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CCP-PO-016
Revision 4

CCP Gas Generation Testing Program Quality Assurance Project Plan

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RECORD OF REVISION

Revision Number	Date Approved	Description of Revision
0	06/13/2005	Initial issue.
1	07/28/2005	Addressed Carlsbad Field Office (CBFO) Document Review Record (DRR)
2	04/10/2006	Revised to correct steps 4.5.1[B.1] and 5.5.1[A], and added reference to Section 8.0. Addressed CBFO DRR.
3	04/13/2006	Minor revision due to inadvertently changing < to ≤ on Table in Section 5.5 in previous revision.
4	03/27/2009	Revised to bring the procedure more prescriptive with DOE/WIPP-01-3187, *Quality Assurance Program Plan for TRUPACT-II Gas Generation Test Program* and *Contact Handled Transuranic Waste Authorized Methods for Payload Control* (CH-TRAMPAC). Besides editorial corrections, the non-required Site Project Manager (SPM) position was removed; quality control (QC) requirements of Section 2 and Section 3 were made consistent with each other, and to eliminate references to procedures which were eliminated because they were incorporated into one procedure, CCP-TP-083, *CCP Heated Gas Test Canister Operations*.

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1.0 INTRODUCTION

The Gas Generation Testing Program (GGTP) is designed to establish the concentration of flammable gases and/or gas generation rates in a test category waste container intended for shipment in the Transuranic Package Transporter-II (TRUPACT-II) or HalfPACT packages. The phrase gas generation testing (GGT) refers to any activity that establishes the flammable gas concentration or the flammable gas generation rate (FGGR). This includes, but is not limited to, measurements performed directly on waste containers or during tests performed on waste containers.

DOE/WIPP-01-3187, *Quality Assurance Program Plan for TRUPACT-II Gas Generation Test Program* (QAPP) provides the basis of the GGTP. The QAPP describes GGT methods generally without providing specific details on the type of equipment used. The testing method used by the Central Characterization Project (CCP) for full container testing is the Gas Generation Test Canister (GGTC) or bell jar measurement method. The bell jar measurement method involves measuring parameters from gas contained between the drum and the canister that encloses the drum. GGTC pressure and temperature are recorded, and gas concentration is determined using a Mobile Gas Sampling System (MGSS) (Figure 1-1. MGSS Sampling Method).

This Quality Assurance Project Plan (QAPjP) is a subset of the overall CCP Quality Assurance program described in CCP-PO-002, *CCP Transuranic Waste Certification Plan*; it implements the quality assurance and quality control (QC) requirements of DOE/WIPP-01-3187.

2.0 PROGRAM DESCRIPTION

This section describes the scope of the GGTP and the data QCs required for the GGTP.

2.1 Data Quality Objectives (DQOs)

2.1.1 The design input of the GGTP is presented in this section as DQOs. DQOs are qualitative and quantitative statements that clarify GGTP technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used to establish the quality and quantity of data needed to support decisions. The data obtained through the GGTP will be used to ensure that the transportation of contact-handled (CH) transuranic (TRU) waste in the TRUPACT-II meets the applicable requirements set forth in the *TRUPACT-II Safety Analysis Report* (SAR).

2.1.2 The DQOs for the GGTP are as follows:

[A] Hydrogen/Methane Gas Generation Rate – Establish the hydrogen/methane generation rate in moles/sec.

[B] Total Gas Generation Rate – For Waste Type IV, establish the total gas generation rate in the waste container.

[C] Flammable Volatile Organic Compound (VOC) Concentration – If the flammable VOC concentration cannot be shown through acceptable knowledge (AK) or process knowledge (PK) to be less than or equal to 500 parts per million (ppm) by volume, establish the headspace concentration of flammable VOCs in a waste container using Headspace Gas (HSG) Sampling.

2.1.3 The CCP is responsible for establishing the headspace concentration of methane and VOCs for each drum tested. This information will be used to ensure that shipped drums satisfy the limits on flammable VOCs in accordance with CCP-PO-003, *CCP Transuranic Authorized Methods for Payload Control (CCP CH-TRAMPAC)* and is outside the scope of this QAPjP.

2.1.4 Intrusion into a waste drum after GGT does not invalidate the results of GGT as long as the drum has the same waste material content after the intrusion. GGT results are considered to remain valid for a drum if the GGTP provides verification that the waste content of the drum has not changed as a result of any intrusions after GGT was performed.

2.2 GGTP Scope

The scope of this QAPjP is twofold. The first, or short-term, objective is to facilitate shipment of waste in the test category by testing individual payload containers to show compliance with the flammable and total gas generation and concentration requirements. The second, or long-term, objective is to improve waste shippability for specific populations or subpopulations of waste by arriving at more realistic gas generation rates based on the results of measurement and testing.

In order to achieve compliance with the short-term objective, the GGTP must demonstrate compliance with Section 5.2.5 [D][D.4], Test Startup and Test Completion, of the CCP CH-TRAMPAC. Key to compliance with this section is the ability of the GGTP to demonstrate that the testing protocol allows the program to obtain “sufficient data”.

The test startup consists of placing the waste container in the test apparatus and, if specified in Table 5.2-10, Decay Heat Criteria for Container Selection, of the CCP CH-TRAMPAC, heating the test unit to the required test temperature. Site-specific operating procedures describe the sampling and analysis required on a routine basis. The test will be terminated after sufficient data are obtained to calculate the hydrogen gas generation rate.

The term "sufficient data" is defined as data on the parameters needed to quantify a bounding and applicable gas generation rate for the container under the test conditions prescribed in the *Contact Handled Transuranic Waste Authorized Methods for Payload Control* (CH-TRAMPAC), Section 5.2.5, Unified Flammable Gas Test Procedure (UFGTP). For containers that are tested at an elevated temperature (Waste Type IV), a thermal equilibration period exists. Measurements are taken after the equilibration period to quantify the maximum flammable gas and total gas generation rates. In this case, sufficient data is measurement of flammable gas and total gas generation rates, temperature, and pressures during a testing period that is extended until the rates are shown to remain constant or decrease, or until the testing period (time from container isolation and commencement of heating to the collection of the final gas sample) equals or exceeds the time of the allowed shipping period. In all cases, the collection of data as described herein ensures that the measured rates determined through testing are representative of the gas generation properties of the container over the allowed shipping period. The measured rates are then compared to the respective limits to demonstrate compliance with the allowable gas generation rates.

Requirements to demonstrate compliance with the long-term objective can be found in Section 5.2.5 [E], Implementation of Unified Flammable Gas Test Procedure Long-Term Objective, of the CCP CH-TRAMPAC. Procedure CCP-TP-138, *CCP Execution of Long-Term Objective for the Unified Flammable Gas Test Procedure*, implements these requirements.

The long-term objective of the UFGTP is applied to a population of containers with consistent gas generation properties. The long-term objective of the UFGTP may be implemented once the required data have been collected through measurement and/or testing for a subpopulation of these containers. If a bounding FGGR value for compliance determination can be established and shown to be below the maximum allowable FGGR for the population, no further need exists to test every container in the population. If the bounding FGGR value exceeds the maximum allowable FGGR, the population will continue to be processed under the measurement and testing methodology of the UFGTP. This methodology is consistent with that used in the determination of dose-dependent G values in Appendix 3.3 of the *CH-TRU Payload Appendices*.

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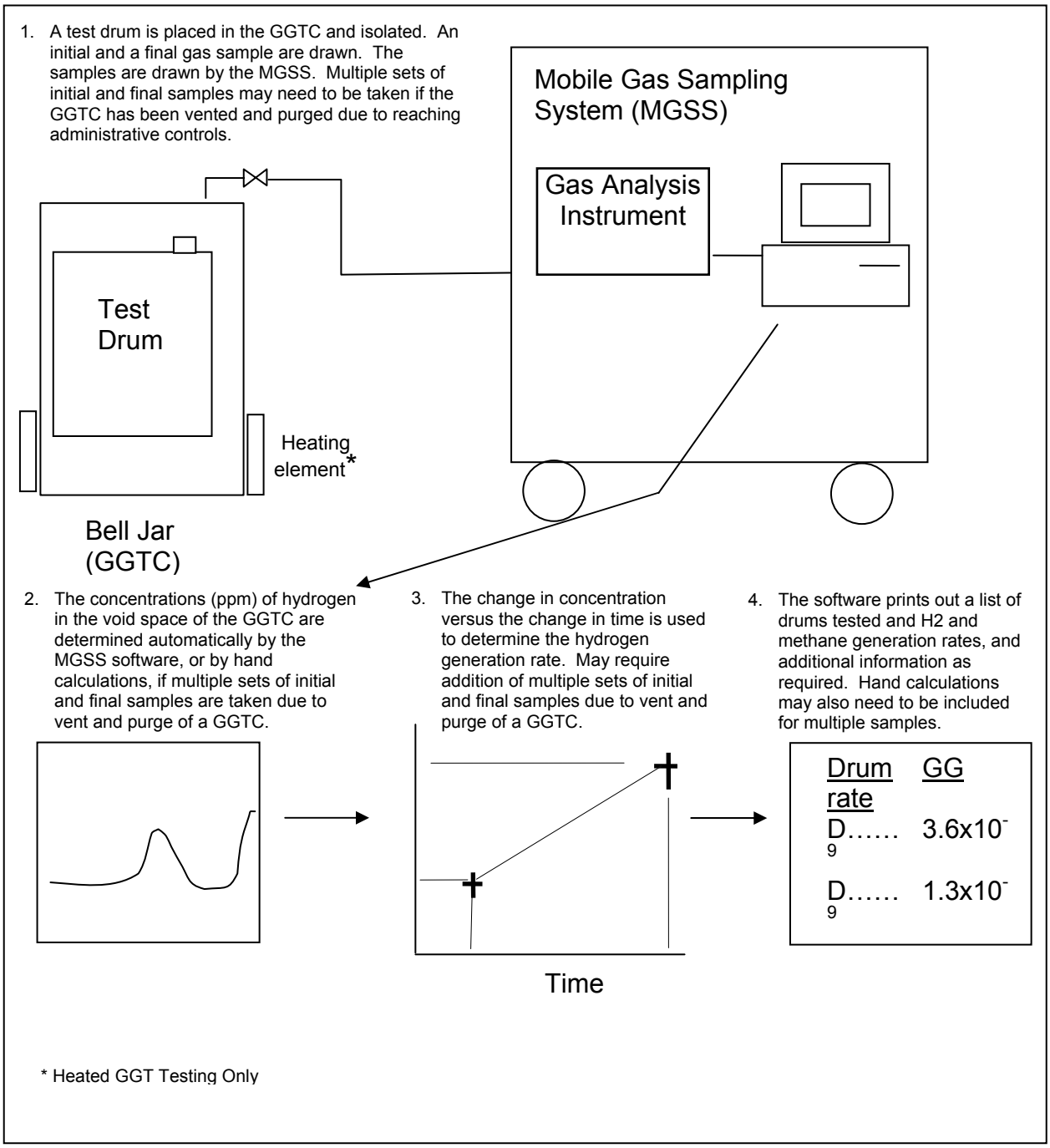
Figure 1-1. MGSS Sampling Method



3.0 GGTP ORGANIZATION

This section describes the roles and responsibilities of the participants in the GGTP.

3.1 Vendor Project Manager (VPM)

3.1.1 Responsible for the operation and maintenance of the GGT apparatus and the management of the data generated from GGT operations.

3.1.2 Performs the function of GGTP Manager

3.2 Independent Technical Reviewer (ITR)

3.2.1 Responsible for performing technical reviews of GGT Batch Data Report (BDRs) prior to submittal to the Quality Assurance Officer (QAO).

3.3 Quality Assurance Officer (QAO)

3.3.1 Responsible for the review and validation of GGT data, nonconformances, documentation, and GGT BDRs.

3.4 Operator/Technical Supervisor (TS)

3.4.1 Responsible for performing the loading and unloading of drums in the GGTCs.

3.4.2 Samples candidate drums in the GGTCs.

3.4.3 Compiles GGT BDRs and forwards to the ITR.

3.4.4 Reviews the screening of candidate drums for GGT.

3.4.5 Documents any nonconformances in accordance with CCP-QP-005, *CCP TRU Nonconforming Item Reporting and Control.*

3.4.6 Assists the manager in coordination of GGT operation.

3.5 Review and Approval of Documents

3.5.1 This document is reviewed and approved by the U.S. Department of Energy Carlsbad Field Office (DOE/CBFO).

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3.5.2 CCP procedures used to implement the requirements of this document shall be reviewed, approved, and maintained in accordance with CCP-QP-010, *CCP Document Preparation, Approval and Control*.

3.6 Documentation and Records

3.6.1 Documentation and records generated by GGT are maintained in accordance with CCP-QP-008, *CCP Records Management*.

3.7 Training

3.7.1 Personnel involved in the generation of data in support of GGT will be trained and qualified in accordance with CCP-QP-002, *CCP Training and Qualification Plan*.

3.8 Procurement/Software

3.8.1 Procurement of equipment, standards, and software shall be in accordance with CCP-QP-015, *CCP Procurement,* and CCP-QP-022, *CCP Software Quality Assurance Plan*.

4.0 GGT PROCESS DESCRIPTION

4.1 The criteria for selection of the waste containers for GGT and the waste parameters that must be characterized prior to the test are described in the CCP CH-TRAMPAC. A waste container that meets one of the definitions below is a test category waste container.

- A waste container decay heat exceeds analytical limit
- The waste type has no bounding G value
- The flammable VOC concentration in container headspace cannot be demonstrated to be less than or equal to 500 ppm.

4.2 In order to calculate the total gas generation rate, hydrogen/methane gas generation rate, and hydrogen gas generation rate, the following information is obtained or measured:

- Initial and final GGTC hydrogen concentration
- Elapsed time between initial and final sampling
- Effective resistance to the release of hydrogen (sec/mole) (R_{eff}). The effective resistance is computed by summing the individual confinement layer resistances.
- Void Volume
- Isolation date and time
- Drum closure date
- Methane/Hydrogen Ratio
- Initial and final GGTC sampling temperature and pressure of GGTC

4.3 The drum test temperature is determined in accordance with Table 4-1, Decay Heat Criteria for Drum Selection (Ref: CCP-PO-003, Table 5.2-10), and the Drum Equilibration Time Requirements are listed in Table 4-2, Drum Equilibration Time Requirements.

Table 4-1. Decay Heat Criteria for Drum Selection (Ref: CCP-PO-003, Table 5.2-10)

Shipping Category	Maximum Decay Heat per TRUPACT-II/HalfPACT (watts)	Test Temperature
All shipping categories in Waste Type IV (55-Gal Drum)	7/7	135 ^{o}F
All shipping categories in Waste Type IV for other container types	7/3.5	148 ^{o}F

Table 4-2. Drum Equilibration Time Requirements

Activity	Required Drum Equilibration Time	Basis	Reference
After HSG Sampling, prior to GGT if the drum lid is removed and for rigid-liner repack drums	14 days	Restoration of H_2 in headspace volume	CALC-000-T-000242, Determine Equilibration Time Required Between Headspace Gas Sampling and Gas Generation Testing; M. Rivera ltr MAR-003-04, Drum Age Requirement for Rigid-Liner Repack Drums
After drum is packaged, prior to GGT	38 days	Equilibrium hydrogen diffusion rate from drum vent	J. Schierloh, LATA, Feb 25, 2000; "Determination of GGT Equilibration and Sampling Durations for Newly Generated Waste Drums"

4.4 Drum Isolation and Sampling

4.4.1 The CCP procedure that addresses the heated methods is CCP-TP-083, *CCP Heated Gas Test Canister Operations*. MGSS is the primary sampling method used in GGT sampling.

[A] MGSS Sampling Method

[A.1] The MGSS (See Figure 1-1) consists of a gas chromatograph (GC) mounted on a portable cart, with an integral sampling manifold that is capable of being purged with a vacuum pump to <10 Torr. The GC uses an approximately 2 meter, 1/8" diameter MS-5A packed column, a thermal conductivity detector, and vendor software to integrate and quantify peaks. The MGSS sampling process is summarized as follows: The Operator/TS performs a calibration verification. If the prerequisites are satisfactory, the MGSS may be used to sample GGTCs. GGTC sampling by the MGSS consists of attaching the sample hose, evacuating the hose and manifold, and then purging a volume of the unknown gas into the manifold. After a complete purge, the gas is then injected into the GC and a trace is generated and analyzed. The GC vendor software determines the ppm concentration of the hydrogen in the unknown. The data is exported to a Software Quality Assurance (SQA)-controlled application that is used to calculate the hydrogen generation rate. The hydrogen/methane gas generation rate is determined by using the ratio of Hydrogen/Methane (H_2/CH_4) as determined by HSG Analysis or by using the ratios in Table 4-3, Methane Determination. The total gas generation rate is determined by using the initial and final sampling pressure.

Table 4-3. Methane Determination

Waste Type	Measurable H_2 and CH_4 Values in HSG	No Measurable H_2 and/or CH_4 Values in HSG	Reference
IV	Actual Ratio	Ratio of 0.1	*

* "Estimation of Methane/Hydrogen Ratios in Waste Type IV Transuranic Waste Containers." Shaw Environmental and Infrastructure, Inc. 02/11/03.

[B] Heated Drum Isolation and Sampling

[B.1] The waste drum to be tested is loaded into a GGTC in accordance with CCP-TP-083. A Leak Test of the GGTC is performed upon loading the drum into GGTC and prior to starting the heating of the GGTC. The drum is heated gradually to the test temperature, 135 °F or 148 °F, as specified in Table 4-1. To ensure that the waste and the gases within the test canister are thoroughly heated and the system has reached equilibrium or steady state condition, a minimum of 120 hours (after isolation) should elapse before the initial sample is taken. Sampling prior to reaching this steady state condition could result in a false failure. The final sample is drawn at ≥ 240 hours after drum isolation, to determine the gas generation characteristics of the waste drum inside. Final sampling can be performed after a minimum of 48 hours from initial sampling..

[C] Drum Void Volume Determination

[C.1] One of the following methods will be used to measure/estimate the void volume of the drum:

(a) Estimation based on visual examination (VE) during packaging.

(b) Estimation based on the drum fill percentage as determined by real-time radiography (RTR).

[C.2] The method of estimation (step 4.4.1[C.1](b) above) has been shown to result in a conservative estimate of the gas volume as stated in M. Rivera ltr MAR-001-03 to E. D'Amico, "New Approach for Estimating Drum Void Volumes in Type IV Waste", April 9, 2003.

5.0 QUALITY ASSURANCE OBJECTIVES (QAOs)

5.1 Precision and Accuracy

The QAO for precision of the measured or calculated H_2/CH_4 and total gas generation rates shall be less than or equal to a relative percent difference of 25 percent. The QAO for accuracy of the measured or calculated H_2/CH_4 and total gas generation rates shall be between 70 to 130 percent recovery (%R). In the case where a gas generation rate is not measured directly but calculated from knowledge of other measured or estimated parameters, the requirements of precision and accuracy listed above shall be met as demonstrated through an error propagation analysis. The Precision and Accuracy of the hydrogen generation rate and total gas generation rate calculations are derived from error propagation analysis.

CCP uses the error propagation analysis for Hydrogen Generation Rate Testing which is documented in Internal memo, M. Rivera to E. D'Amico, "Bounding Propagated Error Analysis for the CCP GGTP", February 15, 2006.

CCP uses the PRQL of 6.90E-9 moles/second for the H_2/CH_4 generation rate. This PRQL is less than the lowest allowable generation rate of 3.03E-8 moles/second of Waste Type IV (55-gallon drum) waste expected to be shipped from Idaho National Laboratory (INL). CCP uses the PRQL for Total Gas Generation Rate of 6.36E-7 moles/second which is less than the rate allowed by DOE, CH-TRAMPAC, Table 5.2-11 for 55-gallon drums.

5.2 Representativeness

In order to ensure representativeness of gas samples, Leak Tests or system monitoring shall be performed on the test and gas-sampling systems in accordance with site-specific requirements that have been approved by Carlsbad Field Office (CBFO).

CCP will perform a Leak Test of the GGTC upon loading the drum into GGTC and prior to starting the heating of the GGTC and a Vacuum Leak Check will be performed on the sampling manifold prior to each sampling batch to verify integrity of the sampling line connection.

5.3 Completeness

All waste containers in which the flammable VOC concentration cannot be shown through AK or PK to be less than or equal to 500 ppm by volume shall have a valid gas sample collected and analyzed to establish the flammable VOC concentration.

CCP will sample and analyze all waste containers in which the flammable VOC concentration cannot be shown through AK or PK to be less than or equal to 500 ppm to establish the flammable VOC concentration.

Containers that undergo gas generation testing shall have valid parameter measurements to establish the hydrogen and methane gas generation rates in the container. All containers where compliance with the total gas generation limits is not shown by conservative theoretical analysis in accordance with the CH-TRAMPAC shall have valid parameter values to establish the total gas generation rate.

CCP will test containers to establish the hydrogen/methane and total gas generation rates.

5.4 Comparability

Comparability of data shall be ensured through the use of standardized, approved testing, sampling, and analytical techniques. Consistent use and application of uniform procedures, calibration of analysis instruments against nationally acceptable (traceable to National Institute of Science and Technology [NIST]) or manufacturer-certified standards, and use of instruments that are of the required precision and accuracy should ensure data measurements on different waste containers are comparable.

CCP ensures the data is comparable by use of standardized procedures which will require the use of calibrated instrumentation (traceable to NIST standards or manufacturer-certified standards) with the required precision and accuracy to ensure data measurements on different waste containers are comparable.

5.5 QC Requirements for Program Sampling and Analysis

To ensure that data of known and documented quality are produced from the program gas sampling and analysis procedures, laboratory personnel collecting gas samples from containers shall comply with site specific QC requirements for additional samples within a sampling batch. A batch is defined by the number of GGTC which began the isolation/heating cycle at the same time.

The following table establishes the QC programmatic requirements, so that known and documented quality are produced.

QC Sample	Minimum Frequency	Acceptance Criteria
Calibration Verification Accuracy	One per Sampling Batch	%R 70-130%

5.6 Equipment Testing, Inspection, and Maintenance Requirements

CCP procedures define the use, testing, inspection, handling, storage, maintenance, and calibration of measuring and test equipment (M&TE).

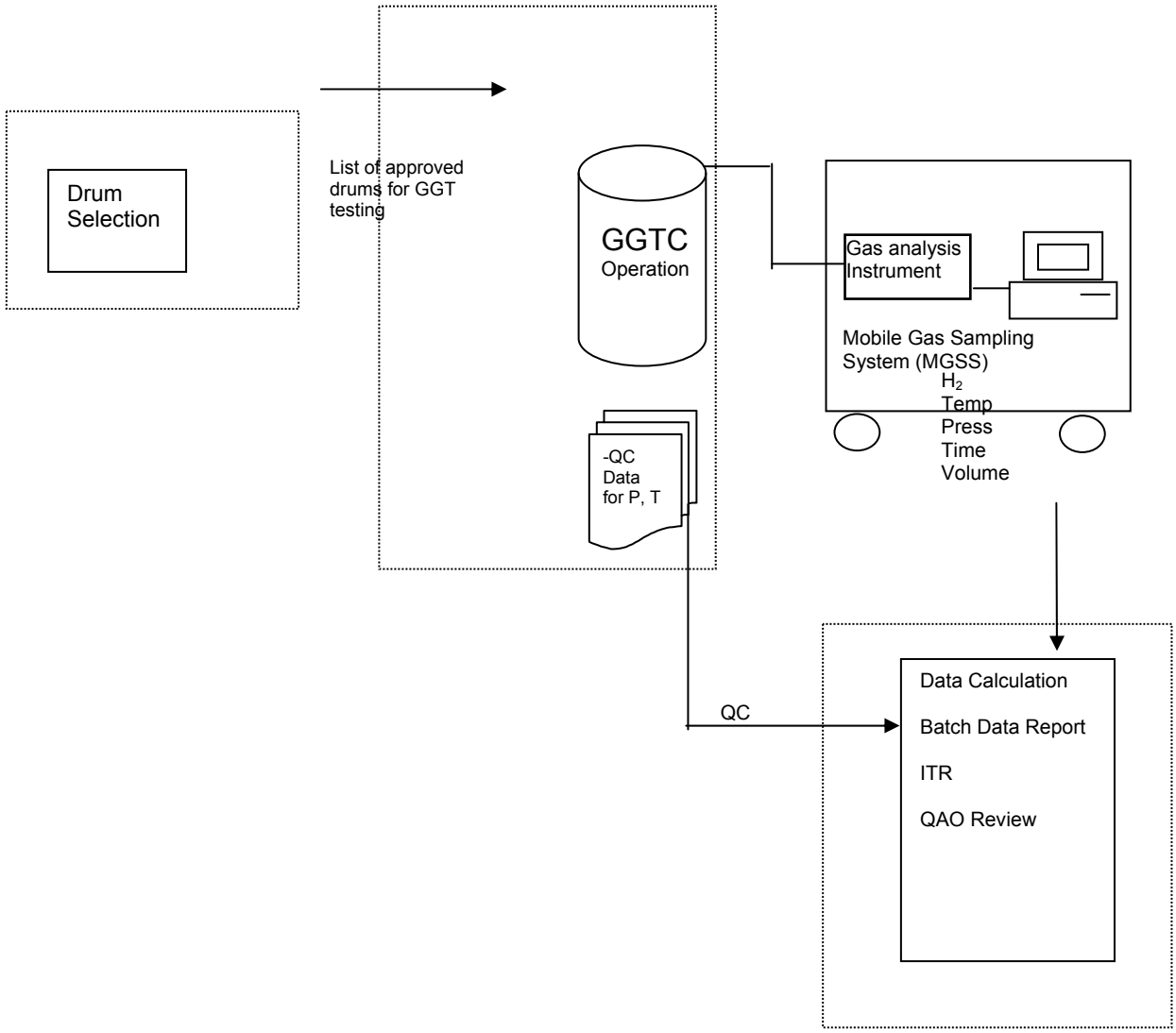
6.0 DATA MANAGEMENT, DATA REDUCTION, VALIDATION AND REPORTING

6.1 Data Management

6.1.1 Data Management for GGT is conducted according to Figure 6-1, Data Management in the GGT; MGSS Method.

6.1.2 The drum selection and preparation for GGT is done in accordance with CCP-TP-083. The procedure details the steps of pre-test, test, and post test to ensure data quality. The procedure gives instruction for apparatus bolt torquing and leak testing, container equilibrium times, measurement of temperature and pressure, void volume determination, scheduling of gas samples, and personnel responsible for performing the data validation. Since sampling is performed directly from the GGTC, there is no provision for chain-of-custody.

Figure 6-1. Data Management in the GGT



6.2 Data Reduction

6.2.1 The following information is required as input to the GGT calculation software:

[A] Provided by Operator/TS (additional samples may be taken):

- Hydrogen concentration in ppm, Initial and Final Sample and any additional samples
- Date and Time of Initial and Final Sample and any additional samples
- Temperature and Pressure of GGTC at the time of Initial and Final Sample and any additional samples
- Pressure of the Drum Sample(s)
- Isolation Date/Time
- Unique BDR number
- Drum Closure date
- R_{eff}
- Drum void volume
- Methane/Hydrogen ratio

6.2.2 The Operator/TS, after completing a set of GGT final samples, reviews the data appendices from the GGTC test run to identify any invalid test runs. If the appendices indicate that any of the drums in the testing batch failed to meet the test criteria (Peak/Valley temperature limits), the drum is deleted from the batch and a Nonconformance Report (NCR) generated in accordance with CCP-QP-005.

6.2.3 The GGTP Data Calculation Workbook generates the hydrogen gas generation rate according to the following equation:

$$CG = \frac{X_{Outer} \times (n_i + n_o)^2}{\left[\{t \times (n_i + n_0)\} + \left\{ R_{eff} \times n_i^2 \times \left(1 - e^{\frac{-[n_i + n_o]}{R_{eff} \times n_i \times n_o} \times t} \right) \right\} + \left\{ R_{eff} \times n_i \times (n_i + n_o) \times \left(e^{\frac{-[t_s \times n_o + t \times (n_i + n_o)]}{R_{eff} \times n_i \times n_o}} - e^{\frac{-t_s}{R_{eff} \times n_i}} \right) \right\} \right]}$$

Where:

CG = hydrogen gas generation rate associated with the waste within the drum

X_{outer} = increase of hydrogen in the void volume of the test canister (mole fraction of hydrogen)

n_i = moles of gas within the void volume of the drum

n_0 = moles of gas within the canister, outside of the drum

R_{eff} = effective resistance to hydrogen permeation through various layers of confinement

t = sampling period (period between initial and final sampling)

t_s = drum age (lapsed time between original packaging and the gas generation testing)

6.2.4 The Operator/TS assigns a unique BDR identification number in the format SSYYGGNXXX where SS is the site designation, YY are the last two digits of the year, GG is place holder, N is the instrument number, and xxx is a sequential number starting with 001 each year, assembles, and paginates the GGTP BDR in accordance with CCP-TP-083.

6.2.5 The results are submitted to an ITR for independent technical review and signature approval, and then to the QAO for validation and signature approval. The QAO reviews the BDR and forwards to Records in accordance with CCP-QP-008.

[A] Individual Drum Reports — The CCP CH-TRAMPAC defines the information and data that must be included in a BDR. The result of the calculation for each drum is presented on an individual form, called a Gas Generation Testing "Drum Data Sheet".

The Drum Data Sheet provides the following:

- Drum Number
- Hydrogen Gas Generation Rate
- Hydrogen/Methane Gas Generation Rate
- Total Gas Generation Rate (if required)
- Sampling Batch Number

[B] BDRs — The data calculation software provides a complete printout of the supporting information required to validate the BDR. The calculation spreadsheet printout includes:

- Cover Sheet/Table of Contents
- Continuing Calibration Verification (CCV) Report
- Drum Data Sheet for each drum
- QC data
- Independent Review Checklist
- QAO Review Checklist
- GC Chromatogram(s)
- Drum Information sheet
- GGTC checklist
- NCRs if applicable

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6.3 Data Review and Validation

6.3.1 Data review, validation, and verification at the data generation level requires review from an ITR and signature release from the QAO. These reviews are documented using checklists signed by the reviewer. The reviewed data are assembled into a BDR containing data reduced for reporting, and then paginated.

[A] Independent Technical Review (ITR)

[A.1] The Review Checklist will ensure that the analyst has collected characterization data and documented it according to program requirements. This review will ensure that:

- Data generation and reduction were conducted in a technically correct manner in accordance with the method used
- Data were reported in the proper units, and to the correct number of significant figures
- Calculations were performed by a valid calculation program
- Data were reviewed for transcription errors
- QA documentation is complete

[A.2] The ITR performs a technical review of the BDR in accordance with CCP-TP-083. The ITR then forwards the BDR to the QAO for validation.

[B] QAO Signature Release

[B.1] Ensure the BDR is complete and the QAOs have been met.

[B.2] After QAO signature release of checklist, the QAO forwards the BDR to the Facility Records Custodian, in accordance with CCP-QP-008.

6.4 Nonconformances and Disposition of Failed Drums

6.4.1 Activities affecting GGT process-specific parameters require that NCRs be generated in accordance with CCP-QP-005.

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7.0 RECORDS

7.1 There are no records generated by this document.

8.0 REFERENCES

8.1 References

8.1.1 *CH-TRU Payload Appendices*

8.1.2 U. S. Department of Energy, *Contact-Handled Transuranic Waste Authorized Methods for Payload Control* (CH-TRAMPAC)., Carlsbad Field Office, Carlsbad, NM

8.1.3 CCP-PO-002, *CCP Transuranic Waste Certification Plan*

8.1.4 CCP-PO-003, *CCP Transuranic Authorized Methods for Payload Control (CCP CH-TRAMPAC)*

8.1.5 CCP-QP-002, *CCP Training and Qualification Plan*

8.1.6 CCP-QP-005, *CCP TRU Nonconforming Item Reporting and Control*

8.1.7 CCP-QP-008, *CCP Records Management*

8.1.8 CCP-QP-010, *CCP Document Preparation, Approval and Control*

8.1.9 CCP-QP-015, *CCP Procurement*

8.1.10 CCP-QP-022, *CCP Software Quality Assurance Plan*

8.1.11 CCP-TP-083, *CCP Heated Gas Test Canister Operations*

8.1.12 CCP-TP-138, *CCP Execution of Long-Term Objective for the Unified Flammable Gas Test Procedure*

8.1.13 DOE/WIPP-01-3187, *Quality Assurance Program Plan for TRUPACT-II Gas Generation Test Program*

8.1.14 *TRUPACT-II Safety Analysis Report* (SAR)

8.1.15 M. Rivera internal memo February 15, 2006, to E. D'Amico, "Bounding Propagated Error Analysis for the CCP GGTP"

8.1.16 "Estimation of Methane/Hydrogen Ratios in Waste Type IV Transuranic Waste Containers," Shaw Environmental & Infrastructure, Inc., February 11, 2003

8.1.17 M. Rivera ltr MAR-001-03 to E. D'Amico, "New Approach for Estimating Drum Void Volumes in Type IV Waste", April 9, 2003

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8.1.18 M. Rivera ltr MAR-002-04 to Eric D'Amico, TRU Special Projects, TRU Orphans, "New Negative Total Gas Generation Rate Threshold for GGTP", January 29, 2004

8.1.19 M. Rivera ltr MAR-003-04, to Eric D'Amico, TRU Special Projects, TRU Orphans, "Drum Age Requirement for Rigid-Liner Repack Drums", February 10, 2004

8.1.20 *Unified Flammable Gas Test Procedure* (UFGTP)

8.1.21 J. Schierloh, LATA, Feb 25, 2000; "Determination of GGT Equilibration and Sampling Durations for Newly Generated Waste Drums"