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Note Concerning the Enclosed Report:

The enclosed report "Evaluation of the Effect of Elevated Temperatures on the Waste Containers in Room 7 of Panel 7 to Determine if an Additional Reaction Hazard Has Been Introduced" was developed by the LANL-Carlsbad office to document their evaluations of the potential impact of elevated temperature on transuranic waste containers emplaced in Panel 7, Room 7, the location of the breached container within the WIPP repository.

This report does not identify any new safety concerns.

These report documents findings previously identified but not documented, however, the adverse effects of elevated temperatures on waste streams within the active disposal panel/room have been well known since the photograph of the breached drum provided evidence of a heat event. These concerns have been factored into the worker safety considerations and planning for the subsequent manned entries. The report evaluates and describes the form of each waste stream emplaced in Panel 7 and summarizes each stream's vulnerabilities in the presence of elevated temperatures.

The report indicates that of the twelve waste streams present in Panel 7, only LA-MIN02-V.001 – to which the breached drum belongs – represents continued risk of a reaction hazard. This is not new information, as the balance of that waste stream has been under careful evaluation and study since the identification of the breached drum. The report concludes that the elevated temperatures could not cause a reaction in the other 11 waste streams present in Panel 7.

The assumed temperature conditions and conclusions included in this report are the postulations of LANL-CO, based on visual review and analysis of the photo evidence.



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Evaluation of the Effect of Elevated Temperatures on the Waste Containers in Room 7 of Panel 7 to Determine if an Additional Reaction Hazard Has Been Introduced

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Summary

The Los Alamos National Laboratory – Carlsbad Operations (LANL-CO) Difficult Waste Team has evaluated the effect of a heat generating event on the adjacent waste containers in the Waste Isolation Pilot Plant (WIPP) Room 7 of Panel 7 to determine if a heat event could have chemically or physically changed the waste and introduced a reaction hazard. This assessment relies upon documentation available to the LANL-CO and physical evidence in Room 7. Los Alamos National Laboratory (LANL) has not conducted testing to support these analyses. Unreacted drums of nitrate salt waste stream, LA-MIN02-V.001, continue to pose a potential reaction hazard in Room 7. The other waste streams present in Room 7 are not likely to have developed reaction hazards as a result of heating.

Background

On May 1, 2014, NWP declared a potentially inadequate safety analysis (PISA) based on the possibility that a container of nitrate salt bearing waste had contributed to the release of radioactivity in the WIPP underground. Recent entries into underground Room 7 have confirmed that at least one nitrate salt bearing waste container from Los Alamos National Laboratory is breached and is a likely source of the radioactive release.¹ Photographs from the May 12, 2014 entry into Room 7 showed evidence of melted plastic and rubber on 55-gallon drums and standard waste boxes, indicating the production of heat likely occurred in the room.² Subsequent entries into Room 7 showed heat damage on the nitrate salt bearing waste drum and surrounding waste drums. As part of the continuing investigation LANL-CO was tasked by the Department of Energy Carlsbad Field Office (CBFO) to evaluate the effect of heat and elevated temperature in Room 7 on the waste containers emplaced there to determine if the heat has chemically or physically changed the waste and introduced a reaction hazard causing the waste to spontaneously combust, self-heat, autoignite, or explode.

Based on a review of the information available to date regarding the release in Room 7 the event did not appear to involve an explosion. Damage to surrounding containers, backfill bags, shrink wrap and slip sheets was likely due to the heat generated and not direct burning of the plastic materials. Based on the

¹ Waste Isolation Pilot Plant Nitrate Salt Bearing Waste Container Isolation Plan, Department of Energy and Nuclear Waste Partnership, May 30, 2014

² WIPP UPDATE: May 12, 2014, U.S. Department of Energy, http://www.wipp.energy.gov/Special/WIPP%20Update%205_12_14.pdf, Accessed June 2, 2014

photographic evidence³ of the color of the steel on the breached LANL drum, a small area of the drum reached a minimum temperature of 340°C⁴. The maximum surface temperature of the drum is bounded by the critical temperature of low-carbon steel^{5,6} (700-870°C)⁷ due to the apparent lack of structural deformation on the site of the discoloration. The immediately adjacent drums do not show signs of radiant heat damage that would exceed 230°C, the auto ignition temperature of paper⁸. The damage to container gaskets, polypropylene backfill bags, shrink wrap, and slip sheets indicate a room wide temperature sufficient to cause the polymers in these items to flow or melt without burning which will happen at approximately 170°C⁹. Based solely on the photographic information it appears that some surfaces on the LANL drum may have reached temperatures of up to 700-870°C¹⁰ and the waste in a large portion of the room reached temperatures up to 170°C¹¹ to 230°C¹². The evaluation that follows is based on this temperature range.

Containers from Waste Stream LA-MIN02-V.001

Container Type	Total Number of Containers in Room 7	Number of Containers Overpacked in Standard Waste Boxes (SWBs)
55 Gallon Drum	43	1
Pipe Overpack Component (POC) 12-in	12	0

The fifty-five containers that represents LANL's LA-MIN02-V.001 waste stream in Room 7 contain nitrate salts, an oxidizer, mixed with Swheat Scoop – a wheat-based organic kitty litter – that LANL used as an absorbent in remediation/repackaging activities. Some of these drums also contain other organic compounds such as neutralizers added to treat free liquids during remediation/repackaging activities.

³ Lee, Ronnie. "Fwd" (Contains attachment "Effects of Reactive Payloads in a DOT Type A Container(A).pdf") Message to Mike Sensibaugh, J. R. Stroble, James Rhoades, Mark Percy, Ed Gulbransen, Farok Sharif, Kathryn W. Johns-Hughes, and Murthy Devarakonda. May 16, 2014. E-mail.

⁴ Oberg, Erik Jones, Franklin D. Horton, Holbrook L. Ryffel, Henry H. Machinery's Handbook (29th Edition) & Guide to Machinery's Handbook. Industrial Press, 2012. Accessed at:

<http://app.knovel.com/hotlink/toc/id:kpMHEGMH24/machinerys-handbook-29th>, Accessed June 11, 2014

⁵ Reference "ASTM A1008", Skolnik Industries, Inc., 55 Gallon Open Head Drum Tech Drawing,

http://www.skolnik.com/images/drawings/CQ5508Q_A3.pdf, Accessed June 11, 2014.

⁶ ASTM Standard A568/A568M, 2013, "Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for" ASTM International, West Conshohocken, PA, 2013

⁷ Oberg, Erik Jones, Franklin D. Horton, Holbrook L. Ryffel, Henry H. Machinery's Handbook (29th Edition) & Guide to Machinery's Handbook. Industrial Press, 2012

⁸ Weyerhaeuser Writing and Printing Paper MSDS, <http://www.weyerhaeuser.com/pdfs/msds/453.pdf>, Accessed June 11, 2014

⁹ "Polypropylene." *Hawley's Condensed Chemical Dictionary* -14th Ed. New York: John Wiley & Sons, Inc., 2001.

¹⁰ Oberg, Erik Jones, Franklin D. Horton, Holbrook L. Ryffel, Henry H. Machinery's Handbook (29th Edition) & Guide to Machinery's Handbook. Industrial Press, 2012

¹¹ "Polypropylene." *Hawley's Condensed Chemical Dictionary* -14th Ed. New York: John Wiley & Sons, Inc., 2001.

¹² Weyerhaeuser Writing and Printing Paper MSDS, <http://www.weyerhaeuser.com/pdfs/msds/453.pdf>, Accessed June 11, 2014

Photographs from Room 7 verify that at least one container from this waste stream has reacted, is breached, possibly due to a chemical reaction, and is a likely source of the radioactive release.

Because of the mixture of organics (fuel) and nitrate salts (oxidizer) in these drums they continue to pose a potential hazard. There may be some of these containers that have not reacted, even within the main heat zone. However the 170-230°C temperatures likely experienced by some of the other LA-MIN02-V.001 drums may have dried out some of the unreacted oxidizer-organic mixtures increasing their potential for spontaneous reaction. This dehydration of the fuel-oxidizer mixtures caused by the heating of the drums is recognized as a condition known to increase the potential for reaction.^{13,14,15} Reactions may have occurred within some of these drums at levels insufficient to lead to detectable visible evidence.

Containers from Waste Stream LA-MHD01.001

Container Type	Total Number of Containers in Room 7	Number of Containers Overpacked in SWBs
55 Gallon Drum	18	10
POC 12-in	2	0
SWB	1	N/A

An evaluation of the contents of the twenty-one containers that represent LANL's LA-MHD01.001 waste stream in Room 7 was conducted and the results of the evaluation are included in the table on the next page.

¹³ Fire, Frank L. *The Common Sense Approach to Hazardous Materials*, Saddle Brook, NJ: Penn Well Publishing Company, 1986, p 188-189

¹⁴ Wyman, Charles E. et al. "43 Hydrolysis of Cellulose and Hemicellulose", *Polysaccharides - Structural Diversity and Functional Versatility*, 2nd Edition, New York: CRC Press, 2004.

¹⁵ Bretherick, L. *Handbook of Reactive Chemical Hazards*. 4th ed. Boston, MA: Butterworth-Heinemann Ltd., 1990, p. 1338

Container	Contents
LA00000054517	Metal debris, metal cans, electrical equipment, plastic bags, leaded-rubber apron, hose
LA00000066775	Metal can with material, glass, lead, plastic debris, homogeneous solids (0.6 kg)
LA00000066776	Metal can with material, glass, plastic debris, homogeneous solids (1.0 kg)
LA00000066912	Metal cans with material, glass, plastic debris, homogeneous solids (1.1 kg)
LA00000067039	Metal cans with material, glass, lead, plastic debris, homogeneous solids (5.7 kg)
LA00000067040	Metal cans with material, glass, lead, plastic debris, homogeneous solids (3.5 kg)
LA00000067171	Plastic bags/bottles/plugs, rubber hose/gloves, aluminum probes, cheese cloth, glass jar, vinyl tape
LA00000067318	Leaded rubber gloves, metal cans/lids/scrap
LA00000067396	Metal cans/lids/scrap, glass, cheese cloth, electrical cord, vinyl tape, plastic debris
LA00000069023	Metal debris, leaded rubber gloves, plastic containers/debris
LA00000083715	Metal cans, lead shielding, ceramics, plastic debris, cheese cloth
LA00000083725	Metal debris, plastic bottles/debris, rubber debris, cheese cloth, lead lined gloves
LA00000085273	HEPA filter, metal debris, plastic bag
LA00000087907	Metal can with material, glass, plastic debris
LA00000088053	Open 20 gallon drum with material, metal lids/scrap, lead, rubber gloves, plastic containers/debris
LA00000092644	plastic debris, metal cans, ceramics, lead shielding
LA00000092777	plastic debris, metal cans, lead, rocks, ash
LA00000092840	Metal cans with material, metal 5 gallon bucket, metal lids/scrap, glass, lead, plastic, cloth, homogeneous solids (18.0 kg)
LA00000092974	Metal cans with material, metal lids, lead, glass, plastic bags, homogeneous solids (7.3 kg)
LA00000094127	room trash, cemented waste, rusty cans, plastic
SB10147	Vented 55 gallon drums, open 30 gallon drum, metal cans with material, scrap metal, glass, coveralls, wood, plastic debris, homogeneous solids (1.0 kg)

These twenty-one containers have been compared to a list of containers provided by LANL and Central Characterization Project (CCP) to LANL-CO which contain homogeneous solids identified as nitrate salt waste.¹⁶ None of the twenty-one containers listed above are found on the list; therefore, based on the best available information, the conclusion is that the homogeneous solids in these containers are not nitrate salt waste. Heat generated in Room 7 would not create a reaction hazard in these containers.

¹⁶ Email Communication: Davis Christensen, "Final number 707", May 23, 2014.

Containers from Waste Stream LA-CIN01.001

Container Type	Total Number of Containers in Room 7	Number of Containers Overpacked in SWBs
55 Gallon Drum	60	55

The sixty containers that represent LANL's LA-CIN01.001 waste stream in Room 7 consists of cemented inorganic homogeneous TRU waste generated in LANL's Plutonium Facility (TA-55).

Waste Lock 770 (sodium polyacrylate), an organic absorbent, was used on top of the cement in remediation/repackaging activities on all of these drums. The cemented waste contains nitrate salts, but does not pose a reaction hazard because the nitrates are solidified in cement and Waste Lock 770 will not combust under normal circumstances.¹⁷ Heat generated in Room 7 would not create a reaction hazard in these containers.

Containers from Waste Stream LA-MHD03.001

Container Type	Total Number of Containers in Room 7
SWB	1

An evaluation of the single SWB (LA00000068005) that represents LANL's LA-MHD03.001 waste stream in Room 7 was conducted using packaging paperwork and radiography. Information on the contents of the SWB shows it to contain waste from three drums repackaged into the SWB. The contents of these drums include: absorbent, cardboard, cloth coveralls, paper, plastic debris, glass debris, metal scrap, rubber aspirator bulbs, and wood. This container and its three parent drums have been compared to a list of containers agreed on by LANL and CCP to contain homogeneous solids identified as nitrate salt waste.¹⁸ Neither the SWB nor the three drums overlap with the list; therefore, based on the best available information, there are no nitrate salts in this container.

Based on the description of the contents of this single SWB, this container does not pose a reaction hazard in Room 7. Heat generated in Room 7 would not create a reaction hazard in this container.

¹⁷ Waste Lock 770® MSDS, http://www.m2polymer.com/pdf/MSDS_Waste_Lock_770.pdf, Accessed June 12, 2014

¹⁸ Email Communication: Davis Christensen, "Final number 707", May 23, 2014.

Containers from Waste Stream LA-MHD04.001

Container Type	Total Number of Containers in Room 7
SWB	9

An evaluation of the nine containers that represents LANL's LA-MHD04.001 waste stream in Room 7 was conducted and the results of the evaluation are included in the table below.

Container	Contents
LA00000068119	scrapped glovebox and ductwork
LA00000068120	scrapped glovebox and ductwork
LA00000068121	scrapped glovebox and ductwork
LA00000068229	wood chips, rad-trash, and air filters
LA00000068231	rad-trash and foam
LA00000068235	scrapped glovebox
LA00000068237	scrapped pencil tank and bag-out bag
LA00000068240	pipe and rad-trash/PPE
LA00000068241	pipe and conduit

Based on the description of the contents of the nine containers of the LA-MHD04.001 waste stream, these containers do not pose a reaction hazard in Room 7. Heat generated in Room 7 would not create a reaction hazard in these containers.

Containers from Waste Stream BN510.2

Container Type	Total Number of Containers in Room 7
100 Gallon Drum	6
SWB (overpacked drums)	3

The BN510.2 debris waste stream is generated at Idaho National Laboratory's (INL) Advanced Mixed Waste Treatment Project (AMWTP) from the supercompaction of 55-gallon containers of debris waste. With a force of 2,000 tons, or 4 million pounds, the Supercompactor can compact a 55-gallon drum to roughly one-fifth its original size. The compacted drum is called a puck. Up to 6 pucks are placed in a 100-gallon drum. If 100-gallon drums become damaged, they are overpacked into SWBs. The uncompacted waste consists of various combustible and noncombustible debris materials that originated from Argonne National Laboratory-East (AE), Materials and Fuels Complex (AW), Battelle Columbus (BC), Mound (MD), and Rocky Flats (RF), as well as AMWTP self-generated (i.e., BN item description codes (IDCs)) non-polychlorinated biphenyl (non-PCB) debris waste within the AMWTP Waste Treatment Facility (WMF-676).

This waste stream does not pose a reaction hazard. Supercompaction removes air volume and doubly encapsulates the waste – rendering it unlikely to burn even when exposed to fire. Heat generated in Room 7 would not likely create a reaction hazard in these containers.

Containers from Waste Stream BN510.3

Container Type	Total Number of Containers in Room 7
100 Gallon Drum	15

The BN510.3 newly generated debris waste stream is generated at INL's AMWTP from the supercompaction of 55-gallon containers of debris waste. With a force of 2,000 tons, or 4 million pounds, the Supercompactor can compact a 55-gallon drum to roughly one-fifth its original size. The compacted drum is called a puck. Up to 6 pucks are placed in a 100-gallon drum. Waste Stream BN510.3 is almost identical to BN510.2 except that it contains pre-1980 INL-Exhumed Subsurface Disposal Area (SD) debris waste and hexachlorobutadiene (hazardous waste number D033) that is not in the BN510.2 waste stream. With these two exceptions BN510.3 is the same as BN510.2.

This waste stream does not pose a reaction hazard. Hexachlorobutadiene is present in extremely low concentrations in this debris waste stream and does not autoignite until 610°C (1,130°F)¹⁹. Supercompaction removes air volume and doubly encapsulates the waste – rendering it unlikely to burn even when exposed to fire. Heat generated in Room 7 would not create a reaction hazard in these containers.

Containers from Waste Stream IN-BNINW216

Container Type	Total Number of Containers in Room 7	Number of Containers Overpacked in SWBs	Number of Containers Overpacked in Ten-Drum Overpacks (TDOPs)
55 Gallon Drum	19	12	0
85 Gallon Drum	36	N/A	36
SWB	27	N/A	0

All of the containers in Room 7 from waste stream IN-BNINW216 consist of aqueous sludge waste from Rocky Flat's Building 774 that was solidified with Portland cement or a diatomite/Portland cement mixture. The First/Second Stage Sludge waste stream consists of >50% by volume secondary sludge or filter cake from wastewater treatment processes or heavy metal sludges from recovery processes. Nine of the containers are sludge that was placed into a 55-gallon drum that had Portland cement but were not mixed. The excess liquid in the sludge was immobilized, but a solid monolith was not formed. Seventy-three of the containers are sludge that was co-fed into a 55-gallon drum with a diatomite and Portland cement mixture, which formed a solid monolith after curing.

The following inorganic absorbents were used during remediation/repackaging activities: Aquaset (sodium montmorillonite clay material), Aquaset II-G (granular sepiolite clay), and Micro-Cel E (synthetic calcium silicate).

¹⁹ Pohanish, Richard P. (2012). Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens (6th Edition). Elsevier. Accessed at: http://app.knovel.com/web/toc.v/cid:kpSHTHCC12/viewerType:toc/root_slug:sittigs-handbook-toxic-3/url_slug:sittigs-handbook-toxic-3/?

This waste stream does not pose a reaction hazard because all eighty-two containers are cemented metal oxides and only inorganic absorbents were used during remediation/repackaging activities. Heat generated in Room 7 would not create a reaction hazard in these containers.

Containers from Waste Stream IN-ID-RF-S3114

Container Type	Total Number of Containers in Room 7	Number of Containers Overpacked in TDOPs
55 Gallon Drum	328	328

The three-hundred and twenty-eight containers of waste stream IN-ID-RF-S3114 in Room 7 consist of immobilized organic liquids produced in the Rocky Flats Grease Plant. In this process, the organic liquids were processed through an extruder with Micro-Cel E (synthetic calcium silicate).

The following inorganic absorbents were used: Micro-Cel E (synthetic calcium silicate), Oil-Dri™ (clay absorbent), and vermiculite.

This waste stream does not pose a reaction hazard. Contained within the waste matrix is a considerable quantity of organic material that could be considered as fuel; however, it is adsorbed onto an inorganic matrix. There are no oxidizers in waste stream IN-ID-RF-S3114. The effect of heat generated in Room 7 would increase the diffusion rate of radiolysis products and the Volatile Organic Compound (VOC) evaporation rate from the waste during the temperature excursion. But these rates would have returned to the room temperature equilibrium levels near those seen at certification, once the waste cooled. Heat generated in Room 7 would not create a reaction hazard in these containers.

Containers from Waste Stream SR-221H-PuOx

Container Type	Total Number of Containers in Room 7
POC 12-in	51

The fifty-one containers of the Savannah River Site (SRS) waste stream SR-221H-PuOx in Room 7 are comprised of plutonium oxide blended with a non-hazardous inorganic material to facilitate termination of safeguards. The exact composition of the inorganic blending material is Unclassified Controlled Nuclear Information (UCNI); therefore, it is not explicitly listed in this document.

This waste stream does not pose a reaction hazard. It contains neither fuel nor oxidizer. Heat generated in Room 7 would not create a reaction hazard in these containers.

Containers from Waste Stream SR-MD-PAD1

Container Type	Total Number of Containers in Room 7
Standard Large Box 2 (SLB2)	4

An evaluation of the four Standard Large Box 2 (SLB2) that represent SRS SR-MD-PAD1 waste stream in Room 7 was conducted and the results of the evaluation are included in the table below.

Container	Contents (per Radiography Data)
SR46019	Metal debris, tools, wood, rubber debris, plastic, cloth
SR46020	Metal debris, wood, rubber debris, plastic, absorbent, Plexiglas
SR46021Z	Metal debris, absorbent, wood, plastic
SR46029Z	Metal debris, absorbent, wood, rubber debris, plastic debris, tools, batteries, electrical devices

Containers present in Room 7 of waste stream SR-MD-PAD1 consist of heterogeneous debris with organic absorbent. There are no nitrates or other oxidizers in the contents. Based on the description of the contents of the four containers of the SR-MD-PAD1 waste stream, this waste stream does not pose a reaction hazard in Room 7. Heat generated in Room 7 would not create a reaction hazard in these containers.

Containers from Waste Stream SR-W027-HBL-BOX

Container Type	Total Number of Containers in Room 7
SLB2	4

An evaluation of the contents of the four SLB2s that represents SRS SR-W027-HBL-BOX waste stream in Room 7 was conducted and the results of the evaluation are included in the table below.

Container	Contents (per Radiography Data)
SR57167702	Metal debris, absorbent, wood, plastic, motors, wood
SR57170918	Metal debris, tools, absorbent, wood, rubber debris, plastic
WMAPSLB007	Metal debris, tools, absorbent, wood, cardboard, rubber debris, plastic, Plexiglas, electrical cord
WMAPSLB046	Metal debris, HEPA filters, wood, cardboard, rubber debris, plastic, absorbent, Plexiglas

Based on the description of the contents of the four containers of the SR-W027-HBL-BOX waste stream and the use of inorganic absorbents, this waste stream does not pose a reaction hazard. Heat generated in Room 7 would not create a reaction hazard in these containers.