 316 WELDS	SFA-5.9 S31680	-	41	-
-	-	-	-	-	-	-	-	-	-
-	-	-	PWR FUEL ASSEMBLY	-	-	-	-	△4 773.4	21
-	21-PWR WP ASSEMBLY WITH SNF	-	-	-	-	-	-	41574	1
		-	-	-	-	-	-	△3 41598	△3 1

SKETCH NUMBER SK-0219 SHEET 24 OF 25 REVISION 01

REVISION HISTORY

ZONE	REV	DESCRIPTION	DATE	APPROVED
D3-1	-	CONTINUED FROM SHEET 1	02/22/01	SMB
A4-6	01	34.9 WAS 37	02/22/01	SMB
A6-6	01	ADDED DETAIL CC CALLOUT	02/22/01	SMB
C6-7	01	ADDED SECTION W	02/22/01	SMB
D7-7	01	ADDED SECTION V	02/22/01	SMB
-	01	ADDED ITEM 18 IN ZONES C5-7, B7-13, C8-24, AND A4-22	02/22/01	SMB
-	01	ADDED ITEM 19 IN ZONES B4-7, C8-24, AND A2-22	02/22/01	SMB
C3-7	01	INNER SHELL ASSEMBLY PERSPECTIVE VIEW MODIFIED TO SHOW EXPLODED FUEL BASKET TUBES AND PLATE ASSEMBLY	02/22/01	SMB
-	01	ITEM 15 WAS ITEM 14 IN ZONES C2-7, C5-13, D3-13, D8-19, AND C8-24	02/22/01	SMB
-	01	ITEM 16 WAS ITEM 15 IN ZONES D1-7, C3-13, C5-19, AND C8-24	02/22/01	SMB
-	01	ITEM 17 WAS ITEM 16 IN ZONES C4-7, A2-19, AND C8-24	02/22/01	SMB
B8-7	01	4762 WAS 4712	02/22/01	SMB
-	01	88.9 WAS 50 IN ZONES A8-7, C5-19, AND C4-24	02/22/01	SMB
-	01	ITEM 20 WAS ITEM 17 IN ZONES C3-8, C1-12, B8-13, A4-12, D8-20, AND C8-24	02/22/01	SMB
A4-8	01	ADDED DETAIL DD TO SHOW CALLOUTS OF ITEM 21 AND ITEM 22	02/22/01	SMB
B7-8	01	ADDED DETAIL DD CALLOUT	02/22/01	SMB
A3-8	01	ADDED ITEM 20 CALLOUT	02/22/01	SMB
C2-12	01	ADDED ITEM 22	02/22/01	SMB
-	01	ITEM 23 WAS ITEM 19 IN ZONES A2-8, A4-12, A6-20, AND B8-24	02/22/01	SMB
-	01	ITEM 24 WAS ITEM 20 IN ZONES B2-8, B5-12, B2-21, AND B8-24	02/22/01	SMB
A8-8	01	76.2 WAS 77	02/22/01	SMB
D5-8	01	1454 WAS 1430	02/22/01	SMB
D8-9	01	ADDED SECTION R	02/22/01	SMB
-	01	DELETED 10 TYP IN ZONES B5-9, C5-9, AND D5-9	02/22/01	SMB
-	01	ADDED 20 TYP IN ZONES B5-9, C5-9, AND D5-9	02/22/01	SMB
-	01	ITEM 26 WAS ITEM 22 IN ZONES D7-9, A7-21, AND B8-24	02/22/01	SMB
-	01	ITEM 25 WAS ITEM 21 IN ZONES D6-9, C7-21, AND B8-24	02/22/01	SMB
-	01	ITEM 28 WAS ITEM 24 IN ZONES C7-9, B1-21, AND B8-24	02/22/01	SMB
-	01	ITEM 27 WAS ITEM 23 IN ZONES B7-21, C6-9, AND B8-24	02/22/01	SMB
C8-9	01	ADDED SECTION T	02/22/01	SMB
-	01	ITEM 30 WAS ITEM 26 IN ZONES B8-9, D3-22, AND B8-24	02/22/01	SMB
-	01	ITEM 29 WAS ITEM 25 IN ZONES D6-22, B7-9, AND B8-24	02/22/01	SMB
B8-9	01	ADDED SECTION U	02/22/01	SMB
-	01	ITEM 31 WAS ITEM 27 IN ZONES C4-10, A8-22, AND B8-24	02/22/01	SMB
-	01	ITEM 33 WAS ITEM 29 IN ZONES C4-11, C2-23, AND B8-24	02/22/01	SMB
-	01	ITEM 32 WAS ITEM 28 IN ZONES D2-11, C6-23, AND B8-24	02/22/01	SMB
-	01	ITEM 35 WAS ITEM 31 IN ZONES B4-11, B1-23, AND A8-24	02/22/01	SMB
-	01	ITEM 34 WAS ITEM 30 IN ZONES B2-11, A6-23, AND A8-24	02/22/01	SMB
-	01	6.35 WAS 12.7 IN ZONES D4-12 AND D2-12	02/22/01	SMB
D3-12	01	ADDED W9 IN 2 PLACES	02/22/01	SMB
D8-25	01	ADDED WELD 9	02/22/01	SMB
D3-12	01	ADDED W7 IN 2 PLACES	02/22/01	SMB
B4-12	01	ADDED W19	02/22/01	SMB
-	01	ADDED ITEM 13 CALLOUT IN ZONES D2-12 AND D5-12	02/22/01	SMB
C2-12	01	ITEM 21 WAS ITEM 18	02/22/01	SMB
C8-25	01	ADDED WELD 19	02/22/01	SMB
C4-12	01	W18 WAS W14	02/22/01	SMB
C8-25	01	WELD 18 WAS WELD 14	02/22/01	SMB
C4-12	01	6.35 WAS 12.7	02/22/01	SMB
C3-12	01	W17 WAS W13	02/22/01	SMB
C8-25	01	WELD 17 WAS WELD 13	02/22/01	SMB
C4-12	01	ADDED W17	02/22/01	SMB
B1-12	01	W21 WAS W16	02/22/01	SMB
C8-25	01	WELD 21 WAS WELD 16	02/22/01	SMB
A2-12	01	W20 WAS W15	02/22/01	SMB
C8-25	01	WELD 20 WAS WELD 15	02/22/01	SMB
C8-13	01	W10 WAS W9	02/22/01	SMB
C8-25	01	WELD 10 WAS WELD 9	02/22/01	SMB
C8-13	01	12.7 WAS 12.5 IN 2 PLACES	02/22/01	SMB
-	01	TYP WAS REMOVED FROM DIMENSIONS IN ZONES A3-13 AND B4-13	02/22/01	SMB
-	01	REFERENCE NOTE 1 CALLOUT WAS REMOVED IN ZONES A3-13 AND B4-13	02/22/01	SMB
C8-25	01	ADDED WELD 13 AND WELD 14	02/22/01	SMB
D3-25	-	CONTINUED ON SHEET 25	02/22/01	SMB

WASTE PACKAGE DEPARTMENT

M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR

SKETCH NUMBER SK-0219 | REVISION 01

SCALE 0.125 | SHEET 24 OF 25

WELD LIST				
WELD NUMBER	WELD TYPE	MATERIAL	MASS (KG)	QTY REQ'D
1	GROOVE	SFA-5.14 N06022	7.8	1
2	FILLET	SFA-5.14 N06022	35	1
3	FILLET	SFA-5.14 N06022	13	1
4	FILLET	SFA-5.14 N06022	12	1
5	FILLET	SFA-5.14 N06022	12	1
6	FILLET	SFA-5.14 N06022	11	1
7	FILLET	SFA-5.14 N06022	0.16	4
8	FILLET	SFA-5.14 N06022	0.17	2
9	GROOVE	SFA-5.14 N06022	0.09	2
10	GROOVE	SFA-5.14 N06022	3.3	2
11	FILLET	SFA-5.14 N06022	1.9	1
12	SQUARE	SFA-5.14 N06022	1.6	1
13	FILLET	SFA-5.9 S31680	0.18	1
14	FILLET	SFA-5.9 S31680	0.18	1
15	SQUARE	SFA-5.9 S31680	0.001	1
16	SQUARE	SFA-5.9 S31680	0.002	2
17	FILLET	SFA-5.9 S31680	0.15	2
18	FILLET	SFA-5.9 S31680	0.16	1
19	GROOVE	SFA-5.9 S31680	0.08	1
20	FILLET	SFA-5.9 S31680	0.01	1
21	FILLET	SFA-5.9 S31680	0.07	1
22	FILLET	SFA-5.14 N06022	14	2
23	GROOVE	SFA-5.9 S31680	40	1
24	GROOVE	SFA-5.14 N06022	1.9	1
25	FILLET	SFA-5.14 N06022	0.81	1
26	GROOVE	SFA-5.14 N06022	13	1
27	FILLET	SFA-5.14 N06022	37	1
28	FILLET	SFA-5.18 K10726	0.11	128
29	FILLET	SFA-5.18 K10726	0.15	64
30	FILLET	SFA-5.18 K10726	0.17	64
TOTAL CARBON STEEL WELDS		SFA-5.18 K10726	34	-
TOTAL ALLOY 22 WELDS	-	SFA-5.14 N06022	182	-
TOTAL 316 WELDS	-	SFA-5.9 S31680	41	-

NOTES:

1. GEOMETRY FOR THE EVACUATION-BACKFILL VALVE IS TBD.
2. THE 21-PWR WASTE PACKAGE CONFIGURATION WITH ABSORBER PLATES IS IDENTICAL TO THE 21-PWR WASTE PACKAGE CONFIGURATION WITH CONTROL RODS, EXCEPT FOR THE MATERIAL COMPOSITION OF THE FUEL BASKET A, B, AND C PLATES. ALL INFORMATION PROVIDED IN THIS TABLE IS FOR THE 21-PWR WASTE PACKAGE CONFIGURATION WITH ABSORBER PLATES, UNLESS OTHERWISE NOTED.
3. INFORMATION FOR THE 21-PWR WASTE PACKAGE CONFIGURATION WITH CONTROL RODS.
4. CRWMS M&O 1997. WASTE CONTAINER CAVITY SIZE DETERMINATION. BBAA00000-01717-0200-00026 REV 00. LAS VEGAS, NV: CRWMS M&O. ACC: MOL. 19980106.0061
5. WELD 15 SQUARE BUTT WELD IS PLACED ON THE EXPOSED SURFACES ABOVE THE OPEN CREVICE CREATED BETWEEN THE MATING SURFACES OF BOTH SHEAR RING SECTION-1 COMPONENTS. THIS WELD IS INTENDED TO INSURE ISOLATION OF THE INTERIOR OF THE INNER SHELL ASSEMBLY FROM EXTERNAL ENVIRONMENTS.
6. WELD 16 SQUARE BUTT WELDS ARE PLACED ON THE EXPOSED SURFACES ABOVE THE OPEN CREVICE CREATED BETWEEN THE MATING SURFACES OF THE SHEAR RING SECTION-1 AND THE SHEAR RING SECTION-2 COMPONENTS. THIS WELD IS INTENDED TO INSURE ISOLATION OF THE INTERIOR OF THE INNER SHELL ASSEMBLY FROM EXTERNAL ENVIRONMENTS.

REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED
A3-25	-	CONTINUED FROM SHEET 25	02/22/01	SMB
A3-20	01	DETAIL AA WAS MODIFIED DUE TO ITEM 21 REDESIGN	02/22/01	SMB
-	01	ITEM 22 WAS ADDED IN ZONES D3-20 WITH SECTION AA AND C8-24	02/22/01	SMB
B2-20	01	ADDED SECTION AA-AA WITH DETAIL FF	02/22/01	SMB
A2-20	01	ADDED DETAIL FF	02/22/01	SMB
C2-21	01	95.25 WAS 101.6	02/22/01	SMB
D3-24	01	25333 WAS 24647	02/22/01	SMB
D3-24	01	25357 WAS 24671	02/22/01	SMB
D3-24	01	5728 WAS 5679	02/22/01	SMB
D3-24	01	4194 WAS 4152	02/22/01	SMB
D3-24	01	423 WAS 416	02/22/01	SMB
D3-24	01	713 WAS 718	02/22/01	SMB
D3-24	01	377 WAS 371	02/22/01	SMB
C4-24	01	6.35 WAS 27 IN 3 PLACES	02/22/01	SMB
C3-24	01	0.96 WAS 13 IN 2 PLACES	02/22/01	SMB
C3-24	01	154 WAS 161	02/22/01	SMB
C3-24	01	156 WAS 176	02/22/01	SMB
C3-24	01	8554 WAS 8529	02/22/01	SMB
C3-24	01	18725 WAS 18062	02/22/01	SMB
C3-24	01	18748 WAS 18086	02/22/01	SMB
C3-24	01	1274 WAS 708	02/22/01	SMB
C3-24	01	675 WAS 646	02/22/01	SMB
C3-24	01	672 WAS 632	02/22/01	SMB
C3-24	01	0.89 WAS 12	02/22/01	SMB
B4-24	01	6.35 WAS 6.4	02/22/01	SMB
B3-24	01	0.82 WAS .84	02/22/01	SMB
-	01	ADDED TOTAL CARBON STEEL WELDS IN ZONES A5-24 AND B8-25	02/22/01	SMB
-	01	182 WAS 183 IN ZONES A3-24 AND B7-25	02/22/01	SMB
-	01	41 WAS 59 IN ZONES A3-24 AND B7-25	02/22/01	SMB
A3-24	01	41574 WAS 40889	02/22/01	SMB
A3-24	01	41598 WAS 40913	02/22/01	SMB
D7-25	01	0.16 WAS .20	02/22/01	SMB
D6-25	01	4 WAS 2	02/22/01	SMB
D7-25	01	0.17 WAS .98	02/22/01	SMB
D7-25	01	3.3 WAS 3.2	02/22/01	SMB
C7-25	01	1.9 WAS 2.1	02/22/01	SMB
C7-25	01	1.6 WAS 1.7	02/22/01	SMB
C7-25	01	0.15 WAS .18	02/22/01	SMB
C7-25	01	0.16 WAS .90	02/22/01	SMB
C7-25	01	0.01 WAS .01	02/22/01	SMB
-	01	REFERENCE NOTE 1 WAS REFERENCE NOTE 2 IN ZONES B6-20 AND B8-25	02/22/01	SMB
-	01	REFERENCE NOTE 2 WAS REFERENCE NOTE 3 IN ZONES B8-25 AND D6-24	02/22/01	SMB
-	01	REFERENCE NOTE 3 WAS REFERENCE NOTE 4 IN ZONES D3-24 IN 2 PLACES, C3-24 IN 2 PLACES, B4-24 IN 4 PLACES, B3-24 IN 8 PLACES, A4-24 IN 2 PLACES, A3-24 IN 6 PLACES, AND B8-25	02/22/01	SMB
A8-25	01	REFERENCE NOTE 4 WAS REFERENCE NOTE 5 IN ZONES A8-25 AND A3-24	02/22/01	SMB
A8-25	01	REFERENCE NOTE 5 WAS ADDED	02/22/01	SMB
A8-25	01	REFERENCE NOTE 6 WAS ADDED	02/22/01	SMB

SKETCH NUMBER	SHEET	REVISION
SK-0219	25 OF 25	01

REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED
A3-24	-	CONTINUED FROM SHEET 24	02/22/01	SMB
B8-13	01	ADDED W13 AND W14	02/22/01	SMB
-	01	W22 WAS W17 IN ZONES A5-13 AND D1-13	02/22/01	SMB
C8-25	01	WELD 22 WAS WELD 17	02/22/01	SMB
C5-13	01	W12 WAS W10	02/22/01	SMB
C8-25	01	WELD 12 WAS WELD 11	02/22/01	SMB
C5-13	01	9.525 WAS 10 IN 2 PLACES	02/22/01	SMB
C5-13	01	W11 WAS W10	02/22/01	SMB
C8-25	01	WELD 11 WAS WELD 10	02/22/01	SMB
C4-13	01	W24 WAS W19	02/22/01	SMB
C8-25	01	WELD 24 WAS WELD 19	02/22/01	SMB
C3-13	01	9.525 WAS 9.5	02/22/01	SMB
C3-13	01	W25 WAS W20	02/22/01	SMB
C8-25	01	WELD 25 WAS WELD 20	02/22/01	SMB
C3-13	01	6.35 WAS 6.4	02/22/01	SMB
C3-13	01	W27 WAS W22	02/22/01	SMB
C8-25	01	WELD 27 WAS WELD 22	02/22/01	SMB
C1-13	01	W26 WAS W21	02/22/01	SMB
C8-25	01	WELD 26 WAS WELD 21	02/22/01	SMB
D1-13	01	W23 WAS W18	02/22/01	SMB
C8-25	01	WELD 23 WAS WELD 18	02/22/01	SMB
C7-14	01	ADDED SECTION R-R TO SHOW ADDITION OF W28 IN 4 PLACES	02/22/01	SMB
C8-25	01	ADDED WELD 28	02/22/01	SMB
C8-25	01	ADDED WELD 29	02/22/01	SMB
B7-14	01	ADDED SECTION T-T TO SHOW ADDITION OF W29 IN 4 PLACES	02/22/01	SMB
A8-14	01	ADDED SECTION V-V TO SHOW ADDITION OF W15 WITH REFERENCE NOTE 5	02/22/01	SMB
C8-25	01	ADDED WELD 15	02/22/01	SMB
A3-14	01	ADDED SECTION W-W TO SHOW ADDITION OF W16 WITH REFERENCE NOTE 6	02/22/01	SMB
C8-25	01	ADDED WELD 16	02/22/01	SMB
B3-14	01	ADDED SECTION U-U TO SHOW ADDITION OF W30 IN 4 PLACES	02/22/01	SMB
D6-15	01	OD AND ID REMOVED FROM DIMENSIONS	02/22/01	SMB
B8-15	01	5004 WAS 4955	02/22/01	SMB
A6-16	01	245 DIMENSION WAS REMOVED	02/22/01	SMB
B8-25	01	ADDED WELD 30	02/22/01	SMB
-	01	25.4 WAS 25 IN ZONES C3-17, C8-17, AND D4-24 IN 2 PLACES	02/22/01	SMB
B2-17	01	12.7 WAS 12.5	02/22/01	SMB
-	01	9.525 WAS 10 IN ZONES C6-18 AND C4-24	02/22/01	SMB
-	01	ITEM 13 WAS ADDED IN ZONES B4-18 WITH SECTION Y AND C8-24 IN 2 PLACES	02/22/01	SMB
A4-18	01	ADDED SECTION Y-Y WITH DETAIL EE	02/22/01	SMB
B2-18	01	ADDED DETAIL EE	02/22/01	SMB
-	01	ITEM 12 OUTER SHELL LID LIFTING FEATURE PLATE-1 WAS OUTER SHELL LID LIFTING FEATURE IN ZONES D4-18 AND C5-24 IN 2 PLACES	02/22/01	SMB
D4-18	01	ITEM 12 WAS REDESIGNED	02/22/01	SMB
C4-18	01	SECTION L-L MODIFIED DUE TO ITEM 12 REDESIGN	02/22/01	SMB
C1-18	01	DETAIL U WAS MODIFIED DUE TO ITEM 12 REDESIGN	02/22/01	SMB
A5-19	01	INNER SHELL CLOSURE CONFIGURATION MODIFIED	02/22/01	SMB
B8-19	01	4673 WAS 4635	02/22/01	SMB
D6-20	01	1454 WAS 1430	02/22/01	SMB
-	01	50.8 WAS 50 IN ZONES B8-20 AND C4-24	02/22/01	SMB
B7-20	01	101.6 WAS 102	02/22/01	SMB
B7-20	01	76.2 WAS 76	02/22/01	SMB
B7-20	01	19.05 WAS 19	02/22/01	SMB
A6-20	01	SCALE 2.500 WAS 3.500	02/22/01	SMB
A8-20	01	DETAIL Y MODIFIED DUE TO REDESIGN OF ITEM 20	02/22/01	SMB
A8-20	01	25.4 WAS 25	02/22/01	SMB
-	01	12.7 WAS 13 IN ZONES A7-20 AND A8-20	02/22/01	SMB
D8-20	01	ITEM 20 WAS REDESIGNED	02/22/01	SMB
B7-20	01	SECTION N-N MODIFIED DUE TO REDESIGN OF ITEM 20	02/22/01	SMB
-	01	ITEM 21 INNER LID LIFTING FEATURE PLATE-1 WAS ITEM 18 INNER LID LIFTING FEATURE IN ZONES D5-20 AND C5-24	02/22/01	SMB
D5-20	01	ITEM 21 WAS REDESIGNED	02/22/01	SMB
B5-20	01	SECTION P-P MODIFIED DUE TO REDESIGN OF ITEM 21	02/22/01	SMB
D5-25	-	CONTINUED ON SHEET 25	02/22/01	SMB

WASTE PACKAGE DEPARTMENT

M&O Civilian Radioactive Waste Management System MANAGEMENT & OPERATING CONTRACTOR

SKETCH NUMBER	REVISION
SK-0219	01
SCALE 0.125	SHEET 25 OF 25

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
SPECIAL INSTRUCTION SHEET
Complete Only Applicable Items

file list 5-21-01 nfc

1. QA: QA
Page: 1 of: 1

This is a placeholder page for records that cannot be scanned.

2. Record Date 03/07/2001	3. Accession Number ATT-TOMOL.20010521.0062
4. Author Name(s) ADAM K. SCHEIDER	5. Author Organization N/A
6. Title/Description SWING-DOWN OF 21-PWR WASTE PACKAGE	
7. Document Number(s) CAL-UDC-ME-000013	8. Version Designator REV 00
9. Document Type DATA	10. Medium CD-ROM
11. Access Control Code PUB	
12. Traceability Designator DC # 27456	

13. Comments
THIS IS A SPECIAL PROCESS CD-ROM DUE TO THE CD-ROM ENCLOSED AS PART OF ATTACHMENT II, AND CAN BE LOCATED THROUGH THE RPC

NOTE: SEE ATTACHMENT OF ELECTRONIC SOURCE FILE VERIFICATION FORM PER AP-17.1Q/ICN 3, SECTION 5.1 (C), ELECTRONIC RECORDS.

THIS DATA SUBMITTAL TO THE RECORDS PROCESSING CENTER IS FOR ARCHIVE PURPOSES ONLY, AND IS NOT AVAILABLE FOR VIEWING OR REPRODUCTION

1 of 2

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

ELECTRONIC SOURCE FILE VERIFICATION

QA: N/A

1. DOCUMENT TITLE: SWING-DOWN OF 21-PWR WASTE PACKAGE	
2. DOCUMENT IDENTIFIER: CAL-UDC-ME-000013	3. REVISION DESIGNATOR: REV. 00

ELECTRONIC SOURCE FILE INFORMATION

4. ELECTRONIC SOURCE FILE NAME WITH FILE EXTENSION PROVIDED BY THE SOFTWARE: calME9r01.doc		
5. DATE LAST MODIFIED: 05/04/2001 / See attached	6. ELECTRONIC SOURCE FILE APPLICATION: (I.E., EXCEL, WORD, CORELDRAW) MS WORD / See attached	7. FILE SIZE IN KILOBYTES: 906KB / See attached
8. FILE LINKAGE INSTRUCTIONS/INFORMATION: NORMAL - NORMAL		

9. FILE CUSTODIAN: (I.E., DC, OR DC APPROVED CUSTODIAN) DOCUMENT CONTROL	10. FILE LOCATION FOR DC APPROVED CUSTODIAN: (I.E., SERVER, DIRECTORY) NONE - NONE
11. PRINTER SPECIFICATION (I.E., HP4SI) INCLUDING POSTSCRIPT INFORMATION (I.E., PRINTER DRIVER) AND PRINTING PAGE SETUP: (I.E., LANDSCAPE, 11 X 17 PAPER) HP4si, 8.5"x11 Paper, Normal Driver, Portrait /HP5Si Landscape for Att ~~II~~ I. on 11"x 17" paper (AKS MAY 10, 2001)	
12. COMPUTING PLATFORM USED: (I.E., SUN) ~~IBM COMPATIBLE~~ PC # 110765 (DDV 5-10-01)	13. OPERATING EQUIPMENT USED: (I.E., UNIX, SOLARIS) MS WINDOWS
14. ADDITIONAL HARDWARE/SOFTWARE REQUIREMENT USED TO CREATE FILE(S): NONE	15. ACCESS RESTRICTIONS: (IF ANY) NONE

COMMENTS/SPECIAL INSTRUCTIONS

16.

ATTACHMENT II FOR CAL-UDC-ME0000013 REV. 00

SEE ATTACHED #5 & 7 FOR INFORMATION ON ATTACHMENT

CERTIFICATION

17. NAME (Print and Sign) ADAM K. SCHEIDER *Adam K. Scheider*			18. DATE: 05/10/01
19. ORGANIZATION: WPP	20. DEPARTMENT: STRUCTURAL	21. LOCATION/MAILSTOP: MS 423	22. PHONE: 295-4602

DC USE ONLY

23. DATE RECEIVED: 05/10/01	24. DATE REVIEWED: 05/14/2001	25. DATE FILES TRANSFERRED: 05/14/2001
26. NAME (Print and Sign): Marina Blackwell *Marina Blackwell*		27. DATE: 05/16/2001

CD contents:
CAL-UDC-ME-000013 REV 00
Swing-Down of 21-PWR Waste Package
Attachment II

Description	Date	Time	Size
d3hspt1	02/07/2001	1:56 PM	26,625 KB
d3hspt2	02/07/2001	1:52 PM	26,608 KB
d3hspt3	02/07/2001	1:58 PM	26,598 KB
d3hspt3v	02/07/2001	1:54 PM	26,598 KB
elist.inc	02/07/2001	1:52 PM	5,439 KB
nlist.inc	02/07/2001	1:52 PM	5,563 KB
sd.inp	02/07/2001	1:56 PM	37KB
sdt1.k	02/07/2001	1:56 PM	3 KB
sdt2.k	02/07/2001	1:52 PM	3 KB
sdt3.k	02/07/2001	1:58 PM	3 KB
sdt3v.k	02/07/2001	1:54 PM	3 KB

Note: The file sizes may vary with operating system.

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