Attachment 1.
Procedures

Attachment 1.
Procedures

Moab UMTRA Moisture/Density Testing Procedure **(DOE-EM/GJRAC1783)**
MOAB UMTRA Project Lift Approval **(DOE-EM/GJRAC1803)**

Attachment 1. Procedures
Moab UMTRA Project Moisture/Density Testing Procedure
(DOE-EM/GJRAC1783)

DOE–EM/GJRAC1783

Office of Environmental Management – Grand Junction

UMTRA Project

Moab UMTRA Project Moisture/Density Testing Procedure

Revision 3

June 2014

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number DE-DT0002936
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Attachment 1. Procedures (continued)
Moab UMTRA Project Moisture/Density Testing Procedure
(DOE-EM/GJRAC1783)

DOE-EM/GJRAC1783

Moab UMTRA Project
Moisture/Density Testing Procedure

Revision 3

June 2014

Prepared by the Remedial Action Contractor under contract number DE–DT0002936 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Attachment 1. Procedures (*continued*)
Moab UMTRA Project Moisture/Density Testing Procedure
(DOE-EM/GJRAC1783)

Moab UMTRA Project
Moisture/Density Testing Procedure

Revision 3

Review and Approval

Beachem Bosh — Date: 6/26/2014
RAC Quality Assurance/Quality Control Representative

Kathy Turvy — Date: 6/26/2014
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Revision History

Revision	Date	Reason for Revision
0	February 2009	Initial issue.
1	April 2011	Added revised Lift Approval Form and added Emergency Procedure for Troxler gauge damage.
2	January 2013	Revision includes updated text and forms.
3	June 2014	Revision includes content revisions throughout for clarification.

Table of Contents

Attachments

Attachment 1. Procedures (*continued*)
Moab UMTRA Project Moisture/Density Testing Procedure
(DOE-EM/GJRAC1783)

1.0 Purpose and Scope

1.1 Purpose

This procedure provides requirements and methods for the proper moisture/density testing of soils placed at the U.S. Department of Energy Moab Uranium Mill Tailings Remedial Action (UMTRA) Project.

1.2 Scope

This procedure applies to the moisture/density testing of all soil materials placed at the Moab UMTRA Project.

2.0 General

2.1 Definitions

Authorized user – One who has met the training requirements in Section 2.3 of this procedure, has the proper thermoluminescent dosimeter (TLD) (or equivalent) with neutron dosimetry, and is authorized to use the Troxler by the Radiological Control Manager.

Compactable soils – Having a bulk density greater than 70 pounds per cubic foot dry weight in accordance with ASTM International (ASTM) D698, "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))." Compactable soils are also graded material that will pass through a 4-inch grizzly and have soil-like properties.

Frozen material – Material that contains frost or ice or cannot meet the compaction requirements because of frozen water inside the material.

Lift area – An area of the embankment identified for placement.

Lift identification – A discrete number that consists of:
- Moab UMTRA Project (i.e., U for UMTRA Project cell)
- Work Element (i.e., W for residual radioactive material [RRM] placement, I for interim cover placement, R for radon barrier placement, B for biointrusion placement, F for frost protection placement, C for cap rock placement, E for embankment placement, CF for cell floor).
- Lift Area –A1, B1, C1, year, month, and day. (e.g., UWA1090117, UIA1090117, URA1090117, UBA1090117, UFA1090117, UCA1090117).
- Number of lifts tested and approved for a specific lift area on the same day (e.g., 1st lift -00, 2nd lift -01)

EXAMPLE: U for Moab UMTRA Project, W for RRM lift, A1 for lift area, 121206 date for day lift was first tested, -00 for 1st lift tested that day (e.g., UWA1121206-00).

NOTE: The day the lift area is first tested will be the date used for lift identification.

Lot – A portion of a lift area that shall be tested individually to ensure it meets compaction requirements.

Old/new lift interface – The intersection of the old lift and the new lift.

Random number – A number between 0.001 and 0.999 that is generated from a calculator or computer with a random generator.

Standard count – A measurement of a known reference to ensure accurate gauge readings.

Standard proctor – ASTM D698.

Troxler – A moisture/density gauge that uses radioactive materials to determine in-place moisture and density. Special requirements are employed for use and security maintenance of the Troxler.

2.2 Responsibilities

2.2.1 Quality Assurance Manager

The Quality Assurance (QA) Manager is responsible for:

- Implementing and directing Quality Control (QC) activities contained within this procedure.
- Identifying QC problems.
- Initiating, recommending, or providing QC solutions.

2.2.2 QA/QC Representative

The QA/QC Representative is responsible for proper implementation of this procedure.

2.2.3 QC Technician or Qualified Personnel

The QC Technician or qualified personnel is responsible for following the testing and disposal process of this procedure.

2.2.4 Radiation Control Technician

The Radiation Control Technician is responsible for:

- Performing necessary surveys to minimize workers' exposure in accordance with the *Moab UMTRA Project ALARA Program* (DOE-EM/GJRAC1922).
- Posting radiation hazards in accordance with *Moab UMTRA Project Radiological Posting and Access Control* (DOE-EM/GJRAC1748).
- Posting requirements for radiation hazards.
- Briefing radiation workers that enter a controlled area under a radiological work permit (RWP).

2.2.5 Equipment Operator

The equipment operator is responsible for handling and placing the waste.

2.2.6 Authorized User

The authorized user is responsible for:

- Maintaining Troxler security.
- Keeping in compliance with the requirements of this procedure
- Minimizing any radiation exposures from the Troxler.

2.2.7 Radiological Control Manager

The Radiological Control Manager is responsible for:

- Overseeing the Radiation Protection Program at the UMTRA Moab Project.
- Designating, in writing, personnel authorized to use the nuclear density gauge (e.g., the Troxler).

2.3 Precautions and Limitations

- Work shall be immediately terminated by any personnel who feel the activity in progress is unsafe and/or may cause an unsafe condition. Work will be resumed when the condition is corrected.
- All workers are responsible to ensure they have met the requirement of the appropriate Integrated Work Plan/Job Safety Analysis (IWP/JSA) and RWP.
- All personnel shall remain clear of any operating equipment.
- All personnel using the Troxler shall attend the 8-hour Nuclear Moisture/Density Gauge training before use.
- New users shall be required to contact the Radiological Control Manager to add their names to the authorized user list.
- Before removing the Troxler from its designated storage location, the responsible authorized user shall ensure the gauge source rod is in the shielded, locked position and that the transport case is locked.
- The Troxler gauge shall be kept under constant surveillance by the authorized user for as low as reasonably achievable (ALARA) and security purposes.
- The Troxler gauge shall not be chained to a post, chained in the back of an open bed truck, or secured in a similar manner when not in constant surveillance, transport, or in storage.
- Troxler gauge users are required to use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal whenever the portable gauges are not under the control and constant surveillance of the licensee (i.e., the Troxler shall be locked in the cab of a vehicle and chained to the steering wheel, locked in a secured box and chained in the back of a truck, or locked in the cab of the vehicle inside the restricted area).
- The source rod on the Troxler shall not be touched with fingers, hands, or any part of the body unless needed maintenance is performed by a trained service technician.
- All personnel shall minimize their exposure from the unshielded source rod. Authorized users shall embrace the ALARA principles of time, distance, and shielding to accomplish this and shall limit the access of unnecessary personnel to the Troxler. Never look directly under the gauge when lowering the rod into the ground.
- Authorized users shall comply with the *Moab UMTRA Project Radiation Protection Program Manual* (DOE-EM/GJRAC1885).
- Authorized users shall always wear their assigned TLD (or equivalent) when using the Troxler.
- Authorized users shall always return the source to the locked and shielded position after each measurement is taken.
- Troxler gauges shall be stored only in approved storage. Gauges are kept in an approved storage location when not under constant surveillance by an authorized user.
- The *Moab UMTRA Project Emergency/Incident Response Plan* (DOE-EM/GJ1520) shall be initiated should the source rod fail to return to the locked position or should the Troxler be damaged in any way that endangers others (a 25-foot area shall be cordoned off around any damaged Troxler gauge).

2.4 Records

All documentation created as a result of compliance with this procedure is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545). Moab UMTRA Records are retained and maintained in accordance with federal orders, policies, and regulation, and all records created will be maintained and regulated according to the *Records Management Manual.*

All Field Density Test Forms QC-F-002 (Attachment 1) shall be attached to the appropriate Lift Approval Form QC-F-001 (Attachment 2).

Records shall be reviewed and approved before being sent to Records Management.

The Troxler Sign-Out Log Form QC-F-003 (Attachment 3) shall be completed when the Troxler is used

3.0 Requirements and Guidance

3.1 Compliance

- Each lift shall be given a discrete designation (lift identification number) for testing and surveying purposes.
- Each lift shall be tested to meet the specifications.
- Radon barriers shall be compacted to at least 95 percent of a standard proctor (ASTM D698) and have a moisture content of ±3 percent of the optimum moisture.
- RRM shall be compacted to at least 90 percent of a standard proctor (ASTM D698) and have a moisture content of ±3 percent of the optimum moisture. Moisture/density testing shall be performed for each waste or fill material in the lift.
- Perimeter embankments shall be compacted to at least 95 percent of a standard proctor (ASTM D698) and have a moisture content of ±5 percent of the optimum moisture.
- Spoils embankments shall be compacted to at least 90 percent of a standard proctor (ASTM D698) and have a moisture content of ±5 percent of the optimum moisture.
- Construction projects shall be in accordance with specifications in each Project construction plan associated documentation.
- Frost protection shall be compacted to at least 90 percent of a standard proctor (ASTM D698) and have a moisture content of ±5 percent of the optimum moisture.
- All soil density and moisture tests shall be performed with a calibrated nuclear moisture/density gauge in accordance with ASTM D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth") or by the sand-cone method in accordance with ASTM D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-cone Method."
- Proficiency testing of the nuclear moisture/density gauge shall be completed by performing a sand-cone density test and an oven or microwave drying test.
- A sand-cone density test (ASTM D1556) shall be performed jointly with 5 percent of all nuclear density tests.

- An oven or microwave drying test in accordance with ASTM D2216, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," or ASTM D4643, "Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating," shall be performed jointly with 10 percent of all nuclear moisture tests.
- A standard count shall be performed at the start of each day.
- Standard counts must be within the ranges established.

NOTE: If the moisture standard count is not within the indicated range, a moisture dry-back shall be performed to determine the moisture of any material tested (ASTM D2216 or ASTM D4643).

- Soils shall only be placed in cold weather (<32° F) when the required moisture and compaction requirements can be met.
- Troxler gauge security and accountability is kept through use of the Troxler Sign-Out Log Form.
- Lost, damaged, or unaccounted sources require immediate (within 2 hours) notification to the Radiological Control Manager. If the Troxler gauge is damaged, follow the emergency procedure in Attachement 4 for damaged Troxler gauges.
- All applicable U.S. Department of Transportation requirements shall be followed when transporting the Troxler gauge in accordance with Title 49 Code of Federal Regulations Part 173.24 (49 CFR 173.24), "Pipeline and Hazardous Materials Safety Administration, Department of Transportation, General Requirements for Shipments and Packagings," and 49 CFR 173.465, "Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Type A packaging tests."
- Authorized users shall take precautions to protect gauges from damage.

3.2 Procedure

1. Calculate the approximate area of the lift, then sketch the lift area on the Lift Approval Form.
2. Divide the lift into lots (see Addendum E, Remedial Action Inspection Plan, of the *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547) for testing frequencies).
3. Generate random numbers for the in-place moisture/density test coordinates as follows.
   - Generate two random numbers for each lot using a calculator or computer with a random number generator.
   - Multiply one random number by the approximate north/south dimension of the lot and the other random number by the approximate east/west dimension of the lot as measured in feet.
   - Locate the test locations specified by the random numbers.
   - If the sample location is outside the lot, generate two new random numbers.
   - Record this on the Lift Approval Form.
4. Prepare the testing site for the nuclear gauge and/or sand-cone test by leveling the area and removing any loose material from the surface.
5. When testing density and moisture with a nuclear gauge, follow the density gauge manual for operation and ASTM D6938 for the proper testing methods. When testing density by the sand-cone method, follow ASTM D1556.
6. When the lift does not meet compaction or moisture requirements, record the results on the Field Density Test Form and notify the equipment operator to re-work the material.

7. After the equipment operator has reworked the material, retest the material and document the rework performed.
8. The QC representative or qualified personnel shall approve lots that meet compaction and moisture requirements. Document results on the Field Density Form.

NOTE: Conditional approval can be given in the field from gauge readings if the QC Representative is confident that moisture dry-back results will not produce a failing moisture or density.

NOTE: If the QC representative gives conditional approval, and the moisture results produce failing moisture or density, a condition report shall be written unless the lift had no additional material disposed on that particular lift area.

4.0 References

49 CFR 173.24 (Code of Federal Regulations), "Pipeline and Hazardous Materials Safety Administration, Department of Transportation, General Requirements for Shipments and Packagings."

49 CFR 173.465 (Code of Federal Regulations), "Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Type A packaging tests."

ASTM (ASTM International) D698, "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))."

ASTM (ASTM International) D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-cone Method."

ASTM (ASTM International) D2216, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass."

ASTM (ASTM International) D4643, "Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating."

ASTM (ASTM International) D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)."

DOE (U.S. Department of Energy), *Moab UMTRA Project ALARA Program* (DOE-EM/GJRAC1922).

DOE (U.S. Department of Energy), *Moab UMTRA Project Emergency/Incident Response Plan* (DOE-EM/GJ1520).

DOE (U.S. Department of Energy), *Moab UMTRA Project Radiation Protection Program Manual* (DOE-EM/GJRAC1885).

DOE (U.S. Department of Energy), *Moab UMTRA Project Radiological Posting and Access Control* (DOE-EM/GJRAC1748).

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

DOE (U.S. Department of Energy), *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547).

Attachment 1.
Field Density Test Form QC-F-002

Attachment 1. Field Density Test Form QC-F-002

Moab UMTRA Project

FIELD DENSITY TEST

PROJECT: _____ OTHER _____

LIFT IDENTIFICATION: _____ DATE: _____

TEST ID NUMBER(S): _____

TEST LOCATION: _____ ____ D1556 ____ D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model _____ Gauge Serial # _____

Last Calibration Date: N/A

Daily Standard Counts:

Density _____ Moisture _____

____*Method A (Direct Transmission)* or ____*Method B (Backscatter)*

Depth Setting ____ *(inches)* Count Time ____ *(minutes)*

Moisture Count _____ Density Count _____

Wet Density (ρ_m) _____ *(lbs/ft³)* Dry Density _____ *(lbs/ft³)*

Moisture Density _____ *(lbs/ft³)* Moisture Fraction _____ *(%)*

MOISTURE DETERMINATION

____ASTM D2216 @ 110° C or ____ ASTM D4643

Container ID _____

Mass of container & wet specimen (M_{cms})	g
Mass of container & dry specimen (M_{cds})	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	g
Mass of container (M_c)	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	g
Moisture content (w) $w = (M_w / M_s) \times 100$	%

Dry Density (ρ_d) $= (100 \times \rho_m)/(100 + w)$

$\rho d = (\ 100 \times$ _____ $) / (100 +$ _____ $=$ _____ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precidence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

_____ / _____ x 100 = _____ %

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. *(lbs/ft³)* _____

Bulk Density of sand (ρ_1) _____ *g/cm³* _____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) _____ *g*

Mass of bottle & cone **before** filling cone, plate & hole	g
Mass of bottle & cone **after** filling cone, plate & hole	g
Mass of sand to fill cone, plate, & hole (M_2)	g
Mass of sand to fill hole	g
Mass of wet soil & container	g
Mass of container	g
Mass of wet soil (M_3)	g

Test Hole Volume

$V = (M_2 - M_3) / \rho_1$ _____ cm^3

Dry Mass of soil

$M_4 = 100 M_3 / (w + 100)$ _____ g

Wet Denisty

$\rho_m = (M_3 / V) \times 62.43$ _____ *lbs/ft³*

Dry Denisty

$\rho_d = M_4 / V$ _____ *g/cm³*

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ _____ *lbs/ft³*

Soil Description: _____

Proctor ID: _____

____ ASTM D698 or ____ ASTM D1557

Maximum Dry Density ($\gamma_d max$) _____ (lbs/ft³)

Optimum Moisture (w_{opt}) _____ (%)

Required Moisture: _____ % to _____ %

Required Percent Compaction: **90.0** (%)

Comments:

TEST RESULTS:

_____ Pass Date: _____

_____ Failed Moisture

_____ Failed Compaction Time: _____

By: _____ / _____

(print) *(signature)*

_____ _____

QA/QC APPROVAL DATE

Attachment 2.
Lift Approval Form QC-F-001

Attachment 2. Lift Approval Form QC-F-001

LIFT APPROVAL FORM

PROJECT: OTHER

NW CORNER DATE:

P 1			
EW:	X		=
NS:	X		=
P 2			
EW:	X		=
NS:	X		=
P 3			
EW:	X		=
NS:	X		=
P 4			
EW:	X		=
NS:	X		=
P 5			
EW:	X		=
NS:	X		=

Page 2 attached: Y N

IDENTIFY LOTS ABOVE

LIFT ID: - NW CORNER:

Uncompacted Thickness: Compacted Thickness: Debris Disp. By: Date: Time:

NW CORNER of debris placement: EW Dimension NS Dimension

Lift Area (ft²): Lift Volume (yd³):

Comments:

KEYING IN NOTES: N E S W MOISTURE/ DENSITY TESTS ID # (S):

LIFT APPROVED BY DATE: TIME:

QA/QC APPROVAL DATE

QC-F-001
Rev 1, November 2010

File index No. 43.8.2
Page ____ of ____

Attachment 3.
Troxler Sign-Out Log Form QC-F-003

Attachment 3. Troxler Sign-Out Log Form QC-F-003

Moab UMTRA Project
Troxler Sign-out Log

Date	Name of Responsible User	Gauge Serial No.	Location of Where Gauge will be Used	Sign-out *(time & date)*	Sign-in *(time & date)*

QC-F-003
Rev 1, June 2011

File Code Index No.: _____
Page ____ of ____

Attachment 4.
Emergency Procedure for Troxler Gauge Damage

Attachment 4. Emergency Procedure for Troxler Gauge Damage

Emergency Procedure for Troxler Gauge Damage
The following procedures apply when the source fails to return to a shielded position (e.g., as a result of being damaged, source becomes struck below the surface) or if any other emergency or unusual situation arises (e.g., the gauge is struck by a moving vehicle or is in an accident involving a vehicle).

1. Immediately secure the area and keep people at least 25 feet from the gauge in all directions until the situation is assessed and radiation levels are known and notify Radiological Control of situation; however, if any personnel are injured, contact site Health and Safety and immediate supervisors.
2. If any heavy equipment is involved, detain the equipment and operator until it is determined there is no contamination present and is approved by the Operations/Site Manager or designee.
3. Gauge users and other potentially contaminated individuals should not leave the scene until emergency assistance arrives.
4. Visually inspect the gauge to determine the position of the source rod practice ALARA and ensure your safety before performing inspection (exposed or shielded) and the position of the source shutters (open or closed), and the extent of damage, if any, to the source housing and/or shielding.
5. Notify the following persons listed below, but do not leave the scene to make notifications if needed; get someone to assist.
   - Radiological Controls Manager
   - Operations/Site Manager
   - QA Manager
   - Radiological Controls Supervisor
6. Follow the directions provided by the Radiological Control Manager.
7. The Radiological Control Manager must:
   - Arrange for a radiation survey to be conducted as soon as possible by a knowledgeable person using the appropriate radiation detection instrumentation (i.e., the person performing the survey must be competent in the use of the survey instrument).
   - Make necessary notifications.

Reports to the U.S. Nuclear Regulatory Commission and/or the DOE must be made within the reporting time frames specified in regulations. Reporting requirements are found in 10 CFR 20, "Standards for Protection Against Radiation," and 10 CFR 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material.

NOTE: Before shipping a damaged gauge:
- Send close-up photographs of the damaged gauge to Troxler.
- Send a leak test sample to Troxler for analysis or send leak test results.
- Obtain a returned goods authorization number from Troxler.

Attachment 1. Procedures (*continued*)
***Moab UMTRA Project Lift Approval* (DOE-EM/GJRAC1803)**

DOE–EM/GJRAC1803

Office of Environmental Management – Grand Junction

UMTRA Project

Moab UMTRA Project Lift Approval

Revision 7

June 2014

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number DE-DT0002936
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

DOE-EM/GJRAC1803

Moab UMTRA Project
Lift Approval Procedure

Revision 7

June 2014

Prepared by the Remedial Action Contractor under contract number DE-DT0002936
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Attachment 1. Procedures (*continued*)
Moab UMTRA Project Lift Approval (DOE-EM/GJRAC1803)

DOE-EM/GJRAC1803

Moab UMTRA Project
Lift Approval Procedure

Revision 7

Review and Approval

6/26/2014
Beachem Bosh
RAC Quality Assurance Representative
Date

6/26/2014
Kathy Turvy
RAC Quality Assurance Manager
Date

26JUN2014
Kirk Briscoe
RAC Crescent Junction Operations/Site Manager
Date

6/26/14
Steven D. Rima
RAC Environmental, Safety, Health, and Quality Manager
Date

Attachment 1. Procedures (*continued*)
Moab UMTRA Project Lift Approval (DOE-EM/GJRAC1803)

Revision History

Revision No.	Date	Reason/Basis for Revision
0	April 16, 2009	Initial issue.
1	April 23, 2009	Revision update includes correction of lift approval percentage.
2	December 2009	Revision updates include machine parameter changes, compactor information, cold weather placement, and surveying methods.
3	November 2010	Revision updates include updated forms, reference to testing in accordance with DOE-EM/GJRAC1783, horizontal lift compaction requirements, and survey documentation requirements.
4	July 2011	Revision updates include new verbiage to section 3.2.4 Lift Survey.
5	August 2012	Revision updates include adding the correct machine weights and updated forms.
6	January 2013	Revision updates includes new verbiage and deletion of Source Documentation section.
7	June 2014	Revision update includes new content for clarification.

Contents

Attachments

Attachment 1. Procedures (*continued*)
Moab UMTRA Project Lift Approval (DOE-EM/GJRAC1803)

1.0 Purpose and Scope

1.1 Purpose

The purpose of this procedure is to provide a consistent and practical method of compacting residual radioactive material (RRM) on the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project using a machine equipped with a computer-aided earthmoving system (CAES) and to provide methods for approving RRM lifts.

1.2 Scope

This procedure applies to RRM lifts using a machine equipped with a CAES and the approval of RRM lifts.

2.0 General

2.1 Definitions

Computer-aided earthmoving system (CAES) – Machine guidance system that delivers real-time productivity information to machine operators on an in-cab display using satellite navigation technology, machine-mounted components, a radio network, and office-management software.

Layer of snow – Blanket of snow that covers working lift areas without any voids in the snow.

Lift Area – Area of the embankment identified for material placement.

Lift Identification – Discrete number that consists of:
- Moab UMTRA Project (e.g., U for UMTRA Project cell).
- Work Element (e.g., W for RRM placement, I for interim cover placement, R for radon barrier placement, B for biointrusion placement, F for frost protection placement, C for cap rock placement, E for embankment placement, CF for cell floor).
- Lift Area – (e.g., A1, B1, C1) year, month, and day (e.g., UWA1090117, UIA1090117, URA1090117, UBA1090117, UFA1090117, UCA1090117).
- Number of lifts tested and approved for a specific lift area on the same day (e.g., 1st lift -00, 2nd lift -01).

Example: U for Moab UMTRA Project, W for RRM lift, A1 for lift area, 121206 date or day lift was first tested, and -00 for 1st lift tested that day (e.g., UWA1121206-00).

NOTE: The day the lift area is first tested will be the date used for lift identification.

Machine – Heavy equipment that is greater than or equal to 56,669 pounds (lb) in weight.

Machine pass – Movement of a machine across an area of the lift in any direction that meets compaction criteria calculated by an algorithm in the CAES.

Movement of the machine from one side of the lift to the opposite side of the lift, which meets compaction criteria calculated by an algorithm in the CAES, constitutes one pass; the return trip from the opposite side of the lift, which also meets compaction criteria calculated by an algorithm in the compactor's system, constitutes a second pass.

Wheel pass – Movement of the machine rear or front axle/wheels across an area of the lift that meets compaction criteria calculated by an algorithm in the compactor's system. The CAES reports one wheel pass for each end of the machine (i.e., two wheel passes equals one machine pass).

2.2 Responsibilities

2.2.1 Quality Assurance Manager

The Quality Assurance (QA) Manager is responsible for:

- Implementing and directing Quality Control (QC) activities contained within this procedure.
- Identifying QC problems.
- Initiating, recommending, and/or providing QC solutions.

2.2.2 QA/QC Representative

The QA/QC Representative or designee is responsible for the proper implementation of this procedure and for approving lifts in accordance with this procedure.

2.2.3 Operations/Site Manager

The Operations/Site Manager or designee is responsible for issuing directives to equipment operators.

2.2.4 Equipment Operators

Equipment operators are responsible for compacting lifts with the compaction machine in accordance with this procedure.

2.2.5 All Personnel

When involved in compacting RRM lifts using the compaction machine, all employees are responsible for identifying any safety hazards and complying with the applicable Radiological Work Permits and Integrated Work Plans.

2.3 Precautions and Limitations

2.3.1 Stop Work

Work shall be immediately terminated by any personnel who feel the activity in progress is unsafe and/or may create an unsafe condition. Work will be resumed when the condition is corrected.

2.3.2 Safety Protocols

All personnel shall remain clear of any operating equipment and maintain good communication with the equipment operator.

Personnel observing compaction using the compaction machine shall always be in visual view of the operator and shall be in front of the machine and never behind the machine working area while machine is in operation.

2.3.3 Training and Procedures

All personnel using the Troxler Nuclear Density Gauge shall attend 8 hours of Nuclear Moisture/Density Gauge training and shall perform all testing in accordance with Project procedures.

2.4 Records

All documentation created as a result of compliance with this procedure is considered a Project record and will be managed in accordance with *the Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545). Moab UMTRA Records are retained and maintained in accordance with federal orders, policies, and regulation, and all records created will be maintained and regulated according to the *Records Management Manual.*

The compactor screen printout and the calculations of the exported terrain data shall be attached to the Lift Approval Form (QC-F-001) (see Attachment 1).

Following QA/QC approval of the QC documents, the original documentation shall be transmitted to Records.

3.0 Requirements and Guidance

3.1 Compliance

3.1.1 Lift Identification

Each lift shall be given a discrete lift identification number. The lift identification number shall be used to identify all documentation for that lift.

3.1.2 RRM Disposal

No RRM shall be disposed of on a lift until the previous lift is approved, with the exception of management of stockpile material

3.1.3 Lift Thickness

Lift thickness shall not exceed an average uncompacted thickness of 12 inches.

3.1.4 Debris

In accordance with this procedure, debris placement shall be in a single layer, shall be distributed across the lift, and shall comply with the debris size requirements found in Addendum E, "Remedial Action Inspection Plan," of the *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547).

3.1.5 Machine Properties

The machine properties (see Attachments 2 and 3) under the machine parameters tab for the machines shall be:

- Number of levels (the number of machine passes) shall be set at three or four depending on machine weight and/or type. Four machine passes are required for machines weighing between 56,669 and 84,850 lb. Three machine passes are required for 825H Caterpillar compactors and machines weighing greater than or equal to 84,850 lb.

- Lift height shall be set at 12 inches.
- Thick lift threshold shall be set at 2 feet.

3.2 Procedure

3.2.1 Moisture Testing

When performing moisture testing, a representative sample shall be obtained from material placed that day. The QC Representative (or qualified personnel) shall perform a moisture test in accordance with applicable ASTM International (ASTM) standards for each day that material is placed. Test results shall be documented on the Field Density Test Form (QC-F-002) (see Attachment 4).

3.2.2 Debris Inspection

The QC Representative (or qualified personnel) shall inspect the debris once it is spread out across the lift. The debris shall be spread out uniformly across the lift in a manner that minimizes void spaces and shall not exceed debris size requirements. The debris inspection shall be documented on the Lift Approval Form.

3.2.3 Visual Inspection

The QC Representative (or qualified personnel) shall visually inspect the lift areas for frozen material, frost, and snow before placement of RRM. No soil that is frozen, has frost, or is under a layer of snow shall be approved for placement. The inspection shall be documented on the Lift Approval Form under the comment section.

3.2.4 Lift Surveys

Each lift shall be surveyed using a high-accuracy, hand-held global positioning system (GPS) or CAES. When determining the lift thickness of a lift area less than 3,000 square feet, one survey point should be performed for every 15 feet. When determining the lift thickness of a lift area greater than or equal to 3,000 square feet, the survey for each lift shall have a minimum of 10 points. The lift thickness will be determined by comparing the current lift elevations to the previous lift elevations located on the same northing and easting locations. When calculating the loose-lift thickness, no survey point shall be greater than 1.3 feet, as long as the average loose thickness is less than or equal to 1 foot. QC shall perform a visual inspection to ensure the lift is placed with uniform thickness. Surveys shall be documented on the appropriate form and attached to the Lift Approval Form.

3.2.5 CAES Terrain Data

Each lift shall be compacted by a minimum of three or four machine passes depending on weight and type of machine used. To ensure the lift area meets the three or four machine pass requirement, print the compaction screen and identify the lift and export the terrain data for the lift using the CAES.

3.2.6 Requirements for Lift Approval

Lifts that meet the following requirements shall be approved.

- Seventy percent of the pixels have greater than or equal to three or four machine passes depending on weight of machine (green pixels) when placing material on slopes.

- Eighty percent of the pixels have greater than or equal to three or four machine passes depending on weight of machine (green pixels) when placing material on approximately horizontal lifts.
- The average lift thickness is less than or equal to 12 inches with no white pixels on the compactor screen printout.
- The compactor screen print out shows uniform compaction over the entire lift area.

3.2.7 Reworking of Lifts

Lifts that do not meet the Moab UMTRA Project requirements shall be reworked (e.g., adding additional compaction, cutting the lift, adding more moisture); rework performed shall be documented.

3.2.8 Troxler Gauge Testing

The QC Representative (or qualified personnel) shall perform in-place density tests every 6 months in accordance with ASTM Standard D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth),"and ASTM D1556, "Standard Test Method for Density and Unit Wight of Soil in Place by the Sand-Cone Method," to verify the CAES is working correctly.

If the CAES is not used to verify compaction and the lift thickness, then the lift shall be tested in accordance with *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783). The testing frequency, inspections, and required reporting shall comply with the RAIP and surveying shall be performed using a hand-held GPS or a level survey.

4.0 References

ASTM (ASTM International) Standard D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)."

ASTM (ASTM International) Standard D1556, "Standard Test Method for Density and Unit Wight of Soil in Place by the Sand-Cone Method."

DOE (U.S. Department of Energy) *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783).

DOE (U.S. Department of Energy) *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

DOE (U.S. Department of Energy) *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547).

Attachment 1.
Lift Approval Form (QC-F-001)

Attachment 1. Lift Approval Form (QC-F-001)

LIFT APPROVAL FORM

PROJECT: _____ **OTHER** _____

NW CORNER **DATE:** _____

	P_1
	EW: ____ X ____ = ____
	NS: ____ X ____ = ____
	P_2
	EW: ____ X ____ = ____
	NS: ____ X ____ = ____
	P_3
	EW: ____ X ____ = ____
	NS: ____ X ____ = ____
	P_4
	EW: ____ X ____ = ____
	NS: ____ X ____ = ____
	P_5
	EW: ____ X ____ = ____
	NS: ____ X ____ = ____
	Page 2 attached: Y N

IDENTIFY LOTS ABOVE

LIFT ID: _____ - NW CORNER: _____

Uncompacted Thickness: _____ Compacted Thickness: _____ Debris Insp. By: _____ Date: _____ Time: _____

NW CORNER of debris placement: _____ EW Dimension _____ NS Dimension _____

Lift Area (ft²): _____ Lift Volume (yd³): _____

Comments:

KEYING IN NOTES: N E S W _____ MOISTURE/ DENSITY TESTS ID # (S): _____

LIFT APPROVED BY _____ DATE: _____ TIME: _____

_____ _____

QA/QC APPROVAL DATE

QC-F-001
Rev 1, November 2010

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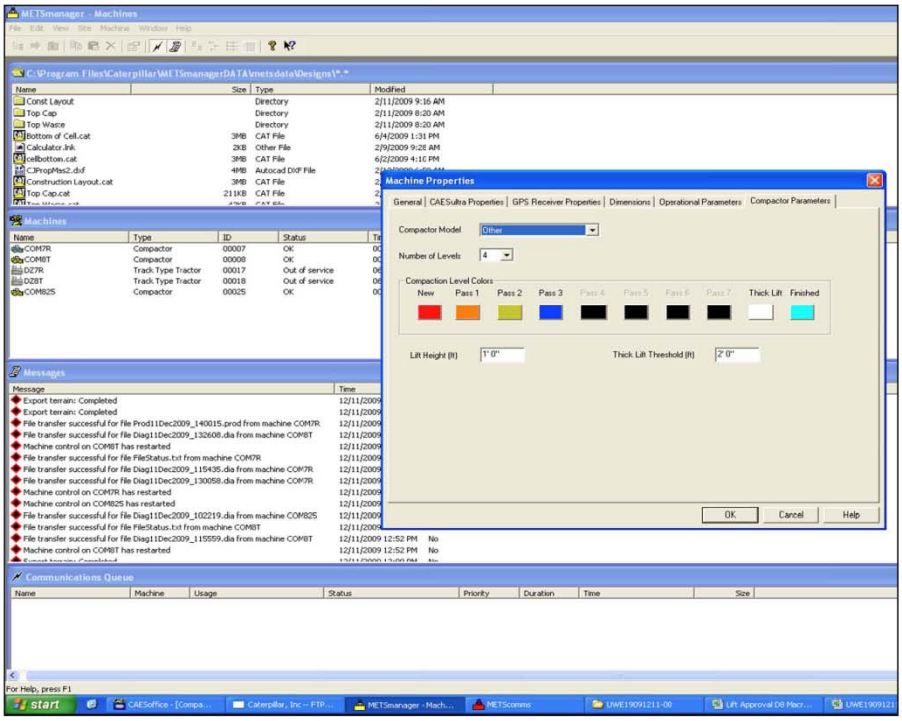
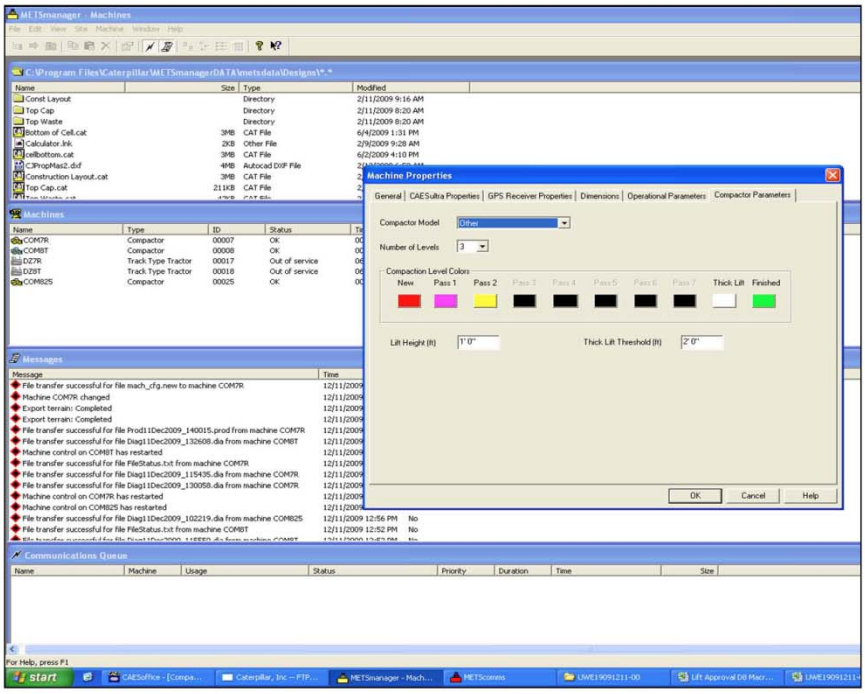
Attachment 2.
Machine Parameters for Machines Weighing 56,669 to 84,850 lb

Attachment 2. Machine Parameters for Machines Weighing 56,669 to 84,850 lb



Attachment 3.
Machine Parameters for CAT 825H Compactors and Machines Weighing Greater Than or Equal to 84,850 lb

Attachment 3. Machine Parameters for CAT 825H Compactors and Machines Weighing Greater Than or Equal to 84,850 lb



Attachment 4.
Field Density Test Form (QC-F-002)

Attachment 4. Field Density Test Form (QC-F-002)

Moab UMTRA Project

FIELD DENSITY TEST

PROJECT: _____ OTHER _____

LIFT IDENTIFICATION: _____ DATE: _____

TEST ID NUMBER(S): _____

TEST LOCATION: _____ ____D1556 ____D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model _____ Gauge Serial # _____

Last Calibration Date: N/A

Daily Standard Counts:

Density _____ Moisture _____

____*Method A (Direct Transmission)* or ____ *Method B (Backscatter)*

Depth Setting _____ *(inches)* Count Time ____ *(minutes)*

Moisture Count _____ Density Count _____

Wet Density (ρ_m) _____ *(lbs/ft³)* Dry Density _____ *(lbs/ft³)*

Moisture Density _____ *(lbs/ft³)* Moisture Fraction _____ *(%)*

MOISTURE DETERMINATION

____ASTM D2216 @ 110° C or ____ ASTM D4643

Container ID _____

Mass of container & wet specimen (M_{cms})		g
Mass of container & dry specimen (M_{cds})		g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$		g
Mass of container (M_c)		g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$		g
Moisture content (w) $w = (M_w / M_s) \times 100$		%

Dry Density ($\rho_d = (100 \times \rho_m)/(100 + w)$)

$\rho d = (\ 100\ \times$ _____ $)\ /\ (100 +$ _____ $) =$ _____ *lbs/ft³*

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

Percent Compaction = ρ_d / $\gamma_d max \times 100$

_____ / _____ x 100 = _____ %

Comments:

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. *(lbs/ft³)* _____

Bulk Density of sand (ρ_1) _____ *g/cm³* _____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_2) _____ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume $V = (M_1 - M_2) / \rho_1$ _____ cm^3

Dry Mass of soil $M_d = 100\ M_3 / (w + 100)$ _____ g

Wet Denisty $\rho_m = (M_3 / V) \times 62.43$ _____ *lbs/ft³*

Dry Denisty $\rho_d = M_d / V$ _____ *g/cm³*

Dry Unit Weight $\gamma_d = \rho_d \times 62.43$ _____ *lbs/ft³*

Soil Description: _____

Proctor ID: _____

____ ASTM D698 or ____ ASTM D1557

Maximum Dry Density ($\gamma_d max$) _____ (lbs/ft³)

Optimum Moisture (w_{opt}) _____ (%)

Required Moisture: _____% to _____%

Required Percent Compaction: 90.0 (%)

TEST RESULTS:

_____ Pass Date: _____

_____ Failed Moisture

_____ Failed Compaction Time: _____

By: _____ / _____
(print) *(signature)*

_____ _____
QA/QC APPROVAL DATE

QC-F-002
Rev 2, June 2011

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