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ADDENDUM B2

**CHEMICAL COMPATIBILITY ANALYSIS OF WASTE FORMS AND CONTAINER
MATERIALS**

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4 **MATERIALS**

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6
7 The chemical compatibility analysis was carried out with all defense generated, contact-handled
8 (CH) and remote-handled (RH) transuranic (TRU)-mixed waste streams reported in the Waste
9 Isolation Pilot Plant (WIPP) Transuranic Waste Baseline Inventory Report (WTWBIR) (DOE,
10 1995). A summary of these waste streams is given in Table C-1 (Chapter C). The reported
11 content of CH and RH streams will be verified through the WIPP Generator/Storage Site Waste
12 Screening and Acceptance Audit Program (Appendix C11).

13
14 All information for the chemical lists and compatibility study is maintained in databases on a
15 personal computer. The chemicals reported by the generator sites are classified into reaction
16 groups as defined by the U.S. Environmental Protection Agency (EPA) document, A Method for
17 Determining the Compatibility of Hazardous Wastes (Hatayama et al., 1980). The chemical lists
18 are derived from the TRUPACT-II database, EPA hazardous waste codes listed in the WTWBIR,
19 and waste descriptions.

20
21 A database program was developed to evaluate the chemical compatibility of the WTWBIR
22 waste streams. Potential incompatibilities are defined on Figure 6 of the EPA document
23 (Hatayama et al., 1980), which identifies combinations of chemical groups that are incompatible
24 and the consequences (e.g., heat generation) of mixing incompatible chemical groups. All
25 incompatible mixtures have been entered into a reference data base to be used in assessing the
26 chemical compatibility of a given list of chemicals. The logic of the program used in evaluating
27 the chemical compatibility by content code is described in detail below.

28
29 As an initial step, the program indexes the entire database according to the WTWBIR waste
30 stream codes. The program then locates the first reaction group within the first waste stream code
31 and picks the highest concentration of any chemical in that group. The selected reaction group is
32 then paired with every other reaction group in the waste stream to check for incompatibility. If a
33 potential incompatibility is found, it is printed out along with the corresponding waste stream
34 codes. After finding all potential incompatibilities for a given waste stream code, the program
35 moves on to the next waste stream code until all waste stream codes have been processed.

36
37 To ensure accuracy, the reference database was printed and checked against the EPA document
38 for chemical compatibility, and the WTWBIR waste stream database was printed and checked
39 against the original WTWBIR forms from the generator sites. The list of potential chemical
40 incompatibilities reported by the program was hand checked using the EPA document as a
41 reference to assure proper functioning of the program. All potential chemical incompatibilities
42 were then evaluated on a case-by-case basis to identify which, if any, of the reactions could
43 occur, given the nature of the waste, and the its chemical constituents, and final waste form.
44

1 Waste streams are classified as "incompatible" if the potential exists for any of the following
2 reactions:

- 3 • corrosion
- 4 • explosion
- 5 • heat generation
- 6 • gas generation (flammable gases)
- 7 • pressure build-up (nonflammable gases)
- 8 • toxic by-product generation

9 Each generator and storage site has produced a comprehensive list of all possible chemicals
10 present in its waste. The chemical components found in each waste generation process are
11 determined by examination of the process technology, by chemical analysis, or by process flow
12 analysis. Under this system, all chemical inputs into the system are accounted for, even though
13 all of these components may not be a part of the waste. For example, generator sites might
14 include both acids and bases in their lists, even though the two groups have been neutralized
15 prior to placement in a waste container.

16
17 In addition to the chemicals listed in Appendix 2 of the EPA document (Hatayama et al., 1980),
18 the following components that exhibit toxicity characteristics defined under 40 CFR §261.24
19 were added to the chemical list in trace (<1 weight percent) quantities:

20
21 Group 3 Acids, Organic

22 2,4-D
23 2,4,5-TP (Silvex)

24
25 Group 17 Halogenated Organics

26 Methoxychlor
27 Toxaphene
28 2,4-D
29 Hexachlorobutadiene
30 Hexachloroethane
31 Tetrachloroethylene
32 2,4,5-Trichlorophenol
33 2,4,6-Trichlorophenol

34
35 All hazardous constituents listed in the Part A Permit are present in the chemical lists and
36 accounted for in the compatibility analysis.

37
38 The compounds listed on the Material Safety Data Sheet for Radiac™ wash were added to the
39 chemical compatibility assessment. The reactive compounds associated with Radiac™ wash are:

<u>GROUP</u>	<u>COMPOUND</u>	<u>CONCENTRATION</u>
3	citric acid	M
106	water	D

The compounds found in the fire suppressants in use at the WIPP facility were added to evaluate chemical compatibility of these materials with the test wastes. The following reactive compounds were added:

<u>GROUP</u>	<u>COMPOUND</u>	<u>CONCENTRATION</u>
14	diethylene glycol monobutyl ether	D
15	fluorosurfactants	D
106	water	D

Ansulite 6 percent AFFF (AFC-3) contains diethylene glycol monobutyl ether, fluorosurfactants, and water. The FORAY Dry Chemical Extinguishing Agent contains potassium aluminum silicate, magnesium aluminum silicate, monoammonium phosphate, ammonium sulfate, and methyl hydrogen polysiloxane, which are not hazardous reactive constituents.

To account for packaging, container, and backfill materials, the following components were added to the database for each content code in dominant (>10 weight %) quantities:

Group 10 Caustics

Magnesium Oxide

Group 23 Metals, other elemental and alloys as sheets, rods, moldings, drops, etc.

Low Carbon Steel D

Group 101 Combustible Materials

Polyethylene D

The chemical concentration levels are reported as either Trace (T) (<1% by weight), Minor (M) (1-10%), or Dominant (D) (>10%). The chemical list is divided into groups based on chemical properties and structure (e.g., acids, caustics, metals, etc.). If incompatible groups are combined, the possibility exists for the reactions listed above. For example, a reaction between Group 1 (Acids, Mineral, Non-oxidizing) and Group 10 (Caustics) could result in heat generation.

Possible chemical incompatibilities between compounds present in trace quantities (<1 percent by weight) and compounds present in concentrations > 1 percent by weight (i.e., D x T, D x T1, D x T2, D x T3, M x T, M x T1, M x T2, or M x T3) are included in this report. However, interactions between compounds present in trace quantities (<1 percent by weight) and compounds present in concentrations < 1 percent by weight do not pose an incompatibility problem for the following reasons:

- 1 • The trace chemicals reported by the sites are in concentrations well below the trace limit
2 of 1 weight percent. Sampling programs show that the concentration levels of these
3 compounds are significantly lower than the upper limit of 1 percent.

- 4 • The trace chemicals are usually dispersed in the waste, which further dilutes
5 concentrations of these materials.

- 6 • Trace chemicals that might be incompatible with major and dominant
7 materials/chemicals would have reacted during the waste treatment process prior to
8 placement in waste containers.

- 9 • Because of restrictions imposed by the EPA on reporting of hazardous wastes, some
10 chemicals are listed in trace quantities even if they have already reacted. Hazardous waste
11 regulations as promulgated by the EPA (EPA, 1988) (known as the mixture rule) require
12 that a mixture of any solid waste and a hazardous waste listed in 40 CFR Part 261,
13 Subpart D, be considered a hazardous waste subject to Resource Conservation and
14 Recovery Act regulations. However, Subpart D does not list minimum concentrations for
15 these listed wastes, with the result that any such mixtures must be considered hazardous
16 waste even if the Subpart D constituent is at or below detection limits.

- 17 • The waste is either solidified and immobilized (solidified materials) or present in bulk
18 form as a solid (solid materials). In almost all cases, any possible reactions take place
19 before the waste is generated in its final form.

- 20 • Total trace chemicals within a payload container are limited to less than 5 weight percent.

21 All potential incompatibilities between trace, minor, and dominant compounds have been
22 analyzed on a case-by-case basis for each waste stream reported in Table C-2 (Chapter C). Some
23 chemicals listed as being present in the waste have reacted prior to placement in a waste
24 container. For example, a site listing a caustic (Group 10) and an acid (Group 1) in its waste has
25 only the neutralized product present in an immobilized form. Further reactions of this type do not
26 occur once the waste is neutralized in its final form. An additional constraint on the chemicals
27 and materials that can be present within each waste stream code is their gas generation potential
28 due to radiolysis.

29
30 Unresolved incompatibilities between trace and minor, trace and dominant, minor and dominant,
31 minor and minor, or dominant and dominant waste constituents were identified and segregated.
32 These wastes cannot be transported until the incompatibilities are resolved (NuPac, 1989). Table
33 C1-1 presents the chemical compatibility analysis for the modified chemical lists for the waste
34 streams presented in Table C-2 (Chapter C). A list of explanations describing any noted
35 incompatibilities precedes Table C1-1.
36

1 Summary of Potential Incompatibilities for Waste Forms and Container Material

2 The following is a listing and explanation of compatibility code numbers used to identify
3 potential incompatibilities in Table C1-1. Where incompatibilities are noted, it is important to
4 remember that these potential incompatibilities will be removed prior to shipment of the waste to
5 WIPP. That is, unacceptable waste properties listed in Chapter C, Section C1-b will be removed
6 prior to shipping. Verification of the compatibility of final waste forms will be carried out by the
7 WIPP Generator/Storage Site Waste Screening and Acceptance Audit Program (Appendix C8).

8
9 Explanation Code Number Descriptions

10 00 (1 x 10, 2 x 10, 3 x 10, 5 x 10, 10 x 13, 10 x 17, 10 x 18, 10 x 19, 10 x 21, 10 x 22, 10 x
11 23, 10 x 24, 10 x 25, 10 x 27, 10 x 32, 10 x 102, 10 x 107) These potential
12 incompatibilities result from the addition of magnesium oxide backfill material.
13 However, the hydration of magnesium oxide results in the formation of brucite
14 (Mg[OH]), which buffers the pH of the solution at approximately 8.5. Therefore, caustic
15 conditions are not produced by the use of magnesium oxide backfill.

16
17 0a. (1 x 4) The potential chemical incompatibility is the possible dehydration or displacement
18 reactions between non-oxidizing mineral acids (Group 1) and alcohols and glycols in
19 waste forms (Group 4) resulting in heat generation. The potential chemical
20 incompatibility results from reporting trace quantities (<1%) of non-oxidizing acid in
21 generator waste streams. However, the non-oxidizing mineral acids are neutralized prior
22 to packaging, and the materials in this waste stream are considered chemically
23 compatible.

24
25 0aa. (1 x 10) The potential chemical incompatibility is the possible acid-base reaction between
26 strong mineral acids (Group 1) and strong caustics (Group 10) resulting in heat
27 generation. The potential chemical incompatibility results from reporting trace quantities
28 (<1%) of non-oxidizing acid in generator waste streams. However, the non-oxidizing
29 mineral acids are neutralized prior to packaging, and the materials in this waste stream
30 are considered chemically compatible.

31
32 0aaa. (1 x 14) The potential chemical incompatibility is the possible hydrolysis reaction
33 between strong mineral acids (Group 1) and ethers (Group 14), resulting in heat
34 generation. The potential chemical incompatibility results from reporting trace quantities
35 (<1%) of non-oxidizing acid in generator waste streams. However, the non-oxidizing
36 mineral acids are neutralized prior to packaging, and the materials in this waste stream
37 are considered chemically compatible.

38
39 0aaaa. (1 x 15) The potential chemical incompatibility is the possible formation of hydrogen
40 fluoride when strong mineral acids (Group 1) mix with inorganic fluorides (Group 15),
41 resulting in toxic gas generation. The potential chemical incompatibility results from
42 reporting trace quantities (<1%) of non-oxidizing acid in generator waste streams.

1 However, the non-oxidizing mineral acids are neutralized prior to packaging, and the
2 materials in this waste stream are considered chemically compatible.

3
4 0b. (1 x 17) The potential chemical incompatibility is the possible reaction between strong
5 mineral acids (Group 1) and halogenated organics (Group 17), resulting in generation of
6 heat and toxic hydrogen halide fumes. The potential chemical incompatibility results
7 from reporting trace quantities (<1%) of non-oxidizing acid in generator waste streams.
8 However, the non-oxidizing mineral acids are neutralized prior to packaging, and the
9 materials in this waste stream are considered chemically compatible.

10
11 0bb. (1 x 19) The potential chemical incompatibility is the possible condensation reaction
12 between strong mineral acids (Group 1) and ketones (Group 19), resulting in generation
13 of heat. The potential chemical incompatibility results from reporting trace quantities
14 (<1%) of non-oxidizing acid in generator waste streams. However, the non-oxidizing
15 mineral acids are neutralized prior to packaging, and the materials in this waste stream
16 are considered chemically compatible.

17
18 1 (1 x 23) The potential chemical incompatibility is the possible reaction between non-
19 oxidizing mineral acids (Group 1) and metals and other elemental alloys as sheets, rods,
20 moldings, drops, etc. (Group 23). The non-oxidizing mineral acids are present only in
21 trace quantities (<1%) and are neutralized and bound in the cemented waste form. Due to
22 the immobilization and prior reaction of the acids, the materials in this waste stream are
23 considered chemically compatible.

24
25 2 (1 x 24) The potential chemical incompatibility is the tendency of non-oxidizing mineral
26 acids (Group 1) to solubilize toxic metals and metal compounds (Group 24). The mineral
27 acids are present only in trace quantities (<1%) and are neutralized and bound in the
28 cemented waste form. Due to the immobilization and prior reaction of the non-oxidizing
29 acids, the materials in this waste stream are considered chemically compatible.

30
31 3 (1 x 101) The potential chemical incompatibility is the possible reaction between non-
32 oxidizing mineral acids (Group 1) and combustible materials (Group 101). The mineral
33 acids are present only in trace quantities (<1%) and are neutralized and bound in the
34 cemented waste form. An absorbent has been added to immobilize free liquids. Due to
35 the immobilization and prior reaction of the non-oxidizing acids, the materials in this
36 waste stream are considered chemically compatible.

37
38 3a. (1 x 102) The potential chemical incompatibility is the possible violent reaction between
39 non-oxidizing mineral acids (Group 1) and explosives (Group 102). However, explosives
40 are not allowed to be shipped to WIPP unless treatment renders them inert. Additionally,
41 mineral acids are present only in trace quantities (<1%) and are neutralized prior to
42 loading in waste containers. Therefore, the materials in this waste stream are considered
43 chemically compatible.

- 1 3aa. (1 x 104) The potential chemical incompatibility is the possible reaction between non-
2 oxidizing mineral acids (Group 1) and strong oxidizing agents (Group 104), resulting in
3 heat and generation of toxic and corrosive gases. However, the mineral acids and
4 oxidizing agents are present in trace quantities (<1%) and neutralized prior to loading in
5 waste containers. Therefore, the materials in this waste stream are considered chemically
6 compatible.
7
- 8 3b. (1 x 106) The potential chemical incompatibility is the possible reaction between mineral
9 acids (Group 1) and water (Group 106), resulting in the generation of heat. This potential
10 incompatibility results from the presence of water in Ansulite™ fire extinguishing agents
11 and/or Radiac™ wash solutions and/or absorbed water. However, the mineral acids are
12 present only in trace quantities (<1%) and are neutralized prior to loading in waste
13 containers. In addition, the presence of any absorbed liquids are immobilized in an
14 absorbent and would not be available for reaction.
15
- 16 3c. (2 x 3) The potential chemical incompatibility is the reaction of oxidizing mineral acids
17 (Group 2) with organic acids (Group 3) resulting in heat and gas generation. The
18 potential chemical incompatibility results from the use of citric acid in Radiac™ wash
19 solutions. The solid citric acid is diluted during preparation of the Radiac™ wash and is
20 often further diluted prior to use for decontamination. As a result, the potential for
21 reactions of solid citric acid with oxidizing mineral acids in waste forms is removed.
22
- 23 3d. (2 x 4) The potential chemical incompatibility is the possible dehydration or displacement
24 reactions between oxidizing mineral acids (Group 2) and alcohols and glycols (Group 4),
25 resulting in heat generation. The potential chemical incompatibility results from reporting
26 trace quantities (<1%) of oxidizing acid in generator waste streams. However, the
27 oxidizing mineral acids are neutralized prior to packaging, and the materials in this waste
28 stream are considered chemically compatible.
29
- 30 3e. (2 x 10) The potential chemical incompatibility is the possible acid-base reaction between
31 oxidizing mineral acids (Group 2) and strong caustics (Group 10), resulting in heat
32 generation. The potential chemical incompatibility results from reporting trace quantities
33 (<1%) of oxidizing acid in generator waste streams. However, the oxidizing mineral acids
34 are neutralized prior to packaging, and the materials in this waste stream are considered
35 chemically compatible.
36
- 37 3ee. (2 x 13) The potential chemical incompatibility is the possible reaction between oxidizing
38 mineral acids (Group 2) and esters (Group 13), resulting in heat generation. The potential
39 chemical incompatibility results from reporting trace quantities (<1%) of oxidizing acid
40 in generator waste streams. However, the oxidizing mineral acids are neutralized prior to
41 packaging, and the materials in this waste stream are considered chemically compatible.
42
- 43 3f. (2 x 14) The potential chemical incompatibility is the possible hydrolysis reaction
44 between oxidizing mineral acids (Group 2) and ethers (Group 14), resulting in heat
45 generation. The potential chemical incompatibility results from reporting trace quantities

1 (<1%) of oxidizing acid in generator waste streams. However, the oxidizing mineral acids
2 are neutralized prior to packaging, and the materials in this waste stream are considered
3 chemically compatible.
4

5 3g. (2 x 15) The potential chemical incompatibility is the possible formation of hydrogen
6 fluoride when oxidizing mineral acids (Group 2) mix with inorganic fluorides (Group
7 15), resulting in toxic gas generation. The potential chemical incompatibility results from
8 reporting trace quantities (<1%) of oxidizing acid in generator waste streams. However,
9 the oxidizing mineral acids are neutralized prior to packaging, and the materials in this
10 waste stream are considered chemically compatible.
11

12 3gg. (2 x 16) The potential chemical incompatibility is the possible reaction between oxidizing
13 mineral acids (Group 2) and aromatic hydrocarbons (Group 16). Oxidation of the
14 hydrocarbon may produce enough heat to ignite the mixture. The potential chemical
15 incompatibility results from reporting trace quantities (<1%) of oxidizing acid in
16 generator waste streams. However, the oxidizing mineral acids are neutralized prior to
17 packaging, and the materials in this waste stream are considered chemically compatible.
18

19 3h. (2 x 17) The potential chemical incompatibility is the possible reaction between oxidizing
20 mineral acids (Group 2) and halogenated organics (Group 17), resulting in generation of
21 heat and toxic hydrogen halide fumes. The potential chemical incompatibility results
22 from reporting trace quantities (<1%) of oxidizing acid in generator waste streams.
23 However, the oxidizing mineral acids are neutralized prior to packaging, and the
24 materials in this waste stream are considered chemically compatible.
25

26 3i. (2 x 19) The potential chemical incompatibility is the possible condensation reaction
27 between oxidizing mineral acids (Group 2) and ketones (Group 19), resulting in
28 generation of heat. The potential chemical incompatibility results from reporting trace
29 quantities (<1%) of oxidizing acid in generator waste streams. However, the oxidizing
30 mineral acids are neutralized prior to packaging, and the materials in this waste stream
31 are considered chemically compatible.
32

33 3j. (2 x 20) The potential chemical incompatibility is the possible reaction between oxidizing
34 mineral acids (Group 2) and mercaptans (Group 20), resulting in generation of heat and
35 toxic hydrogen sulfide fumes. The potential chemical incompatibility results from
36 reporting trace quantities (<1%) of oxidizing acid in generator waste streams. However,
37 the oxidizing mineral acids are neutralized prior to packaging, and the materials in this
38 waste stream are considered chemically compatible.
39

40 4. (2 x 23) The potential chemical incompatibility is the possible reaction between oxidizing
41 mineral acids (Group 2) and metals and other elemental alloys as sheets, rods, moldings,
42 drops, etc. (Group 23). The oxidizing mineral acids are present only in trace quantities
43 (<1%) and are reacted prior to loading in waste containers. In addition, the oxidizing
44 mineral acids are fixed in the solidified product and would not be available to react with
45 the metal.

- 1 5. (2 x 23) The potential chemical incompatibility is the possible reaction between oxidizing
2 mineral acids (Group 2) and metals and other elemental alloys as sheets, rods, moldings,
3 drops, etc. (Group 23). The oxidizing mineral acids are present only in trace quantities
4 (<1%) as residues on glass or rubber gloves, and not as free liquids that could react with
5 metals.
6
- 7 6. (2 x 24) The potential chemical incompatibility is the solubilization of toxic metals and
8 metal compounds (Group 24) in oxidizing mineral acids (Group 2). The oxidizing
9 mineral acids are present only in trace quantities (<1%) and are reacted prior to loading in
10 waste containers. In addition, the oxidizing mineral acids are fixed in the solidified
11 product and would not be available to react with the metal.
12
- 13 7. (2 x 24) The potential chemical incompatibility is the possible reaction between oxidizing
14 mineral acids (Group 2) and toxic metals and compounds (Group 24). The oxidizing
15 mineral acids are present only in trace quantities (<1%) as residues on glass or rubber
16 gloves, and not as free liquids that could react with metals.
17
- 18 7a. (2 x 27) The potential chemical incompatibility is the possible reaction between oxidizing
19 mineral acids (Group 2) and nitro compounds (Group 27), resulting in generation of heat
20 and toxic nitrogen oxide fumes. The potential chemical incompatibility results from
21 reporting trace quantities (<1%) of oxidizing acid in generator waste streams. However,
22 the oxidizing mineral acids are neutralized prior to packaging, and the materials in this
23 waste stream are considered chemically compatible.
24
- 25 8. (2 x 101) The potential chemical incompatibility is the possible reaction between
26 oxidizing mineral acids (Group 2) and combustible materials (Group 101). The oxidizing
27 mineral acids are present only in trace quantities (<1%) as residues on glass or rubber
28 gloves, and not as free liquids that could react with metals.
29
- 30 9. (2 x 101) The potential chemical incompatibility is the possible decomposition of
31 combustible materials (Group 101) by the oxidizing mineral acids (Group 2). The
32 oxidizing mineral acids are present only in trace quantities (<1%) and are reacted prior to
33 loading in waste containers. In addition, the oxidizing mineral acids are fixed in the
34 solidified product and would not be available to react with the combustible materials.
35
- 36 9a. (2 x 102) The potential chemical incompatibility is the possible violent reaction between
37 oxidizing mineral acids (Group 2) and explosives (Group 102). However, explosives are
38 not allowed to be shipped to WIPP unless treatment renders them inert. Additionally,
39 mineral acids are present only in trace quantities (<1%) and are neutralized prior to
40 loading in waste containers. Therefore, the materials in this waste stream are considered
41 chemically compatible.
42
- 43 10. (2 x 106) The potential chemical incompatibility is the possible dissolution of oxidizing
44 mineral acids (Group 2) by water (Group 106). The oxidizing mineral acids are present
45 only in trace quantities (<1%) and reacted prior to loading in waste containers. Both the

1 water and the oxidizing mineral acids are fixed in the solidified product and would not be
2 available for reaction.

3
4 10a. (2 x 106) The potential chemical incompatibility is the possible reaction between
5 oxidizing mineral acids (Group 2) and water (Group 106), resulting in the generation of
6 heat. This potential incompatibility results from the presence of water in Ansulite™ fire
7 extinguishing agents and/or Radiac™ wash solutions and/or absorbed water. However,
8 the mineral acids are present only in trace quantities (<1%) and are neutralized prior to
9 loading in waste containers. In addition, the presence of any absorbed liquids are
10 immobilized in an absorbent and would not be available for reaction.

11
12 11. (3 x 4) The potential chemical incompatibility is the possible reaction between organic
13 acids (Group 3) and alcohols and glycols (Group 4). The organic acids are immobilized
14 in a cement matrix and not available to react with the alcohols and glycols. The alcohols
15 and glycols are also immobilized in the solidified product.

16
17 11aa. (3 x 4) The potential chemical incompatibility is the heat generated by polymerization of
18 alcohols and glycols (Group 4) by organic acids (Group 3). Carboxylic acids with á-
19 halogen substituents, or á-or â-hydroxyl substituents (e.g., citric acid) are the main
20 concern among the organic acids (Group 3). The potential chemical incompatibility
21 results from the use of citric acid in Radiac™ wash solutions. The solid citric acid is
22 diluted during preparation of the Radiac™ wash and is often further diluted prior to use
23 for decontamination. As a result, the potential for reactions of solid citric acid with
24 alcohols and glycols (Group 4) that are dispersed and fixed in waste forms is removed.

25
26 11b. (3 x 10) The potential chemical incompatibility is the possibility of acid-base reactions.
27 The organic acids (Group 3) are neutralized in a cement matrix and are not available to
28 react with the Caustics (Group 10). Thus, this potential chemical incompatibility would
29 not occur.

30
31 11c. (3 x 10) The potential chemical incompatibility is the heat generated by reactions of
32 organic acids (Group 3) with caustics (Group 10). The potential chemical incompatibility
33 results from the use of citric acid in Radiac™ wash solutions. The solid citric acid is
34 diluted during preparation of the Radiac™ wash and is often further diluted prior to use
35 for decontamination. As a result, the potential for reactions of solid citric acid with
36 caustics in test waste forms is removed. The caustic in the waste forms is calcium oxide.
37 Thus, the more significant incompatibility is potential hydrolysis reaction between water
38 and calcium oxide to release heat. Because the calcium oxide is dispersed in the wastes,
39 reaction is considered unlikely.

40
41 11d. (3 x 15) The potential chemical incompatibility is toxic and corrosive fumes generated by
42 reactions of organic acids (Group 3) with metal fluoride salts (Group 15). The potential
43 chemical incompatibility results from the use of citric acid in Radiac™ wash solutions.
44 The solid citric acid is diluted during preparation of the Radiac™ wash and is often

1 further diluted prior to use for decontamination. As a result, the potential for reactions of
2 solid citric acid with fluoride salts in waste forms is removed.
3

4 12. (3 x 24) The potential chemical incompatibility is the possible reaction between organic
5 acids (Group 3) and toxic metals and compounds (Group 24). The organic acids are
6 basified prior to cementation and do not exist as free acids in the resulting product. Based
7 on the immobilization of the acids, reactions are considered highly unlikely. In this case,
8 solubilization is not possible.
9

10 12aa. (3 x 24) The potential chemical incompatibility is solubilization of toxic metals (Group
11 24) by complexation with organic acids (Group 3). The potential chemical
12 incompatibility results from the use of citric acid in Radiac™ wash solutions. The solid
13 citric acid is diluted during preparation of the Radiac™ wash and is often further diluted
14 prior to use for decontamination. As a result, the potential for reactions of solid citric acid
15 with toxic metals in waste forms is removed.
16

17 12bbb. (3 x 104) The potential chemical incompatibility is decomposition of the hydrocarbon
18 moiety of organic acids (Group 3) by oxidizing agents (Group 104) resulting in heat and
19 gas formation. The potential chemical incompatibility results from the use of citric acid in
20 Radiac™ wash solutions. The solid citric acid is diluted during preparation of the
21 Radiac™ wash and is often further diluted prior to use for decontamination. As a result,
22 the potential for reactions of solid citric acid with oxidizing agents that are dispersed and
23 fixed in waste forms is removed.
24

25 12bb. (4 x 104) The potential chemical incompatibility is formation of unstable compounds by
26 reaction of alcohols and glycols (Group 4) with oxidizing agents (Group 104). However
27 the alcohols and glycols are present as trace quantities (<1%) in the waste stream, and
28 they are further isolated by dissemination within the waste stream. Additionally,
29 oxidizing agents must be neutralized prior to shipment to WIPP. Therefore, the final
30 waste form will contain compatible materials.
31

32 12b. (7 x 17) The potential chemical incompatibility between amines (Group 7) and
33 halogenated organics (Group 17) would not occur because the halogenated organics are
34 solidified and are not available for reaction.
35

36 12c. (7 x 24) The potential chemical incompatibility is the possible increase in the solubility of
37 toxic metal compounds in water due to amines acting as potential surfactants. The amines
38 are present only in trace (<1%) and are immobilized through absorption on sorbent
39 materials. Also, these solid waste forms usually contain very little water and excess
40 sorbents are added to waste containers to sorb any fluids.
41

42 12d. (7 x 104) The potential chemical incompatibility is formation of toxic nitrogen oxide
43 fumes by reaction of amines (Group 7) with oxidizing agents (Group 104). However, the
44 alcohols and glycols are present as trace quantities (<1%) in the waste stream, they are
45 further isolated by dissemination within the waste stream. Additionally, oxidizing agents

1 must be neutralized prior to shipment to WIPP. Therefore, the final waste form will
2 contain compatible materials.
3

4 12e. (8 x 23) The potential chemical incompatibility is combustion of some azo compounds
5 (Group 8) on contact with surfaces of metal sheets, rods, drops, etc (Group 23). However
6 the azo compounds are present as trace quantities (<1%) in the waste stream and are
7 further isolated by dissemination within the waste stream. Therefore, spontaneous
8 combustion by reaction with metal surfaces is unlikely.
9

10 12f. (8 x 106) The potential chemical incompatibility is the generation of nitrogen gas by
11 reaction of some azo compounds (Group 8) with water (Group 106). This potential
12 incompatibility results from the presence of water in Ansulite™ fire extinguishing agents
13 and/or Radiac™ wash solutions and/or absorbed water. However, the azo compounds are
14 present only in trace quantities (T<1%) and are disseminated in the waste containers,
15 which minimizes their potential to form nitrogen gas. In addition, the presence of any
16 absorbed liquids are immobilized in an absorbent and would not be available for reaction.
17

18 13. (10 x 17) The potential chemical incompatibility is the possible reaction between caustics
19 (Group 10) and halogenated organics (Group 17). The caustic in this content code is
20 calcium oxide, a solid, which is dispersed in the chloride salts. The halogenated organics
21 are present in only trace quantities (T<1%) and are absorbed, immobilized, or solidified.
22 Due to the immobilization of the calcium oxide in the salt, reactions are considered
23 highly unlikely.
24

25 13a. (10 x 19) The potential chemical incompatibility is the possible self-condensation of
26 ketones (Group 19) catalyzed by caustics (Group 10). The caustic in this content code is
27 calcium oxide, a solid, which is dispersed in the chloride salts. Due to the immobilization
28 of the calcium oxide in salt, reactions are considered highly unlikely.
29

30 14. (10 x 23) The potential incompatibility is the possible reaction between caustics (Group
31 10) metals and other elemental alloys as sheets, rods, moldings, drops, etc. (Group 23).
32 The caustic in this waste stream code is calcium oxide, a solid, which is dispersed in the
33 chloride salts. Due to the immobilization of the calcium oxide in salt, dissolution of
34 metals in caustics is not possible.
35

36 15. (10 x 23) The potential incompatibility is the possible dissolution of metals and other
37 elemental alloys as sheets, rods, moldings, drops, etc. (Group 23) in caustics (Group 10).
38 The caustics are present only in trace quantities (<1%) and are reacted prior to loading in
39 waste containers. In addition, the caustics are fixed in the cemented sludge and would not
40 be available to react with the metals.
41

42 16. (10 x 24) The potential chemical incompatibility is the possible solubilization of toxic
43 metals (Group 24) in caustics (Group 10). The caustic in this content code is calcium
44 oxide, a solid, which is dispersed in the chloride salts. In this case, solubilization is not
45 possible.

- 1
2 16a. (10 x 24) The potential incompatibility is the possible solubility of toxic metals (Group
3 24) in caustics (Group 10). The caustics are present only in trace (<1% quantities and are
4 reacted prior to loading in waste containers. In addition, the caustics are fixed in the
5 cemented sludge and would not be available to react with the metals.
6
- 7 16b. (10 x 27) The potential chemical incompatibility is the formation of salts from nitro
8 alkanes (Group 27) and caustics (Group 10) in the presence of water. The only caustic in
9 this content code is calcium oxide, a solid, which is dispersed in the chloride salts. In
10 addition, liquids are immobilized through absorption on sorbent materials. Due to the
11 immobilization of the caustic in the fused salt, this reaction would not occur.
12
- 13 16c. (10 x 102) The potential chemical incompatibility is the possible violent reaction between
14 caustics (Group 10) and explosives (Group 102) due to the generation of heat. However,
15 explosives are not allowed to be shipped to WIPP unless treatment renders them inert.
16 Additionally, caustics are present only in minor quantities (<10%) and are neutralized
17 prior to loading in waste containers. Therefore, the materials in this waste stream are
18 considered chemically compatible.
19
- 20 17. (10 x 107) This potential incompatibility is an artifact of the EPA method. Calcium oxide
21 appears in Groups 10 and 107, and is compatible within itself.
22
- 23 17a. (14 x 104) This potential incompatibility is the reaction of ethers (Group 14) with strong
24 oxidizers (Group 104) to produce heat, and possibly ignition or explosions. This
25 incompatibility arises from the presence of diethylene glycol monobutyl ether in
26 Ansulite™ fire extinguishing agents. However, the strong oxidizers are present in trace
27 quantities (<1%) and disseminated in the waste, making ignition or explosions unlikely in
28 the event the fire extinguishers are used.
29
- 30 17b. (14 x 107) This potential chemical incompatibility is the reaction of ethers (Group 14)
31 with water reactives (Group 107). This incompatibility arises from the presence of
32 diethylene glycol monobutyl ether in Ansulite™ fire extinguishing agents. However, the
33 water reactive substances are present in trace quantities (<1%) and disseminated in the
34 waste, making reactions unlikely in the event the fire extinguishers are used.
35
- 36 18. (15 x 107) This potential chemical incompatibility is the reaction of fluorides (Group 15)
37 and water reactive substances (Group 107). The solid fluorides are present in only trace
38 quantities (T<1%) and form part of the pyrochemical salt matrix. Calcium oxide, the only
39 water reactive substance present, is a solid dispersed in the pyrochemical salt matrix.
40 These salts always occur with each other and are compatible.
41
- 42 18a. (17 x 20) The potential chemical incompatibility is the possible reaction between
43 halogenated organics (Group 17) and mercaptans (Group 20), resulting in generation of
44 heat. The potential chemical incompatibility results from reporting trace quantities (<1%)
45 of halogenated organics and mercaptans in generator waste streams. However, the

1 chemicals are neutralized prior to packaging, and the materials in this waste stream are
2 considered chemically compatible.

- 3
- 4 19. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
5 (Group 17) with metals and other elemental alloys as sheets, rods, moldings, drops, etc.
6 (Group 23). The halogenated organics are present in only trace quantities ($T_1 < 1\%$) and
7 are fixed in cemented sludge and would not be available to react with the metals.
8
- 9 20. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
10 (Group 17) with metals and other elemental alloys, as sheets, rods, moldings, drops, etc.
11 (Group 23). The halogenated organics are present in only trace quantities ($T < 1\%$) and are
12 absorbed on combustibles. The halogenated organics are not present as free liquids to
13 react with the metals.
14
- 15 21. (17 x 23) The potential chemical incompatibility is the potential reaction between
16 halogenated organics (Group 17) and metals and other elemental alloys as sheets, rods,
17 drops, moldings, etc. (Group 23). Aluminum and magnesium in bulk forms are especially
18 reactive with halogenated hydrocarbons, releasing much heat. Although this is a potential
19 incompatibility, the potential effects are considered minimal for the following reasons.
20 First, the halogenated hydrocarbons are only present in trace quantities (< 1 percent by
21 weight) and are immobilized through absorption on sorbent materials or solidification
22 with calcium silicates or gypsum-base processes. Second, although the metals of concern
23 may occur in dominant quantities in the content code, the metals only occur as large
24 pieces and not in powder form. Due to the trace quantities of immobilized halogenated
25 organics and the non-powder size of the metal pieces, any reaction that may occur will
26 produce minimal heat.
27
- 28 22. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
29 (Group 17) with metals and other elemental alloys, as sheets, rods, moldings, drops, etc.
30 (Group 23). The halogenated organics are present in only very small trace quantities (< 1
31 part per million) as residual films on the glass and not as free liquids that could react with
32 metals.
33
- 34 23. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
35 (Group 17) with metals and other elemental alloys as sheets, rods, moldings, drops, etc.
36 (Group 23). The halogenated organics are present in only trace quantities ($< 1\%$) as
37 coatings on solid organic materials and are not present as free liquids that could react
38 with metals.
39
- 40 24. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
41 (Group 17) with metals and other elemental alloys as sheets, rods, moldings, drops, etc.
42 (Group 23). The halogenated organics are present in only trace quantities ($< 1\%$) as
43 coating on the inorganic solid materials and are not present as free liquids that could react
44 with metals.
45

- 1 25. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
2 (Group 17) with metals and other elemental alloys as sheets, rods, moldings, drops, etc.
3 (Group 23). The halogenated organics are fixed in the cemented product and would not
4 be available for reaction.
5
- 6 26. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
7 (Group 17) with metals and other elemental alloys, as sheets, rods, moldings, drops, etc.
8 (Group 23). The halogenated organics are fixed in the solidified product and are not
9 available for reaction with the metals.
10
- 11 27. (17 x 23) The potential chemical incompatibility is the reaction of halogenated organics
12 (Group 17) with metals and other elemental alloys, as sheets, rods, moldings, drops, etc.
13 (Group 23). An absorbent has been added to immobilize any free liquids that may exist.
14 Due to the trace quantities and immobilization of the halogenated organics, reactions are
15 highly unlikely.
16
- 17 28. (17 x 104) The potential chemical incompatibility is the reaction of halogenated organics
18 (Group 17) with oxidizing agents (Group 107), resulting in the liberation of heat and
19 formation of toxic gases. The halogenated organics are present in only trace quantities
20 (<1%) and are not in the form of free liquids. Additionally, the oxidizing agents are
21 neutralized prior to loading waste containers. Therefore, based on the neutralization of
22 the oxidizing agents, reactions are considered highly unlikely.
23
- 24 28a. (18 x 106) The potential incompatibility is the possible reaction between isocyanates
25 (Group 18) with water (Group 106). The isocyanates are present only in trace quantities
26 (<1%). The water is usually fixed in the solidified product and would not be available for
27 reaction.
28
- 29 28aa. (18 x 106) The potential chemical incompatibility is between isocyanates (Group 18) and
30 water (Group 106) to generate carbon dioxide gas and heat. The potential chemical
31 incompatibility results from the use of water in Ansulite™ fire extinguishing agents and
32 Radiac™ wash solutions. However, isocyanates in the waste forms are present in trace
33 quantities (<1%), are neutralized and fixed prior to loading the waste containers, and are
34 not available for reaction. Therefore, the final waste form contains compatible materials.
35
- 36 28aaa. (19 x 20) The potential chemical incompatibility is the reaction between ketones (Group
37 19) and mercaptans (Group 20), resulting in heat generation. These chemicals are present
38 only in trace quantities (<1%) as coatings on laboratory glassware. Therefore, contact
39 between the chemicals, if it occurs, will be limited.
40
- 41 28b. (21 x 101) The potential chemical incompatibility is the reaction of alkali and alkaline
42 earth metals (Group 21) with residual water present in the combustible materials (101),
43 resulting in heat generation and ignition of the combustible materials. However, the
44 combustible materials are polyethylene and polyvinyl chloride packaging materials which
45 contain no residual water. Additionally, alkali and alkaline earth metals must be

1 neutralized prior to shipment to WIPP. Therefore, the final waste form will contain
2 compatible materials.

3
4 28c. (21 x 104) The potential chemical incompatibility is the violent reaction between alkali
5 and alkaline earth metals (Group 21) and oxidizing agents (Group 104). Oxidizing agents
6 are present in trace quantities (<1%) and are neutralized prior to packaging. Additionally,
7 alkali and alkaline earth metals must be neutralized prior to shipment to WIPP.
8 Therefore, the final waste form will contain compatible materials.

9
10 28d. (21 x 106) The potential chemical incompatibility is the violent reaction between alkali
11 and alkaline earth metals (Group 21) and water (Group 106), resulting in the evolution of
12 hydrogen gas and formation of strong caustics. However, alkali and alkaline earth metals
13 must be neutralized prior to shipment to WIPP. Therefore, the final waste form will
14 contain compatible materials.

15
16 28e. (22 x 106) The potential chemical incompatibility is the reaction of metal powders
17 (Group 22) with water (Group 106), resulting in the evolution of hydrogen gas and
18 production of heat. Metal powders or shavings are present as trace quantities (<1%) on
19 paper, rags, and rubber. This potential incompatibility results from the presence of water
20 in Ansulite™ fire extinguishing agents and/or Radiac™ wash solutions and/or absorbed
21 water. However, metal powders or shavings are present as trace quantities (<1%) on
22 paper, rags, and rubber, which minimizes their potential to form hydrogen gas. In
23 addition, the presence of any absorbed liquids are immobilized in an absorbent and would
24 not be available for reaction.

25
26 29. (23 x 104) The potential incompatibility is the possible reaction between metals and other
27 elemental alloys as sheets, rods, moldings, drops, etc. (Group 23) and oxidizing agents
28 (Group 104). The oxidizing agents are present only in trace quantities (<1%) and reacted
29 prior to loading in waste containers. The waste is mixed with cement to absorb any
30 residual liquid. Due to the immobilization and prior reaction of the oxidizing agents,
31 reactions are highly unlikely.

32
33 30. (23 x 104) The potential incompatibility is the possible reaction between metals, other
34 elemental alloys as sheets, rods, moldings, drops, etc. (Group 23) and oxidizing agents
35 (Group 104). The oxidizing agents are present only in trace quantities (<1%) and
36 dissolved in aqueous solutions that were cemented into a solid monolith-type structure.
37 Due to the immobilization and prior reaction of the oxidizing agents, reactions will not
38 occur.

39
40 31. (23 x 107) The potential incompatibility is the possible reaction between metals and other
41 elemental alloys, as sheets, rods, moldings, drops, etc. (Group 23) and water reactive
42 substances (Group 107). The outer low carbon steel drum is the only Group 23 metal
43 found in this content code. Calcium oxide, the only water reactive substance present, is a
44 solid dispersed in the chloride salts. Based on the immobilization of the calcium oxide in
45 the salt, reactions are considered highly unlikely.

- 1
2 32. (23 x 107) The potential incompatibility is the possible reaction between metals and other
3 elemental alloys as sheets, rods, moldings, drops, etc. (Group 23) and water reactive
4 substances (Group 107). Calcium oxide, the only water reactive substance present, is a
5 solid dispersed in the chloride salts. Based on the immobilization of the calcium oxide in
6 the salt, reactions are considered highly unlikely.
7
8 33. (24 x 106) The potential chemical incompatibility is the possible solubilization of toxic
9 metals (Group 24), which is not a concern since the water (Group 106) from the sludge is
10 fixed in the cemented product and would not be available for reaction.
11
12 33a. (24 x 106) The potential chemical incompatibility is the possible solubilization of toxic
13 metals (Group 24) by water (Group 106). This potential chemical incompatibility results
14 from the use of water in Ansulite™ fire extinguishing agents or Radiac™ wash solutions.
15 Metals in the test waste forms are present in trace quantities (T<1%) as large pieces and
16 not in powdered form. As a result, only minimal heat is expected to be formed.
17
18 34. (24 x 106) The potential incompatibility is the possible solubilization of toxic metals
19 (Group 24). The water (Group 106) is fixed the in the cemented product and would not be
20 available for reaction.
21
22 35. (24 x 107) The potential incompatibility is the possible reaction between toxic metals and
23 metal compounds (Group 24) and water reactive substances (Group 107). The metals are
24 present only in trace quantities (<1% by weight). Calcium oxide, the only water reactive
25 substance present, is a solid dispersed in the chloride salts. Based on the immobilization
26 of the calcium oxide in the salt, reactions are considered highly unlikely.
27
28 36. (24 x 107) The potential incompatibility is the possible reaction between toxic metals and
29 metal compounds (Group 24) and water reactive substances (Group 107). Calcium oxide,
30 the only water reactive substance present, is dispersed in chloride salts. Based on the
31 immobilization of the calcium oxide in the salts, reactions are considered highly unlikely.
32
33 36a. (25 x 101) The potential chemical incompatibility is the reaction of nitrides (Group 25)
34 with residual water present in the combustible materials (Group 101), resulting in
35 formation of ammonia gas, heat generation, and possible ignition of the combustible
36 materials. However, the combustible materials are polyethylene and polyvinyl chloride
37 packaging materials which contain no residual water. Additionally, any reactive nitrides
38 must be neutralized prior to shipment to WIPP. Therefore, the final waste form will
39 contain compatible materials.
40
41 36aa. (25 x 106) The potential chemical incompatibility is the reaction of nitrides (Group 25)
42 with water present in the combustible materials (101), resulting in formation of ammonia
43 gas, heat generation, and possible ignition of the combustible materials. However, any
44 reactive nitrides must be neutralized prior to shipment to WIPP. Therefore, the final
45 waste form will contain compatible materials.

- 1
2 36b. (27 x 104) The potential incompatibility is the possible reaction between nitro
3 compounds (Group 27) and oxidizing agents (Group 107). Calcium oxide, the only water
4 reactive substance present, is dispersed in chloride salts. Reactive oxidizing agents must
5 be neutralized prior to shipment to WIPP. Based on the immobilization of the calcium
6 oxide in the salts and neutralization of oxidizing agents, reactions are considered highly
7 unlikely.
8
- 9 36c. (29 x 104) The potential incompatibility is the possible reaction between saturated
10 aliphatics (Group 29) and oxidizing agents (Group 104). However, reactive oxidizing
11 agents must be neutralized prior to shipment to WIPP. Therefore, the final waste form
12 will contain compatible materials.
13
- 14 36d. (101 x 102) The potential incompatibility is the possible oxidation reaction between
15 combustibles (Group 101) and explosives (102). However, explosives must be reacted
16 prior to shipment to WIPP. Therefore, the final waste form will contain compatible
17 materials.
18
- 19 37. (101 x 104) The potential incompatibility is the possible reaction between combustible
20 materials (Group 101) and oxidizing agents (Group 104). The oxidizing agents are
21 present only in trace quantities (<1%) and are reacted prior to loading in waste
22 containers. In addition, cement is added to absorb any residual liquid. Due to the
23 immobilization and prior reaction of the oxidizing agents, this content code is considered
24 to be chemically compatible.
25
- 26 38. (101 x 104) The potential incompatibility is the possible reaction between combustible
27 materials (Group 101) and oxidizing agents (Group 104). The oxidizing agents are
28 present only in trace quantities (<1%) and are fixed in the solidified product. Due to the
29 immobilization and prior reaction of the oxidizing agents, this content code is considered
30 to be chemically compatible.
31
- 32 39. (101 x 107) The potential incompatibility is the possible reaction between combustible
33 and flammable materials (Group 101) and water reactive substances (Group 107). The
34 dominant combustible material in Group 101 is the polyethylene rigid drum liner.
35 Calcium oxide, the only water reactive substance present, is a solid dispersed in the
36 chloride salts. Based on the immobilization of the calcium oxide in the salt, reactions are
37 considered highly unlikely.
38
- 39 40. (102 x 104) The potential incompatibility is the possible violent reaction between
40 explosives (Group 102) and oxidizing agents (Group 104). However, both of these groups
41 must be neutralized before shipment to WIPP. Therefore, the final waste form will
42 contain compatible materials.
- 43 41. (104 x 107) The potential incompatibility is the possible violent reaction between
44 oxidizing agents (Group 104) and water reactives (Group 107). However, both of these

1 groups must be neutralized before shipment to WIPP. Therefore, the final waste form will
2 contain compatible materials.
3

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