APPENDIX J

SUMMARY OF RECENT INFORMATION RELEVANT TO DISRUPTIVE EVENTS—CRITICALITY

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1. INTRODUCTION

This white paper contains a summary of recently developed information that is relevant to the criticality disruptive event information used to support the *Yucca Mountain Science and Engineering Report* (YMS&ER) (DOE 2001a) and the *Yucca Mountain Preliminary Site Suitability Evaluation* (YMPSSE) (DOE 2001b). The U.S. Department of Energy (DOE) released these two documents for public review in May and August, respectively, of this year.

The white paper focuses on additional information pertaining to the probability of in-package criticality that has been developed since *Probability of Criticality Before 10,000 Years* (CRWMS M&O 2000a) was issued. Portions of this report were used to support the preparation of the YMS&ER (DOE 2001a) and the YMPSSE (DOE 2001b). The summary of this recent information is being used to conduct an impact review, in accordance with AP-2.14Q, *Review of Technical Products and Data*, to determine if this additional information has any impact on the technical analyses supporting the YMS&ER (DOE 2001a) and the YMPSSE (DOE 2001b). This additional information has been developed using preliminary models that are consistent with the methodology described in *Disposal Criticality Analysis Methodology Topical Report* (YMP 2000). The documentation of the additional information in this white paper is an interim step, and primarily used to support this impact review. This information is expected to be formally documented in subsequent Project technical reports, as appropriate.

To assist in the impact review, this white paper briefly describes the criticality disruptive event information that was used to support the YMS&ER (DOE 2001a) and the YMPSSE (DOE 2001b), provides a summary of the additional information recently developed, and discusses the potential implications of this more recent information on our understanding of the criticality disruptive event.

2. SUMMARY DESCRIPTION OF THE 10,000-YEAR CRITICALITY INPUTS

Features, Events, and Processes: System-Level and Criticality (CRWMS M&O 2000b) initially screened out criticality based on results from *Analysis of Mechanisms for Early Waste Package Failure* (CRWMS M&O 2000c) and *Probability of Criticality Before 10,000 Years* (CRWMS M&O 2000a). Subsequently, however, *FY01 Supplemental Science and Performance Analyses* (BSC 2001a, Section 7.3.6) postulated a waste package early failure condition not addressed in the previous references. Additional work has been performed to address this postulated waste package early failure condition and to update the probability of criticality.

3. SUMMARY OF RECENTLY DEVELOPED ADDITIONAL INFORMATION

The following evaluation of the potential for waste package criticality prior to 10,000 years is based on the initial assumption of three early waste package failures. A probability of unity is used for this event although the probability of three non-mechanistic, early waste package failures is given as 0.002 in *FY01 Supplemental Science and Performance Analyses* (BSC 2001a, Section 7.3.6). Several independent events must occur in order to have a criticality event in the failed waste packages. These events include:

- The potential for sufficient water flow to enter the waste package failure location either through (1) a flow path from the mountain surface or (2) condensation from the underside of the drip shield.

- For scenario (1) above, the potential for a drip shield failure to allow water flow from the drift overhead to the failed waste package.

- The potential that the water source is horizontally and vertically aligned to allow flow into the waste package failure location. For scenario (1) above, this includes the potential that a failed drip shield is aligned over a failed waste package and that seepage from the drift overhead strikes the drip shield and waste package in a location that would allow the water to enter the waste package failure location. For scenario (2) above, this includes the potential that the condensation is released above the failed waste package and that it strikes the failed waste package in a location that would allow the water to enter the waste package.

- The potential that the waste package failure location and geometry is such that water could enter and be retained in the waste package in a sufficient volume and for a sufficient period of time to allow for waste form degradation and moderation. Other issues to be considered in the evaluation of this issue include whether the failure location becomes plugged with corrosion products or water impurities and whether the heat generation rate of the waste form is below the evaporation rate of the water inflow.

- The potential that the waste form degradation process would allow for a critical configuration. This includes the potential that: (1) the waste form contains sufficient fissile material to become critical; (2) the neutron absorber material is flushed from the waste form matrix; (3) the corrosion products are flushed from the waste form matrix; and (4) the waste form degrades to a critical configuration.

The following sections discuss these events in detail. In some instances, a preliminary quantification of these events is presented. Because of the recent nature of the information provided in this section, much of it is unpublished; therefore, some source references have been provided where appropriate, but others could not be provided.

3.1 AVAILABILITY OF WATER

The presence of water is essential to the occurrence of waste package criticality. This necessitates the availability of a sufficient and focused water source entering the failed waste package's inner shell. Water flow is surmised to be potentially available from two independent sources: (1) focused flow from the mountain surface to the drift overhead directly above the failed waste package and (2) condensation from the underside of the drip shield directly above the failed waste package.

The availability of a focused flow of water from the mountain surface to the drift directly above the failed waste package in a sufficient quantity to flood a waste package is dependent on two factors. The first factor is the probability that the climate of southern Nevada could support such a flow rate. This probability is given as unity in *Total System Performance Assessment for the Site Recommendation* (CRWMS M&O 2000d, Table 3.2-1). It is based on an analysis that a glacial transition climate is expected to occur within the next 2,000 to 10,000 years. The second factor accounts for seepage from the mountain surface to the emplacement drift above any given waste package. From Table 16 of Results from Abstraction of Drift Seepage (SN0012T0511599.003) the most likely ("Peak of Triangle") seepage fraction can be calculated to be 0.17.

Therefore, the estimated probability of focused flow infiltrating into the mountain surface to the drift directly above the failed waste package is estimated to be 0.17 (1.0×0.17).

The second water source considered is condensation from the underside of the drip shield directly above the failed waste package. An estimate of the probability of this factor has not been undertaken. Therefore, this probability is conservatively assumed to have a value of unity. However, this water source is considered unlikely. In order for water to physically drip from the underside of the drip shield onto the failed waste package, the drip must occur at or near the apex of the drip shield. Condensation flow from other parts of the drip shield surface would either flow down the sides of the drip shield due to gravity or impinge on the waste package surface at a point where flow would not be accessible to the waste package failure location.

3.2 DRIP SHIELD FAILURE

In the water source scenario in which there is a focused water flow from the mountain surface to the drift directly above the failed waste package, it is necessary for the drip shield above the failed waste package to also be failed. This is necessary to allow the water to flow from the drift overhead, through the drip shield, and onto the failed waste package. A drip shield failure can occur due to the following three factors:

1. **Emplacement Error**—For the continuous drip shield, a drip shield segment is misaligned during emplacement resulting in a gap between two segments. Drip shield segments are designed to interlock to provide a continuous protective umbrella for the waste packages, along the length of the emplacement drift.

2. **Fabrication Error**—The drip shield is not fabricated to specifications due to the use of improper materials or bad welds.

3. **Rockfall Event**—A rockfall event can cause the drip shield to breach either through direct impact or via stress corrosion cracking. The residual stresses in the drip shield

resulting from a rockfall as small as 1 metric ton have been calculated to be sufficient to allow for stress corrosion cracking.

3.2.1 Drip Shield Emplacement Error

The probability of drip shield emplacement error is calculated using the binomial model (Walpole et al. 1998, p. 118). The binomial model assumes a given number of drip shield emplacement errors will occur in the repository during the preclosure period and that each drip shield emplacement is an independent event. The binomial model is defined as:

$$P_n(x) = \binom{n}{x} p^x \ (1 - p)^{n-x}$$

where: p is the probability of a single emplacement error
n is the total number of emplacements
x is the expected number of emplacement errors.

The probability of having at least one drip shield emplacement error is calculated by subtracting the probability of having no drip shield emplacements from one. To calculate this probability, the following values are input into the equation above: a single drip shield emplacement error probability (variable p) of 9.0×10^{-5} (CRWMS M&O 2000c, p. 62); and the emplacement of 11,538 drip shields (variable n) [11,538 = 60,000 m (196,850 ft) of total drift length (DOE 2001a, Table 2-2) divided by 5.2 m (17.1 ft) per drip shield segment (CRWMS M&O 2000e, p. II-1)]. Using these inputs, the probability of having at least one drip shield emplacement error is calculated to be 6.5×10^{-1}.

$$1 - P_{11,538}(0) = \{1 - [(9.0 \times 10^{-5})^0 (1\text{-}9.0 \times 10^{-5})^{11,538}]\} = 6.5 \times 10^{-1}$$

3.2.2 Drip Shield Fabrication Error

A probability of 2.4×10^{-3} is estimated for drip shield failure due to fabrication errors. This probability is based on the waste package fabrication error flaw information obtained from *Analysis of Mechanisms for Early Waste Package Failure* (CRWMS M&O 2000c, p. 44). Because no information was readily available for Titanium Grade 7, the Alloy 22 information from *Analysis of Mechanisms for Early Waste Package Failure* (CRWMS M&O 2000c) was used and doubled to account for uncertainty.

Using the lognormal cumulative flaw distribution equation of *Analysis of Mechanisms for Early Waste Package Failure* (CRWMS M&O 2000c, p. 34), the probability of a weld flaw 7.5 mm (0.3 in.) deep (half the depth of the weld on the drip shield) is estimated to be 1.04×10^{-3}. Doubling this weld flaw probability results in 2.08×10^{-3}. Multiplying by the probability of weld inspection failure (1×10^{-4}) presented in *Analysis of Mechanisms for Early Waste Package Failure* (CRWMS M&O 2000c, p. 34) and the number of drip shield segments fabricated (11,538 [60,000 m (196,850 ft) total drift length/5.2 m (17.1 ft) per drip shield segment]) results in a probability of drip shield fabrication error of 2.4×10^{-3}.

3.2.3 Rockfall Event onto Drip Shield

A probability of 7.4×10^{-3} is estimated for drip shield breach due to a rockfall event. This probability is calculated using the expected number of key blocks greater than 1 metric ton. It is estimated that there are 60 key blocks of this magnitude, based on information in *Expected Number of Key Blocks throughout the Emplacement Drifts as a Function of Block Size* (CRWMS M&O 2000f, p. 13, Equation 6). All key blocks identified are assumed to fall within the study period (10,000 years) as no rockfall frequency is available. The total effective length of the key blocks is estimated to be 329 m (1,079 ft), the length per rock mass obtained from *Drift Degradation Analysis* (CRWMS M&O 2000g, Table IX-2). In addition to the key block length, residual stresses in the drip shield that may result in stress corrosion cracking can occur up to 1 m (3.3 ft) on either side of the key block impact point (BSC 2001b). This results in a potential drip shield failure length of 442 m (1,450 ft) out of a total drip shield length of 60,000 m (196,850 ft), or a probability of 7.4×10^{-3}. This estimate assumes that plugging of the drip shield breach by precipitates or corrosion products will not occur.

3.2.4 Cumulative Drip Shield Failure Probability

The cumulative probability of drip shield failure is estimated to be 6.5×10^{-1}. This probability is dominated by the drip shield emplacement error probability. The probability that a failed drip shield is located at a specific location that would allow the focused flow to impinge on a failed waste package is estimated to be one divided by the total number of drip shields. This probability is estimated to be 8.7×10^{-5} (5.2 m/60,000 m; where 5.2 m (17.1 ft) is the length of a drip shield segment (CRWMS M&O 2000e, p. II-1) and 60,000 m (196,850 ft) is the total length of the emplacement drifts (DOE 2001a, Table 2-2). The probability that a failed drip shield is located at a specific location is calculated by multiplying the cumulative drip shield failure probability (6.5×10^{-1}) by the drip shield location probability (8.7×10^{-5}). This value is calculated to be 5.7×10^{-5}. To date, no dependency has been identified for a common mode of drip shield failure and focused flow onto the failed drip shield events.

3.3 FOCUSED FLOW ONTO FAILED WASTE PACKAGE

In order for the water source to enter the failed waste package through the failure location, the flow must be horizontally and vertically aligned in a specific configuration. The following subsections discuss the necessary alignments. Both the horizontal and vertical alignment evaluations assume that the waste package is orientated (tilted) in a manner that is optimum for the water flow to enter the waste package failure location.

3.3.1 Horizontal Alignment of Flow

In either water source scenarios presented in Section 3.1, the water source must impact on the failed waste package in order to allow flow into the waste package failure location. Because of the configuration of the waste package outer barrier trunnion collar, the flow from either source (drip shield breach or condensation from the underside of the drip shield) must impact no more than 165 mm (6.50 in.) from the closure end of the waste package (CRWMS M&O 2000h, Att. I, SK-0175 Rev 02, Sheet 2 of 2). Otherwise, the raised profile of the trunnion collar will prevent flow from reaching the failure location. This results in a probability that the failed waste package will be under the failed drip shield of 8.4×10^{-6}. This probability estimate assumes an average waste package length of 5 m (16.4 ft) and the three failed waste packages out of a total of 11,770 waste packages emplaced.

$$8.4 \times 10^{-6} = (0.165 \text{ m}/5 \text{ m})(3/11{,}770)$$

3.3.2 Vertical Alignment of Flow

For the water source scenario from the mountain surface to the drift overhead, it is estimated that the flow from the drift overhead onto the drip shield and from the drip shield breach onto the waste package must occur within 3.5° of the drip shield or waste package apex. A 7° arc ($2 \times 3.5°$) is based on a maximum waste package tilt angle of 3.3° that can be achieved due to failure of one end of the waste package pallet.

$$3.3° = \sin^{-1} (230 \text{ mm}/4{,}024.8 \text{ mm})$$

where: 230 mm (9.1 in.) is the height of the waste package above the intact end of the waste package pallet

$$230 \text{ mm} = 1{,}012 \text{ mm} - (1{,}564 \text{ mm}/2)$$

where: 1,012 mm (39.8 in.) is the height from emplacement drift floor to the 21-PWR waste package radial center (CRWMS M&O 2000e, Att. II, SK-0144 Rev 01, p. II-3)

1,564 mm (61.6 in.) is the outer barrier diameter of the 21-PWR waste package (CRWMS M&O 2000h, Att. I, SK-0175 Rev 02, p. 1 of 2)]

4,024.8 mm is the length of the waste package from the collapsed pallet end to the intact pallet support

$$4{,}024.8 \text{ mm} = 430 \text{ mm} + (4147.2 - 552.4 \text{ mm})$$

where: 430 mm is the length of bottom trunnion collar on the 21-PWR waste package (CRWMS M&O 2000h, Att. I, SK-0175 Rev 02, p. 2 of 2)

4147.2 mm is the length of the waste package pallet (CRWMS M&O 2000e, Att. III, SK-0144 Rev 01, p. III-1)

552.4 mm is the length of the pallet waste package support (CRWMS M&O 2000e, Att. III, SK-0144 Rev 01, p. III-1)

Otherwise, the flow will roll off the curved sides of either the drip shield or waste package due to gravity rather than flowing horizontally along the drip shield or waste package surface to the failure location. This would further necessitate that the flow source from the drift overhead be within 3.5° of the drift overhead apex. However, the radial arc of the flow from the drift overhead could be greater than 7° if a rockfall results in a drip shield surface depression that could funnel the focused flow from the drift overhead to the drip shield failure location.

The probability of each of these constraints is estimated as 3.9×10^{-2} (7°/180°). In addition, once the water flow contacts the waste package, the location of the waste package failure must be such that flow can enter. This would necessitate the failure to be located on the top half of the waste package lid. Otherwise gravitational forces would pull the flow along the waste package surface to the bottom of the waste package. The probability that the failure location is on the top half of the waste package is estimated as 0.5 (180°/360°). Together, these conditions result in a flow vertical alignment probability of 2.9×10^{-5} $[(7°/180°)^3 \times (180°/360°)]$. It should be noted that even if the flow impact area is increased to 5° on either side of the structure apex (drift, drip shield, and waste package), the vertical alignment probability would only increase to 8.6×10^{-5}.

The probability that condensation from the underside of the drip shield will enter the waste package failure location has some of the same events listed above. These events are the waste package impingement radius (within 3.5° of the waste package apex) and the waste package failure location (top half of the waste package lid weld). The flow vertical alignment probability for this scenario is estimated to be 1.9×10^{-2} $[(7°/180°) \times (180°/360°)]$. If the flow impact area is increased to 5° on either side of the waste package apex, the vertical alignment probability would only increase to 2.8×10^{-2}.

3.4 WASTE PACKAGE WATER ACCUMULATION

The water has to enter the waste package in such a manner that the water can accumulate to sufficient depth and have sufficient flow to allow absorber material and corrosion product removal and provide sufficient moderation to allow criticality to occur. A conservative, but unrealistic, failure configuration would be a discrete failure point on the waste package outer lid weld which is located on the top half of the horizontally emplaced waste package and a complete circumferential failure of the middle and inner lid welds. This configuration is considered unrealistic because "…only the weld region of the outer lid of the outer barrier would be affected by potential improper heat treatment … the inner lid of the outer barrier is not likely to be affected" (BSC 2001c, Section 5.2.4.2). Also, the lid of the inner stainless steel shell would be expected to provide an additional barrier for some period of time. This proposed failure configuration would allow water to enter the waste package and flood the internals up to the height of outer lid weld failure location. The probability that the failed weld will be located on the top half of the emplaced waste package is given in Section 3.3.2 as 0.5.

Once the water is in a position to enter the waste package failure location, four sequential conditions must exist to allow water to accumulate in the waste package. These conditions are:

1. The ability of the flow to enter the waste package failure location given the geometry of the waste package at the weld location.

2. The waste package failure (i.e., weld failure) must of sufficient size to allow the water to penetrate into the waste package internals.

3. Corrosion products and water impurities do not plug the waste package failure.

4. The waste package's waste form decay heat load is sufficiently low that the inflow does not evaporate.

To date, the probabilities of these conditions have not been evaluated and are therefore conservatively assumed to have a value of unity. In addition, the probability of water accumulation in the waste package due to complete failure of the circumferential weld and waste package tilt has not been considered in this evaluation.

3.5 POTENTIAL FOR CRITICALITY

Once water has accumulated inside the waste package inner shell, four additional conditions must exist before a criticality event can occur. These conditions are:

1. The waste package internals and/or waste form must degrade into a configuration conducive to criticality.

2. Corrosion products resulting from the waste package and waste form degradation processes must be removed or segregated from the degraded configuration. Corrosion products would displace water in the degraded waste form matrix. Removal or segregation of the corrosion products would therefore allow for greater neutron moderation and a higher potential for criticality.

3. Neutron absorber materials contained in the basket assembly of the waste package internals and within the waste form matrix itself must be removed from the degraded waste form configuration in order to increase the potential for criticality.

4. The waste form (e.g., spent nuclear fuel) contained in the waste package has to have sufficient potential to allow criticality to occur.

The probability that the waste form contained in a failed waste package has the potential for criticality is conservatively estimated to be 1.6×10^{-2}. This estimate is based on the annual criticality probability per waste package of pressurized water reactor spent nuclear fuel of 1.4×10^{-10} per year per waste package (YMP 1998, Table C-13). The annual criticality probability per waste package is multiplied by 11,770 (the total number of emplaced waste packages [BSC 2001a, Section 7.3.6]) and by the 10,000-year regulatory period. The DOE waste forms have been evaluated to have significantly reduced potential for criticality compared to commercial waste forms (BSC 2001d, Table 14).

To date, the probability of conditions 2 through 4 above has not been evaluated.

3.6 OTHER CONSIDERATIONS

Several issues have not been considered in the above evaluation. These issues include:

- The rate at which water must flow into the waste package in order to accumulate sufficient water to support waste form degradation. The potential repository would not be a closed system, and an inadequate or inconsistent inflow could allow for evaporation of accumulated water over a period of time.

- The loss of water when the flow splashes as it impacts on the drip shield and waste package surfaces.
- Waste package type effects (i.e., some waste packages without an adequate heat generation rate to keep water out do not have a criticality potential and visa versa).
- Surface tension effects for the flow of water that would account for the necessary failure size and flow rate necessary to enter failure.

3.7 QUANTIFICATION OF CRITICALITY PROBABILITY

An event tree with supporting fault trees has been developed to quantify the events and conditions leading to potential for waste package criticality as described above. These trees were developed using the probabilistic risk assessment code SAPHIRE V6.69 (CRWMS M&O 2001). The event tree presenting the evaluation logic for the potential for criticality is given in Figure 1. This event tree consists of eight top events. Each top event represents a separate condition or event that must be met in order to have criticality within the failed waste package. The branching under each top event follows standard event tree convention that requires "success" or "YES" answers to branch up and "failure" or "NO" answers to branch down. The probability of each top event failure branch is provided on the event tree. If a branch has not been quantified, the failure probability is assumed to be unity. The end state of each branching sequence (located in the second to last column of the figure) is either defined as "OK" (sequence has no criticality potential) or "CRITICALITY" (sequence has a potential for criticality). The estimated probability of each "CRITICALITY end state is provided in the last column of Figure 1. The top events of Figure 1 are presented in the same order as Sections 3.1 through 3.5. A brief definition of each top event follows:

WATER-FLOW — Estimates the probability that an adequate water source will be provided from the mountain surface to the drift overhead

CONDENSATION — Estimates the probability that an adequate water source will be provided from condensation on the underside of the drip shield above the failed waste package

DRIP-SHIELD — Estimates the probability of drip shield failure and the probability that the failed drip shield will be under a water source (this top event is only evaluated in conjuncture with the WATER-FLOW top event)

DRIP-WP-FF — Estimates the probability that the water source will take a pathway from the drift overhead through the drip shield to the failed waste package and enter the waste package failure location (this top event is only evaluated in conjuncture with the WATER-FLOW top event)

DRIP-WP-COND Estimates the probability that the water source will take a pathway from the underside of the drip shield to the failed waste package and enter the waste package failure location (this top event is only evaluated in conjuncture with the CONDENSATION top event)

FLOW-ACCUM Estimates the probability that the water striking the failed waste package will enter the failure location and accumulate inside the waste package

FUEL-CRITICAL Estimates the probability that the waste form contained in the failed waste package will degrade into a configuration favorable to criticality

Each of the top events of Figure 1 and defined above are supported by fault trees. Fault trees are constructed to physically represent the system or event logic. The probability of the basic events comprising the fault trees are obtained from the evaluations presented in Sections 3.1 through 3.5. "AND" and "OR" gates are used in the fault trees to represent the dependencies between the basic events. During event tree processing, the fault trees are evaluated to obtain an overall probability for each of the top events. The fault trees for each of the top events are presented in Figures 2 through 8.

From the last column of Figure 1, the probability of criticality prior to 10,000 years has been preliminarily estimated for both focused flow and condensation water source scenarios. The probability of criticality for these scenarios is estimated to be 3.9×10^{-17} and 2.7×10^{-9}, respectively. Although both probability values are below the credibility threshold for the postclosure period as defined in 10 CFR Part 63 (66 FR 55732), the probability for the condensation water source scenario approaches this threshold value. However, the probability for a number of the events identified in this evaluation have not been quantified and it is anticipated that once the probability for these events are quantified the probability of criticality for the condensation water source scenario will be well below the threshold value.

4. IMPLICATIONS OF RECENTLY DEVELOPED ADDITIONAL INFORMATION

The calculations in *Probability of Criticality Before 10,000 Years* (CRWMS M&O 2000a) estimates the probability of criticality to be below the credibility threshold for the postclosure period. This threshold is defined in 10 CFR Part 63 (66 FR 55732) as one chance in ten thousand over the ten-thousand-year regulatory period. The updated information contained in this letter report does not change the overall results of *Probability of Criticality Before 10,000 Years* (CRWMS M&O 2000a). Therefore, the conclusions of *Features, Events, and Processes: System-Level and Criticality* (CRWMS M&O 2000b) regarding criticality are not expected to change as a result of the additional information.

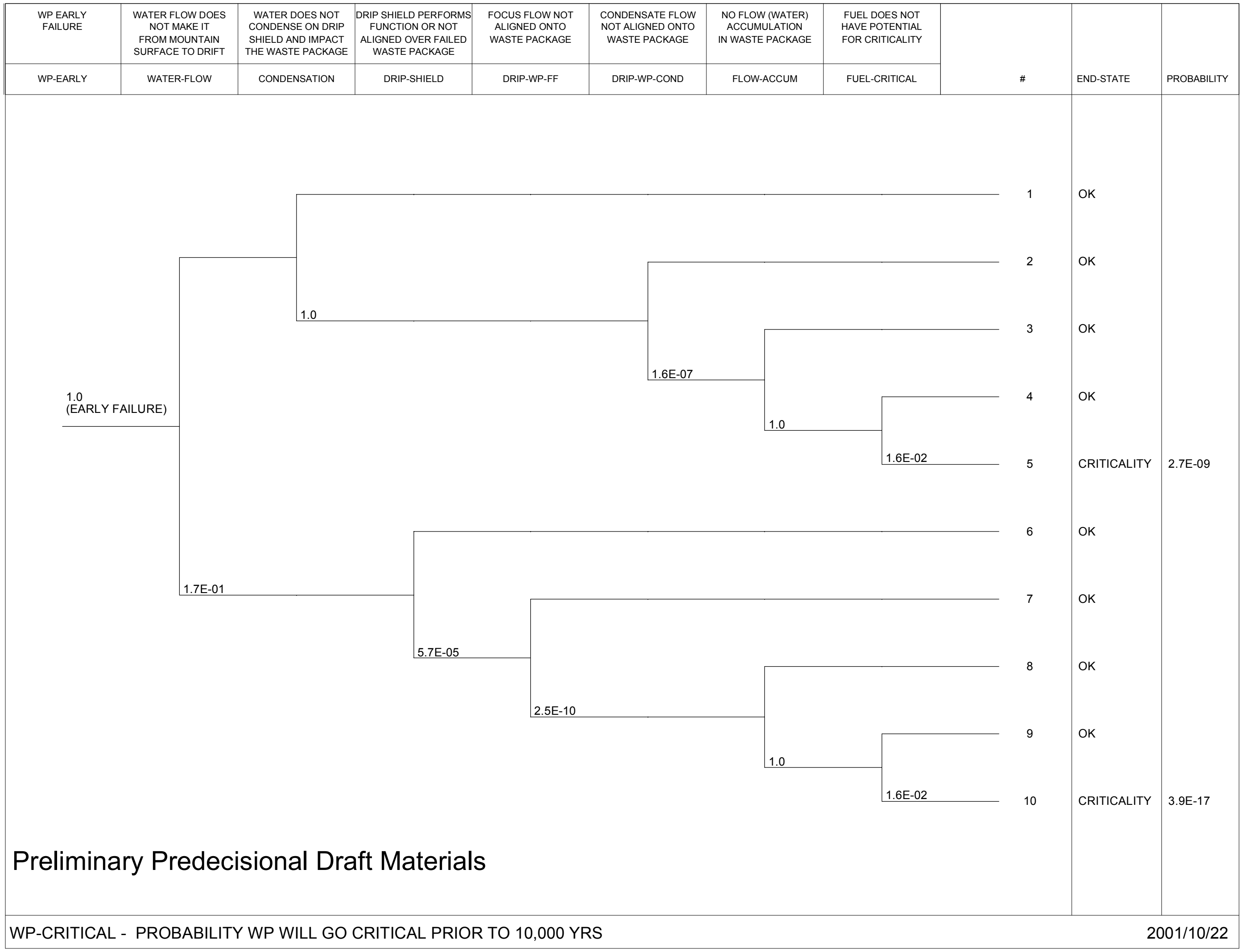
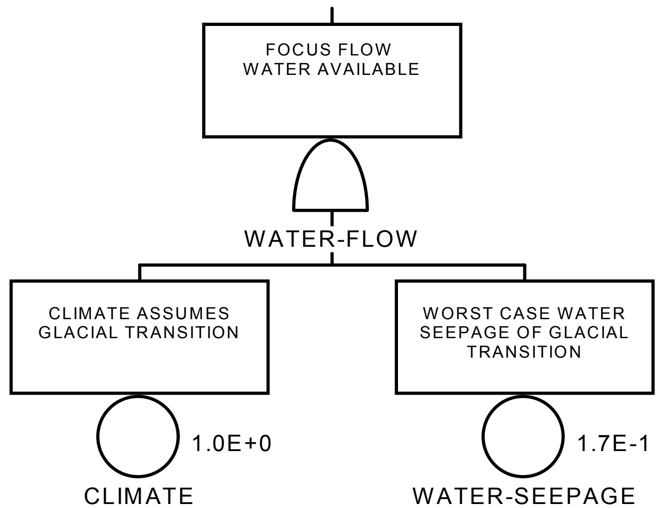


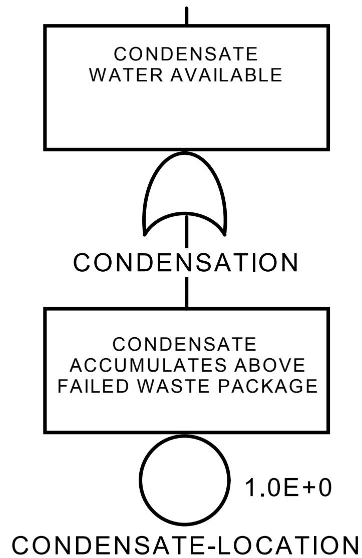
Figure 1. Event Tree for Evaluating the Criticality Disruptive Event



Preliminary Predecisional Draft Materials

WATER-FLOW - FOCUS FLOW OF WATER AVAILABLE TO CAUSE CRITICALITY 2001/10/21

Figure 2. Probability of Water Seepage from Mountain Surface Fault Tree



CONDENSATION - CONDENSATE WATER AVAILABLE 2001/10/21

Figure 3. Probability of Condensation under Drip Shield Fault Tree

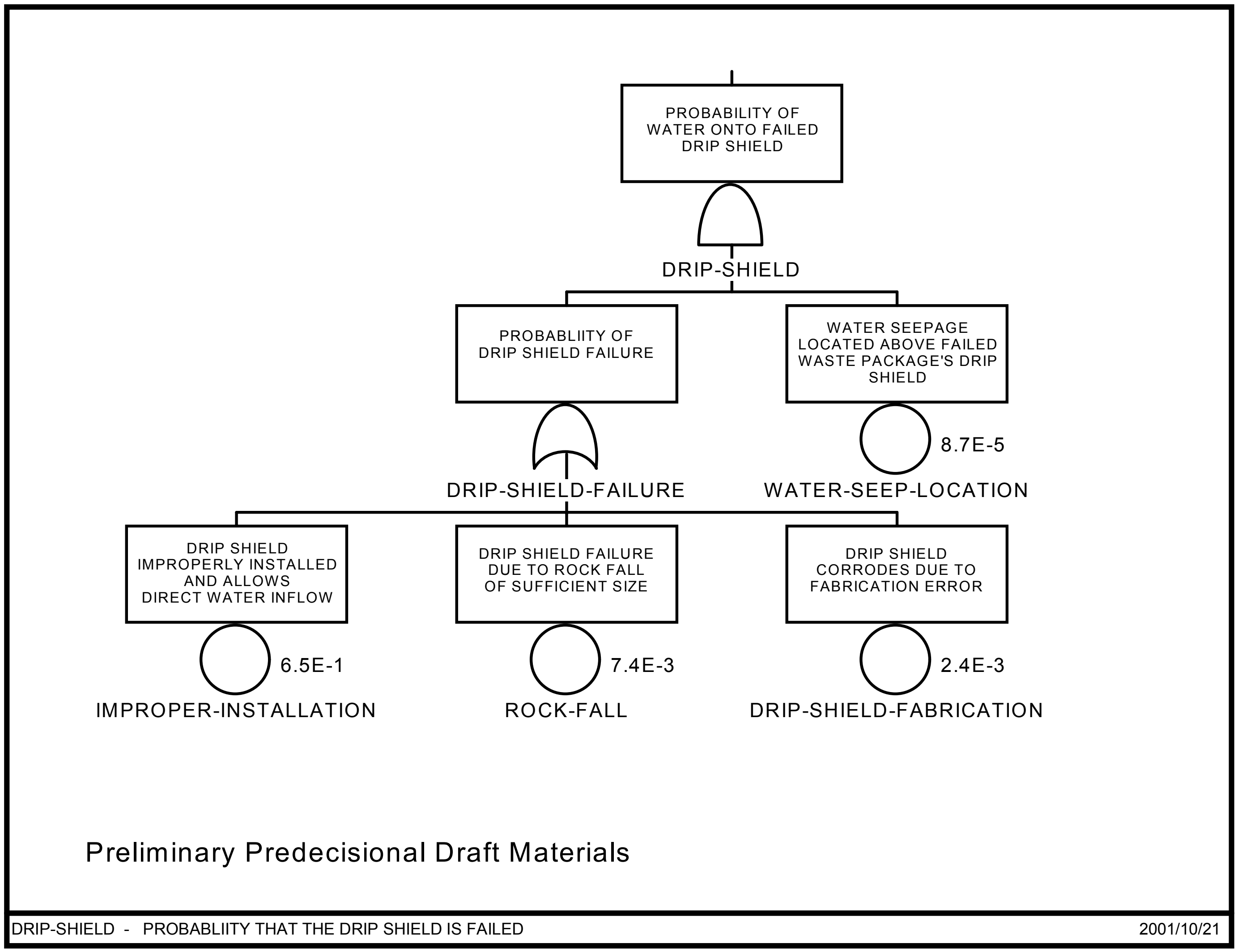
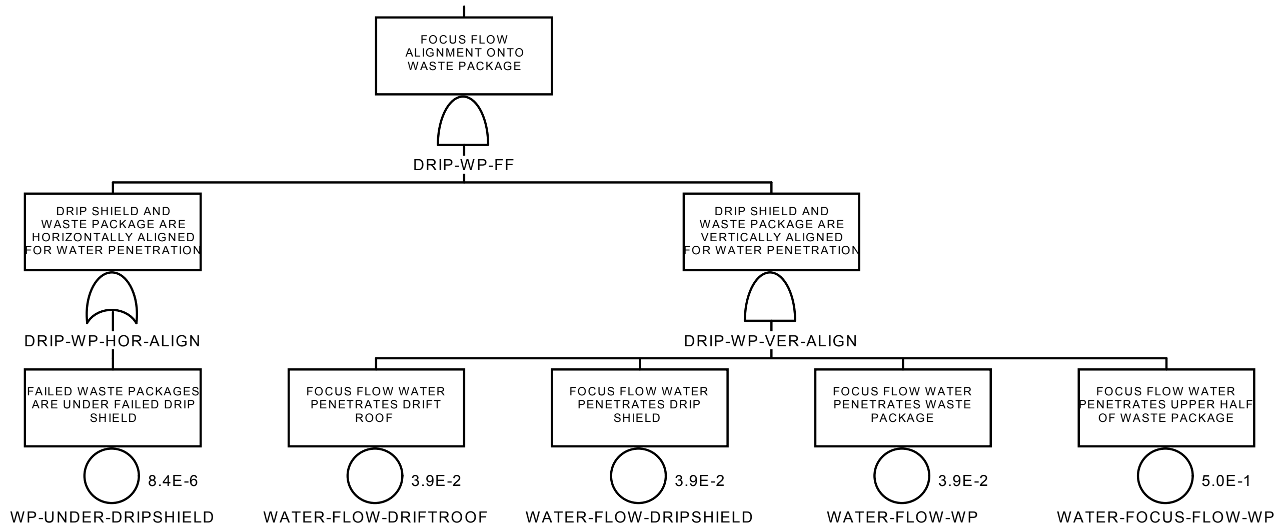


Figure 4. Probability of Drip Shield Failure Fault Tree



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DRIP-WP-FF - FOCUS FLOW ALIGNMENT ONTO WASTE PACKAGE 2001/10/21

Figure 5. Probability of Focused Flow from Drift Overhead onto Failed Waste Package Fault Tree

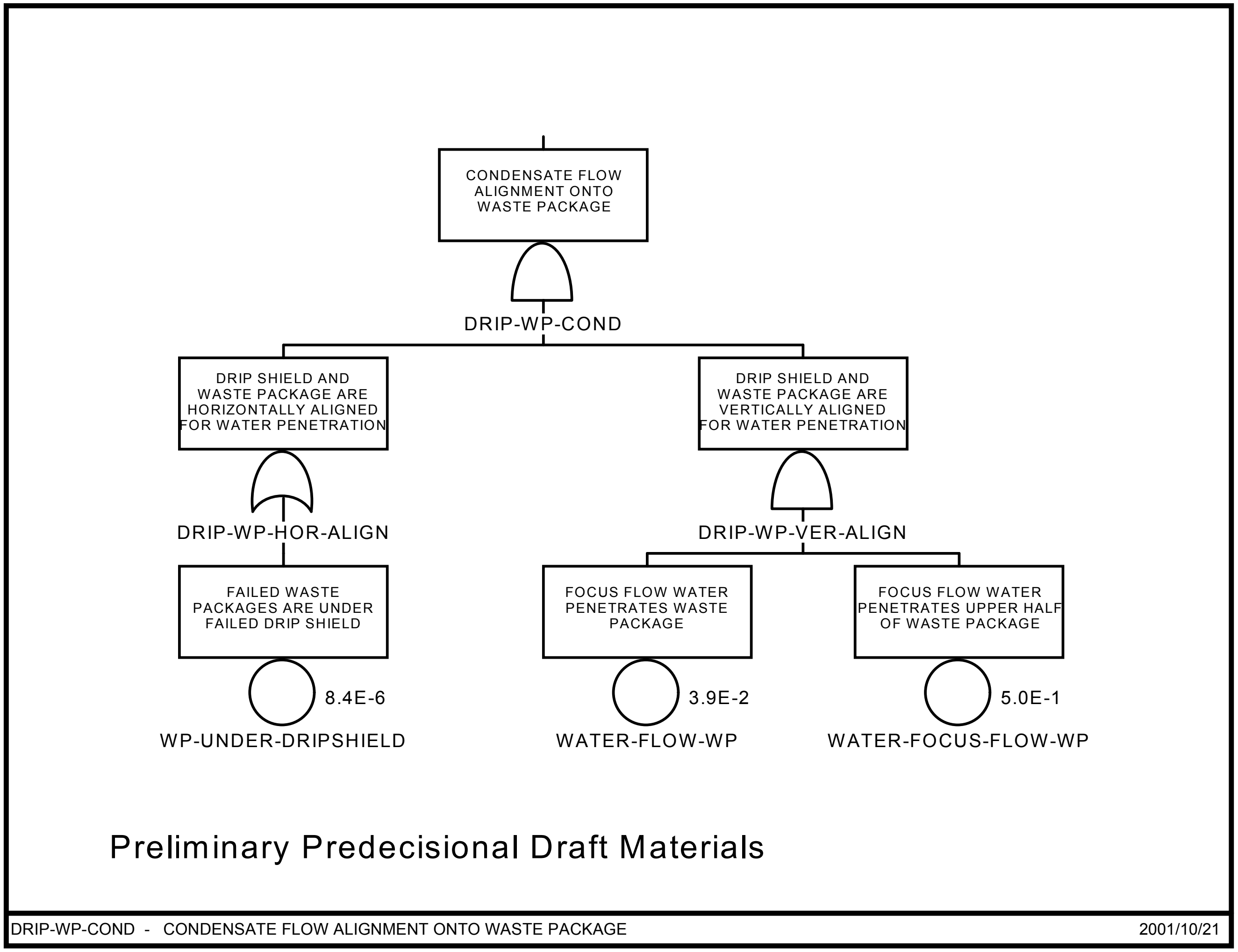
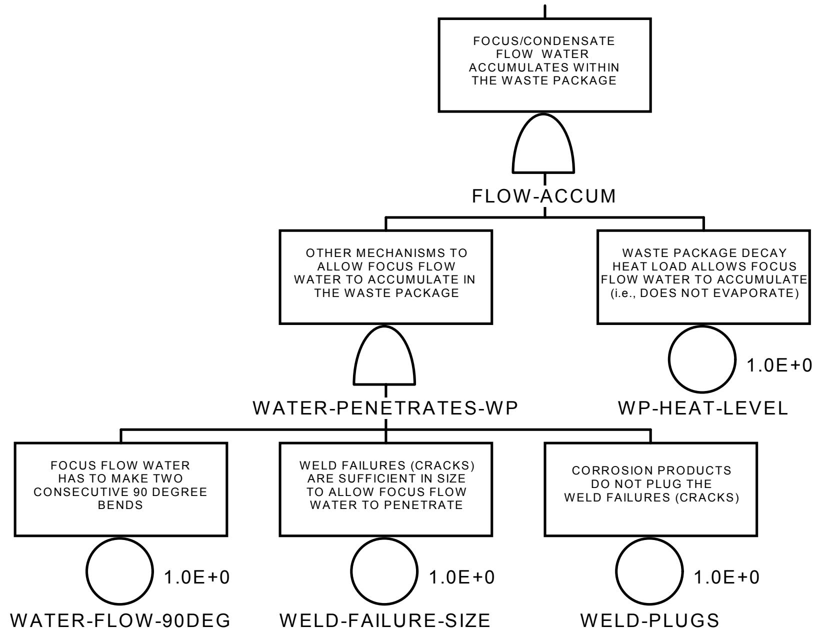


Figure 6. Probability of Focused Flow from Condensation under Drip Shield onto Failed Waste Package Fault Tree



Preliminary Predecisional Draft Materials

FLOW-ACCUM - FOCUS/CONDENSATE FLOW WATER ACCUMULATES WITHIN THE WASTE PA 2001/10/21

Figure 7. Probability of Water Flow into Failed Waste Package Fault Tree

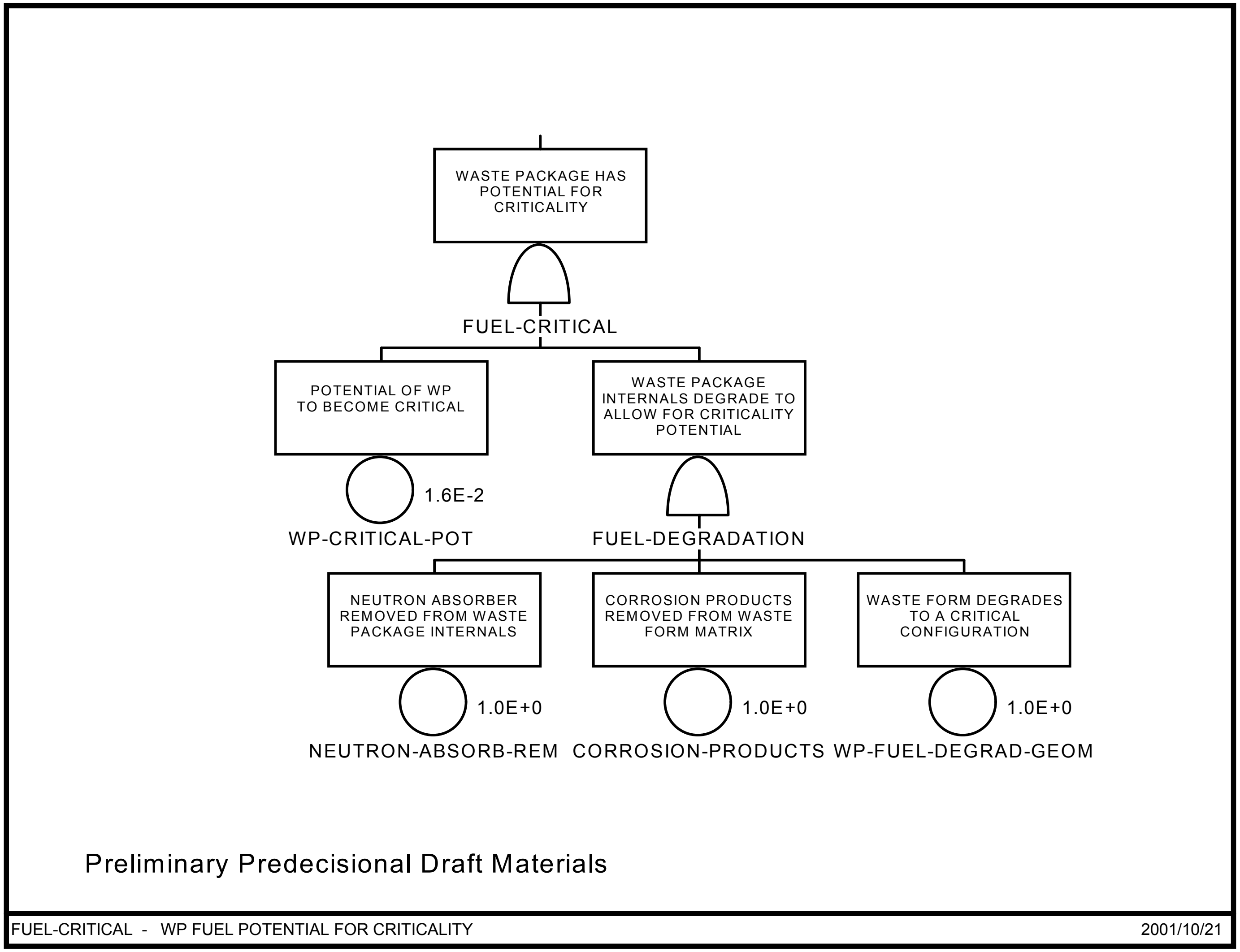


Figure 8. Probability of Failed Waste Package Criticality Fault Tree

5. REFERENCES

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