Environmental Technology Verification Coatings and Coating Equipment Program (ETV CCEP)

Laser Touch™ Beta Model – Testing and Quality Assurance Project Plan (TQAPP)

Revision No. 0

September 16, 1999

Contract No. DAAE30-98-C-1050
Task No. 208
SOW Task No. 3

Prepared by
National Defense Center for Environmental Excellence (NDCEE)

Operated by Concurrent Technologies Corporation

Environmental Technology Verification Coatings and Coating Equipment Program (ETV CCEP)

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Submitted by

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SI to English Conversions

SI Unit	English Unit	Multiply SI by factor to obtain English
°C	°F	3.380 E + 01
L	gal. (U.S.)	2.642 E - 01
m	ft	3.281 E + 00
kg	lbm	2.205 E + 00
kPa	psi	1.4504 E - 01
cm	in.	3.937 E - 01
mm	mil (1 mil = 1/1000th in.)	3.937 E + 02
m/s	ft/min	1.969 E + 02
kg/L	lbm/gal. (U.S.)	8.345 E + 00

List of Abbreviations and Acronyms

AOAC	Association of Official Analytical Chemists
ASTM	American Society for Testing and Materials
CCEP	Coatings and Coating Equipment Program
CTC	Concurrent Technologies Corporation
DFT	dry film thickness
EMS	Environmental Management System
EPA	Environmental Protection Agency
ETV	Environmental Technology Verification
HAP	hazardous air pollutant
HVLP	high-volume, low-pressure
IWRC	Iowa Waste Reduction Center
NDCEE	National Defense Center for Environmental Excellence
NIST	National Institute for Standards and Technology
PAC^{2}E	Painting and Coating Compliance Enhancement
QA/QC	quality assurance/quality control
QMP	Quality Management Plan
TE	transfer efficiency
TQAPP	Testing and Quality Assurance Project Plan
VOC	volatile organic compound
WBS	work breakdown structure

1.0 INTRODUCTION

1.1 Purpose of the Laser Touch™ Beta Model - TQAPP

The primary purpose of this document is to establish the Testing and Quality Assurance Project Plan (TQAPP) for the Laser Touch™ Beta Model targeting device. The document contains formatting and guidelines recommended by the Environmental Technology Verification Coatings and Coating Equipment Program (ETV CCEP).

ETV CCEP project level TQAPPs establish the specific data quality requirements for all technical parties involved in each project. This ETV CCEP TQAPP establishes specific data quality requirements for all technical parties involved in the verification of the Laser Touch™ Beta Model. This TQAPP follows the format described below to facilitate independent reviews of the project plan and test results, and to provide a standard platform of understanding for stakeholders and participants.

1.2 Quality Assurance Category for the ETV CCEP

Projects conducted under the auspices of the ETV CCEP meet or exceed the requirements of the American National Standards Institute/American Society for Quality Control, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, ANSI/ASQC E-4 (1994) standard. All ETV CCEP TQAPPs are adapted from this standard and the ETV Program Quality Management Plan (QMP). The TQAPPs will contain sufficient detail to ensure that measurements are appropriate for achieving project objectives, that data quality is known, and that the data are legally defensible and reproducible.

1.3 Logic and Organization of the Laser Touch™ Beta Model TQAPP

This TQAPP follows the sections outlined in the ANSI/ASQC E-4 standard. As such, this TQAPP identifies processes to be used, test and quality objectives, measurements to be made, data quality requirements and indicators, and procedures for the recording, reviewing and reporting of data.

The major technical sections discussed in this TQAPP are as follows:

- Project Description
- Project Organization and Responsibilities
- Quality Assurance (QA) Objectives
- Site Selection and Sampling Procedures
- Analytical Procedures and Calibration
- Data Reduction, Validation and Reporting
- Internal Quality Control Checks
- Performance and System Audits
- Calculation of Data Quality Indicators
- Corrective Action
- Quality Control Reports to Management
- References
- Appendices
-

1.4 Formatting

In addition to the technical content, this TQAPP also contains standard formatting elements required by the ANSI/ASQC E-4 standard and Concurrent Technologies Corporation (*CTC*) deliverables. Standard format elements include, at a minimum, the following:

- TQAPP Approval Form
- Title Page
- Distribution List
- Table of Contents (with an explanation of any deviations from Category II required elements)
- Document Control Identification (in the plan header)

Section No.	________
Revision No.	________
Date:	________
Page:	__ of __

1.5 Approval Form

Key ETV CCEP personnel indicate their agreement and common understanding of the project objectives and requirements by signing the TQAPP Approval Form for the verification testing of the Laser Touch™ Beta Model. Acknowledgment by each key person indicates commitment toward implementation of the plan.

2.0 PROJECT DESCRIPTION

2.1 General Overview

The overall objective of the ETV CCEP is to verify performance and pollution prevention characteristics of coating technologies and make the results of the testing available to prospective coating technology users. The objective of this particular TQAPP is to establish the performance of the Laser Touch™ Beta Model targeting device. The Laser Touch™ Beta Model was designed by the Iowa Waste Reduction Center (IWRC), and is owned by Laser Touch and Technologies, LLC. The Laser Touch™ Beta Model is used as a pollution prevention tool that enhances the efficiency of manual spray painting applications. The Laser Touch™ Beta Model may contribute to reduced air emissions through improved transfer efficiency (TE) and increased productivity and less rework through improved finish quality. This innovative technology emits two laser beams that overlap at a preset distance from the spray gun, which help the painter judge and maintain the proper spray distance. The laser beams also help with targeting, which can greatly improve the 50% overlap painting technique, thereby increasing consistency in the coating's film thickness.

This test examines the Laser Touch™ Beta Model's effectiveness at improving a painter's TE. The data from this verification test will be compiled and a Verification Report will be developed. In addition, a Verification Statement will be developed from the data contained in the Verification Report. Laser Touch and Technologies, LLC may use the Verification Statement as a marketing tool for the Laser Touch™ Beta Model targeting device.

TE will be the primary criteria for verifying the performance of the targeting device in terms of pollution prevention. As TE increases, less coating material is needed, reducing solvent emissions and the amount of paint solids that are released into the environment. Therefore, equipment that assists in achieving a higher TE is able to provide a means of pollution prevention to the end-users.

The testing of the Laser Touch™ Beta Model will be conducted at the Painting and Coating Compliance Enhancement (PAC^{2}E) facility operated by IWRC in Cedar Falls, Iowa. A drawing of the PAC^{2}E facility is shown in Appendix A (Test Location).

2.1.1 Demonstration Factory Testing Site

The IWRC has been funded by the EPA, under a non-ETV project, to establish a research and training center for painting and coating applications. One aspect of the PAC^{2}E Program is to demonstrate techniques and tools based on new technologies that are capable of improving the painter's application methods in small manufacturing sectors. The PAC^2E facility began conducting research and training in March 1999. The IWRC will perform the verification test activities at this facility under the ETV CCEP's direction. The PAC^2E facility is equipped with liquid and powder coating spray booths, an infrared cure oven and associated equipment. Several additional pieces of equipment are scheduled to be installed before the verification test begins. Table 1 lists the various testing devices and equipment contained in the PAC^2E facility.

This test will be done under the authority and supervision of the ETV CCEP, and always in compliance with this TQAPP. This includes all quality assurance, quality control, and laboratory analysis. A layout of the PAC^2E facility is shown in Appendix A.

2.1.2 Laboratory Facilities

Laboratory facilities available at IWRC are described in Table 1.

Table 1: Testing and Laboratory Equipment

Equipment	Manufacturer	Model	Observations
Manual Spray Gun	Accuspray, Inc	HVLP Series 19	0.9 mm fluid nozzle / #7 Air Cap
Spray Booth	Binks Sames Corp.	PRF 17.5-10-T-LH	Cross-draft Air Flow.
Air Compressor	Quincy	QTH-15-120	950 RPM
Air Dryer	Airtek	TD50	Capacity 50 SCFM (1.4 m^3/min)
Curing Oven	PED Tech., Inc	Three Zone -Contraflow	Infra-red (Reverse Convection)
Conveyor System	Rapid Industries, Inc	Rapid Flex X–348	Enclosed Track, Universal Link Chain.
Mixing Room	Saima, Inc	AccuMix MR1012	10" x 12" x 120"
Electronic Balance	Ohaus	Explorer EO2130	210 grams
Electronic Balance	Ohaus	Explorer EOL210	Top Loader- 22,000 grams
Electronic Balance	Ohaus	Explorer EOL210	Bottom Loader- 22,000 grams
Laser Touch™	IWRC	Beta Model	Attaches to the Spray Gun
Desiccator	Boekel Scientific	D 1380	Cabinet
Digital Timer	Control Company	Traceable® 14-648-1	Accuracy 0.01%
Coating Thickness Gage	Gardner Company Inc	DF-6001nf	Non-Ferrous
Multimeter	Fluke	True RMS 87 III	Display Digital Read-out
Infrared Thermometer	Fluke	80T-IR	Measure Parts Temperature ± 0.1 °C
Engraver	Dremel	290	For Parts Identification
Viscosity Cup	Gardner Company Inc	Standard Ford Cup	#4
Disposable Dishes	Midland Scientific	D1600-3	Aluminum (I.D. 70 mm)
Syringes	Norm-Ject	D-78532	Wt. % Solids Analyses

2.1.3 Statement of Project Objectives

The ETV CCEP promotes the use of more environmentally friendly technologies in products finishing, thereby reducing emissions. The objective of this TQAPP is to verify the increase in the TE and finish quality of manual spray applications through the addition of the Laser Touch™ Beta Model targeting device. Where possible, analysis methods used for these tests will follow those developed by the American Society for Testing and Materials (ASTM).

TE is related to pollution prevention in the paints and coatings industry. TE is defined as the ratio of the quantity of coating solids reaching the part being covered, divided by the quantity of coating solids being applied (Office of Pollution Prevention, 1994). In other words, TE measures the proportion of the amount of paint actually applied to the part divided by the amount of paint sprayed. This fraction is expressed in percent and can be calculated using the volume, or the mass, of solids, as shown in the following formula:

$$\text{Transfer Efficiency} = \frac{\text{Volume (or Mass) of Solids Deposited}}{\text{Volume (or Mass) of Solids Sprayed}} \times 100\%$$

According to the EPA Manual of Pollution Prevention in the Paints and Coatings Industry (1996), the maximization of the TE ratio is the most predominant approach to minimize pollution in the paints and coatings activities. Small improvements in TE can result in a significant reduction of volatile organic compounds (VOC) emissions. Conversely, overspray results in wasted material and represents inefficiency in the coatings system. It contributes to air and water pollution, increases solid hazardous waste, and solid non-hazardous waste.

From information gained during the testing of the Laser Touch™ Beta Model, the end-users may better determine if the Laser Touch™ Beta Model would provide them with a pollution prevention benefit while meeting the finish quality requirements of their application. The end-users make an informed decision based on the best available data. This project intends to supply the end-users with the unbiased technical data to assist them in that decision making process.

The quantitative pollution prevention benefit in terms of improved TE depends on any of the innumerable factors that are unique to each coating production line. The task of verifying every possible combination of these factors is impractical, but a test plan designed from a selection of these factors will provide data that is representative of the exact conditions tested. To qualify the existence of an environmental benefit, this project will establish a baseline consisting of a painter's abilities without the Laser Touch™ Beta Model, which will also serve as the painter's finish quality reference. The verification test with the Laser Touch™ Beta Model will show whether the painter's application technique improves, along with the associated TE and finish quality.

2.2 Technical/Experimental Approach and Guidelines

The following tasks are proposed in pursuit of this project (see estimated schedule in Section 2.3, Table 6):

- Approval of TQAPP by *CTC*, EPA and IWRC
- Conduct verification test of the Laser Touch™ Beta Model targeting device
- Prepare and provide draft Verification Report to EPA
- Prepare and provide final Verification Report to EPA
- Prepare Verification Statement for approval and distribution

Table 2 describes the general guidelines and procedures that will be applied to this TQAPP.

Table 2: Overall Guidelines and Procedures Applied to this TQAPP

• A detailed description of each part of the test will be given.
• Critical and non-critical factors will be listed. Non-critical factors will be held constant throughout the testing. Critical factors will be listed as control (process) factors or response factors (see Section 2.2.10)
• The TQAPP will identify the testing site or sites.
• The testing will be under the control and close supervision of ETV CCEP representatives to ensure the integrity of the third party testing.
• The QA portions of the Laser Touch ™ Beta Model TQAPP will be strictly adhered to.
• A statistically significant number of samples will be analyzed for each critical response factor (see Table 5). Variances (or standard deviations) of each critical response factor will be reported for all results.

2.2.1 Test Approach

The following approach will be used for this TQAPP:

- Standard test parts will be obtained which will enable thorough evaluation of each painter's performance,
- The standard coating will be chosen and provided for the verification test by the IWRC,
- Laser Touch and Technologies, LLC will supply the Laser Touch™ Beta Model to be verified,
- IWRC will supply the facilities necessary to complete the verification test,
- Painters will be invited to the IWRC PAC^{2}E facility to carry out the test,
- Painters will be allowed practice time with spray equipment and coating to become familiar with the spray equipment and the coating's performance,
- Each painter will spray the selected parts without using the Laser Touch™ Beta Model as the first run,
- The painters will be instructed on the use of the Laser Touch™ Beta Model targeting device and given time to practice using the device,
- Each painter will spray the same types of parts using the Laser Touch™ Beta Model as the second run,
- Data such as part weight (before and after paint application), quantity of sprayed paint, quantity of supplied paint, and mil thickness of paint will be collected, following the ASTM 5286 standard,
- A statistically valid test program that efficiently accomplishes the required objectives will be utilized.

2.2.2 Standard Test Parts

The standard test parts to be used for this verification test are shown in Appendix B (Standard Test Parts). The parts are flat aluminum. The chemical and mechanical properties of the aluminum panels have been tested according to ASTM Methods E 1251 and B 557. Results of these tests are listed in Appendix B. The test parts are 121.9 cm (48 in.) long, 101.6 cm (40 in.) wide and 1.5 to 1.7 mm (0.060 to 0.066 in.) thick. One type of part is completely solid, which is called the 'Full' part. The second type of part consists of an outside frame with a horizontal and a vertical member centered in their respective planes, which is called the 'Window' part. The parts received pretreatment at an outside source (see Appendix I). All test parts have two 1.3-cm (1/2-in.) holes punched in opposite corners to suspend the parts from the hooks on the conveyor line. The conveyor advances until a part is centered in the paint booth, and then stops while the painter applies the coating. Appendix C (Apparatus Set-up) shows the position of the part in the paint booth.

The standard test parts are suspended from the conveyor by two hooks. The parts are spaced 6 ft. on center between parts on the overhead conveyor line. There are two runs for each painter; one run performed without the targeting device (Run 1), and one run using the Laser Touch™ Beta Model (Run 2). Each run consists of seven parts from each of the two types. Therefore, a total of 14 parts are coated per run and each painter coats a total of 28 parts.

Each part is assigned a number and letter designation for identification, which will be located on the upper right hand corner of the side that will not be coated. This will allow the number to be viewed while the part is on the overhead conveyor. The part identification scheme should match the following template: XXxXNN

Where:
N = Number
X = Letter
Example = FAaN01

First Letter: The type of Part. Two types are used, a Full part (F) and a Window-design part (W). Even though the parts can easily be identified by sight, the part ID should include this information so that it is available for data analysis.

Second and third Letter: Part Group. Each painter should paint groups of parts with identical second and third letters. This allows each painter's average transfer efficiency to be evaluated, so that procedural errors involving a certain painter or group of painters can be identified. The letter format is (Aa, Ab, Ac.....Zz)

Fourth letter: This letter will designate if the part should be sprayed with, or without, the Laser Touch™ device. This letter will be either Y for Yes, the Laser Touch™ unit was used, or N for No, the Laser Touch™ Beta Model unit was not used. [Note: The parts used for Run 1 are to be sprayed without the use of the Laser Touch™ Beta Model targeting device. Painters will be provided with practice parts to become accustomed to the spray gun and the coating before testing begins.]

ID Number: The ID number will identify the individual parts within a group. Initially, only seven parts of each type will be used each run, but two digits are available for additional parts if desired.

After the parts have been cleaned, they will only be handled with latex gloves to prevent skin oils from being deposited on the surface. Oils on the surface can cause spotting or fish eyes, reducing the quality of the final finish. After the test coating is applied, the standard test parts will be analyzed for dry film thickness (DFT), gloss, visual appearance, and TE.

2.2.3 Coating Specification

IWRC has chosen the Sherwin-Williams Polane HS Plus white single-stage polyurethane enamel as the standard test coating. IWRC will supply the standard test coating to be used for the verification test of the Laser Touch™ Beta Model targeting device. The test coating will be prepared following the coating manufacturer recommendations (see Appendix D, Coating Product Data Sheets). The test coating was chosen because it is a coating employed by the metal finishing industry.

The IWRC obtained 15 gallons of the test coating to complete the verification test. The exact coating preparation procedures will be recorded. For comparison, the test coating will be prepared the same throughout the verification test. A pressure-feed cup will be mounted directly onto the spray gun. The pressure cup has a volume of 1.0 L. IWRC personnel will prepare two batches of paint for each run. The first batch will be used for the practice session and to coat the first type of test parts. The second batch will be used to coat the second type of test parts. Coating samples will be taken just prior to coating the test parts to measure the coating temperature, viscosity, percent solids, density and VOC content. The coating measurements will be recorded on the paint batch worksheet. Each batch will be mixed using 3 parts of the white base material (Sherwin-Williams Polane HS Plus), 1 part of catalyst (Sherwin-Williams Catalyst V66V55), and 0.48 parts of the reducer (Sherwin-Williams MAK R6K30).

The coating will be stored in a closed container until it is transferred to the pressure cup attached to the gun. The painters will apply the coating to a DFT between 0.8 and 1.5 mils, in 1 coat.

Curing of the test parts will be completed as a two step process. Within one hour after the coating is applied, each test part will be force-dried at 82°C (180°F) for seventeen minutes. After all test parts from Run 2 complete the first curing step, all test parts will be force-dried at 82°C (180°F) for an additional 77 minutes. The same gun, coating, and certain operating parameters will be used for each painter involved in the verification test. The application pattern, coating application speed, atomizing air pressure, and fan pattern may vary from painter to painter, but will remain relatively constant during each painter's portion of the test.

2.2.4 Standard Apparatus

This verification test is designed to simulate an actual production line finishing environment at a typical small business. The standard test parts will be transported to the spray booth by an overhead conveyor. A pressure cup will be connected directly to the spray gun. The parts will be manually sprayed by the painters in approximately the same location in the spray booth. A pedestal is located at the center of the spray booth, which will minimize the movement of the parts as they are being coated. The Accuspray Model 19 high-volume, low-pressure (HVLP) spray gun will be used throughout this test as the application equipment. The spray gun will use a 0.9 mm (0.036 in.) fluid tip, a 0.9 mm (0.036 in.) fluid needle and a #7 air cap. The spray gun will be preset at a dynamic output air pressure of 10 psig with the fan pattern control knob opened two turns, and the fluid control valve opened three turns. The painter will be allowed to adjust the fluid flow, air pressure, and fan pattern so that they may each apply the best possible coating finish. The product data sheet for the Accuspray Model 19 HVLP spray gun is attached as Appendix E. Each painter will also choose the best gun-to-target distance that meets his/her coating application method.

After each part is coated, the conveyor will move the part into the cure oven. The cure oven will be set up throughout the verification test to specific temperature and cure cycles. The conveyor will move parts into the cure oven, pause for a preset time limit, and then move the parts out of the cure oven. After the standard test parts have been cured, the parts will be removed from the conveyor.

The booth air velocity will be checked prior to the start of each run. If the air booth velocity is measured below 0.5 m/s, the booth make-up air vents will be adjusted to increase the air velocity. If the make-up air adjustments cannot increase the booth air velocity beyond 0.5 m/s, the booth filters shall be changed before testing may continue.

Run 2 will be nearly identical to Run 1, except that the painter will use the Laser Touch™ Beta Model targeting device mounted on the spray gun.

2.2.5 Process Standards

Two types of standard test parts are used in the verification test. The two types of standard test parts have different surface areas (see Appendix A). A standard coating will be used throughout the verification test. The TE analysis will follow Procedure A of ASTM D 5286. The environmental (ambient) conditions of the PAC^{2}E facility, both inside the booth near the spray zone and the flash-off zone after the cure will be monitored. The cure time and temperature will be identical for all runs. The Laser Touch™ Beta Model operating distance will be held constant during Run 2 for each painter; whereas, the operating distance may have a higher degree of variability during Run 1. The pretreatment method will be applied identically for all standard test parts. Operating parameters will be held relatively constant throughout the verification test.

The painters will adjust the spray gun settings prior to Run 1 to meet their application technique. Once the paint gun is set up for a particular painter, all of the settings will be recorded on the Paint Gun Setup Data Sheet and no further adjustments will be allowed. An example of the Paint Gun Setup Data Sheet is found in Appendix F (Data Collection Sheets).

The painters will each be allowed to practice painting with the spray gun on practice parts before both runs. Each painter will be allowed up to 30 minutes to become comfortable with the spray gun setup and to become comfortable with the way the coating is applied. During the first practice session, IWRC will check the wet film thickness of the practice parts to determine whether the painter is applying the appropriate amount of coating to meet the target DFT range. Once it is determined that the wet film thickness is between 2.0 mils and 3.0 mils, IWRC will inform the painters that they must try to maintain that film build by the visual appearance of the applied coating. The painter must try to maintain the same film build throughout both test runs.

Prior to Run 2, the painters will be trained to use the Laser Touch™ Beta Model targeting device. Details on the contents of the Laser Touch™ Beta Model training session are located in Appendix G (Laser Touch™ Classroom Content). The painters will then be allowed to practice using the Laser Touch™ Beta Model for up to 30 minutes on practice parts to prior to Run 2.

Standard test parts will be used for the verification test. The preparation of the test coating will be the same for all runs. The cure time and temperature for the test coating is listed in Table 4. The factory (ambient) conditions will be checked once during each run both inside the spray booth near the rack of parts and outside the spray booth in the flash-off area. The pretreatment will be the same for all standard test parts.

2.2.6 Design of Experiment

Flat aluminum parts are used in this verification test for reproducibility. Coated standard test parts will be analyzed for DFT, gloss, TE, and visual appearance. For the TE analysis, the weight of all parts will be measured before being coated and again after being cured. The painters are instructed to use 50% overlap of the fan pattern.

The standard test parts will be suspended from the conveyor and manually coated. Ten painters will take part in this verification test. Every painter will paint fourteen parts in Run 1 and fourteen parts in Run 2. Each run will be comprised of two groups of parts with seven parts in each group. The first group will consist of the Full-type parts and the second group will consist of the Window-type parts.

For each painter, the finish quality of the test parts from Run 2 will be compared to the test parts from Run 1. The finish quality should not be sacrificed to obtain the “best” possible TE for either run. A visual inspection will be performed on the parts to determine an immediate pass or fail of the parts. If a part does not pass the following criteria, it will not be included in any further analyses of the test parts:

- A visually noticeable run or sag,
- A visually noticeable drip.

2.2.7 Performance Testing

Standard test parts will be used for DFT, gloss, TE, and visual appearance analysis. The coating characteristics may be affected by other parameters of the testing process, such as pretreatment and apparatus setup. The pretreatment process will be the same for all test parts; therefore, the variability of the pretreatment process should not be a significant factor. The apparatus setup will be modified by each painter to meet his/her application characteristics; however, the apparatus setup will be held relatively constant for each painter. Parameters such as paint fluid pressure and atomizing air pressure will be adjusted by the painter to meet his/her application technique and then held constant. DFT measurements will be used to determine the variations in film thickness. Gloss tests will be used to analyze the quality of the coating finish. TE measurements will be used to determine the quantitative improvement between normal manual spray painting techniques and the use of the Laser Touch™ Beta Model targeting device. Additionally, the visual appearance analysis will look for any abnormalities in the applied coating. The TE test will follow Procedure A of ASTM D 5286.

As much of the procedure as possible will be videotaped for future reference. IWRC staff members will videotape the painters as well as the settings on the equipment and as much of the testing procedures as practical. The videotapes allow review in the event a particular procedure, test, or piece of equipment needs to be altered.

The standard test parts will be weighed and the weights recorded prior to being suspended on the conveyor. The weight of the gun, cup, coating, coating container, and during Run 2 the Laser Touch™ Beta Model, will be recorded on the worksheets immediately before the painter begins applying the coating to each test part. After each standard test part has been coated, the spray gun, cup, coating, coating container, and during Run 2 the Laser Touch™ Beta Model, will be re-weighed and the weights will be recorded.

The standard test parts will be fully cured in an infrared/ convection oven. The speed of the overhead conveyor line and setup of the cure oven will be recorded on the cure oven worksheets, (see Appendix F), to assure that the cure oven is operated consistently. The temperature of a standard test part from each run will be measured at the approximate center of the part at a distance of 2 feet from the exit of the cure oven with an infrared thermometer and recorded in the test logbook.

After the parts are fully cured and cooled to room temperature in the two-stage cure process, the parts will be re-weighed. The standard test parts will be hung from the scale and weighed as before, with all sources of air movement turned off. The DFT of the paint on each part will also be recorded in the logbook. Mil thickness readings will be taken in several locations on each part.

After completing Run1, the painters will be introduced to the Laser Touch™ unit and instructed in the proper use of this device. The classroom curriculum for the 30-minute training session is provided in Appendix G. After the classroom session, the painters will spend another 30 minutes practicing using the Laser Touch™ targeting device to become accustomed to spraying with the Laser Touch™ Beta Model targeting device.

The Laser Touch™ Beta Model targeting device will be installed on the same spray gun that was used to paint the previous sets of standard test parts. A member of the IWRC staff will demonstrate the use of the Laser Touch™ Beta Model targeting device to aim, check and maintain distance, and improve overlap. Once the painter is ready to begin Run 2, the density, temperature and viscosity measurements of the paint will be made.

2.2.8 Quantitative Measurements

In order to evaluate the TE and the finish quality obtained with the tests after the implementation of the Laser Touch™ device on spray painting guns, several measurements will be taken from the non-coated and coated test parts. In the case of the non-coated parts, the area in square feet and the weight of the parts will be measured. For the coated parts, weight and DFT will be measured. This procedure will follow ASTM D 5286 whenever practical.

The uniformity of the coating applied can be determined by measuring DFT at several specified locations on the standards test parts. Measurement sites will be at twelve locations on the coated surface of the standard test part type F (Full), and twelve locations on the coated surface of the standard test part type W (Window). Five parts will be randomly selected from each group. Appendix B displays the standard test parts with their respective locations of the mil thickness reading. These sites will be numbered and measurements will be taken accordingly. Five standard test parts per group will be randomly selected for DFT measurement, which gives a total of 60 DFT sites per run and 120 DFT sites per painter. The measurements will be recorded and can be correlated to a specific site on each standard test part for each test. The thickness measurement data will be used to evaluate not only the mean thickness across the part, but also the variation of the thickness and differences in the edge and the central portions of the parts. Also, a correlation between the painter's consistency and the use of the Laser Touch™ device will be examined.

In addition to the verification test, the ETV CCEP and IWRC will evaluate potential environmental benefits associated with using the Laser Touch™ on paint spray guns. Therefore, TE values will be quantitatively measured for both runs using nearly identical test conditions. A qualitative comparison will then be made to determine if spray painting guns with the Laser Touch™ attached have a potentially higher TE than spray guns which do not feature the device.

In order to evaluate the finish quality obtained by the coating equipment tested, several measurements will be taken from the coated test specimens such as DFT, gloss, and visual appearance.

2.2.9 Participation

IWRC has a research and training center for coating operations. IWRC staff will perform the testing activities during this verification test. Audits of the testing performed at the PAC^{2}E facility will ensure that the test is conducted in a professional and quality assured manner. The PAC^{2}E facility contains equipment required for industrial coatings research. The actual coating of the test parts will be completed at the PAC^{2}E facility, along with the laboratory measurements and analyses. The ETV CCEP will provide technical support and oversight for the testing performed by IWRC. The ETV CCEP will conduct audits of the testing performed at the PAC^{2}E facility.

The ETV CCEP will observe all testing performed at the IWRC facility to help insure that the proper testing and analysis procedures are followed. Jeff England of IWRC will be responsible for performing the tests and analyses according to the TQAPP and for maintaining quality records that will be reviewed by the ETV CCEP.

The population of painters for this verification will be composed of trade school students and industrial spray painting technicians from small manufacturing companies in the Midwest. Trade schools students are being utilized to determine the impact the Laser Touch™ Beta Model has on trained painters with relatively little work experience. The small manufacturing companies will be selected to participate depending on their responsiveness and availability of their painters to participate in the verification process. A maximum of three painters from each company will be allowed to participate. A total of ten painters will participate in this verification test. Only one painter may participate in testing each day. Testing will take place between 8:00 a.m. and 4:00 p.m. for the majority of the painters. Other times may be used during audits to increase the number of painters observed. The painter's shall have no previous experience using the Laser Touch™ Beta Model targeting device. The painters will complete the Laser Touch™ Research Questionnaire (see Appendix G, Attachment A) detailing their painting experience and level of training received.

2.2.10 Critical and Non-Critical Factors

For the purpose of this TQAPP, the following definitions will be used for critical control factors, non-critical factors, and critical response factors.

A critical control factor is a factor that is varied in a controlled manner within the design of the experiment to determine its effect on a particular outcome of a system. Non-critical control factors are all the factors that are to be held relatively constant or randomized throughout the testing for each specific piece of equipment (some non-critical factors may vary from equipment to equipment). Critical response factors are the measured outcomes of each combination of critical and non-critical control factors given in the design of experiments.

In this context, the term "critical" does not convey the importance of a particular factor (that can only be determined through experimentation and characterization of the total process), but its relationship within the design of experiments. In the case of a verification testing of a particular piece of coating equipment, there is only one critical control factor, and that is the piece of coating equipment itself. All other processing factors will be held relatively constant (or randomized) and are non-critical control factors. Therefore, the multiple runs and sample measurements within each run for each critical response factor will be used to determine the amount of variation expected for each critical response factor.

For this TQAPP, the critical control factors, non-critical factors, and critical response factors are identified in a table format along with acceptance criteria (where appropriate), data quality indicators, measurement locations, and measurement frequencies, broken down by each run. For example, parameters associated with the metal surface pretreatment will remain constant and thus be non-critical control factors, while a parameter such as DFT is identified as a critical response factor.

The only critical control factor is the Laser Touch™ itself (see Table 3). The non-critical control factors are shown in Table 4, and the critical response factors to be measured are shown in Table 5.

The pretreatment/cleaning process will be the same for all standard test panels. The pretreatment process should not have an impact on the results of this verification test. The pretreatment of the panels is intended to prepare the surface for coating application and for adhesion promotion. The pretreatment process cleans the surface of the standard test parts. To verify that these parts are reasonable clean for surface coating applications, a water break test (ASTM B 767) will be performed on five random parts. A part is considered clean if the water does not bead on the surface of the part.

The TE test will follow ASTM D 5286. A TE value will be determined for each part and on a part-to-part basis.

The DFT measurements will follow ASTM D 1400 Test Method C. Thickness measurements will be taken on a representative sample of the standard test parts as shown in Appendix B. Measurement using the eddy current methods will be done on each of five selected standard test parts per group per run. From this data an overall DFT and a DFT variation across the standard test part will be reported. The purpose of this comparison is to verify that a uniform DFT has been applied to the standard test parts and to calculate the mass of the paint sprayed over the test part in order to attain the TE ratio for each painter.

The gloss analysis will follow ASTM D 523. Gloss measurements will be taken on five test parts for each group as a comparison of finish quality between Run 1 and Run 2.

The visual appearance analysis will use normal lighting to examine the surface of the painted part. The parts will be examined for fish-eyes in the finish, the presence of orange peel, the evenness of the coating, and the difference in the visual gloss caused by sandpaper finish, drips, runs, and inclusions (such as dirt, fuzz, and fibers). A comparison will be made between parts from Run 1 and Run 2.

The values in the Total Number column reflect the experimental design of coating fourteen standard test parts for Run 1 and fourteen standard test parts for Run 2 per painter.

Table 3. Critical Control Factors

Critical Control Factor
Laser Touch™ Beta Model

Table 4. Non-Critical Control Factors

Non-Critical Factor	Set Points/ Acceptance Criteria	Measurement Location	Frequency	Total Number for the Test
Dynamic Input Air Pressure	30–40 psig at spray gun (set by painter)	Factory Floor	Before and after each run	40
Product Involved in Testing	Standard Test Parts	N/A	14 Test Parts per run	280
Pretreatment/Cleaning	Water break	Factory floor	Random parts	10
Ambient Factory Relative Humidity	RH will vary <30% for each painter	Factory floor	Before and after each run	40
Ambient Factory Temperature	20–30 °C	Factory floor	Before and after each run	40
Booth Relative Humidity	RH will vary <30% for each painter	Factory floor	Before and after each run	40
Booth Temperature	20–30 °C	Factory floor	Before and after each run	40
Spray Booth Air Flow	0.5–0.9 m/s (100–175 ft/min)	Factory floor	Before and after each run	40
Temperature of Parts as Coated	20–30 °C	Center of test part	Once per run	20
Distance to Parts	10.2–24.5 cm (4–10 in.)	Factory floor	Once per run	20
VOC Content of Applied Coating	<336 g/L (<2.8 lb/gal)	Sample from coating pot	1 sample per batch/run	40
Density of Applied Coating	1160–1280 g/L (9.7–10.7 lb/gal)	Sample from coating pot	1 sample per batch/run	40
Wt.% Solids of Applied Coating	68.0–73 %	Sample from coating pot	1 sample per batch/run	40
Coating Temperature, as Applied	20–30 °C	Sample from coating	1 sample per run	40
Coating Viscosity as Applied	50-65 sec. #4 Ford cup	Sample from coating pot	1 sample per batch/run	40
Oven Temperature	78–87 °C (172–189 °F)	Factory floor	Once per group	40
Oven Cure Time	1^{st} cure 17 min 2^{nd} cure 77min	Factory floor	Once each run	20

Table 5. Critical Response Factors†

Critical Response Factor	Measurement Location	Frequency	Total Number for the Test
Test Cap Air Pressure	Air Cap	Once per run	20
Overall DFT (Eddy Current methods)	Appendix B shows location of measurement points.	12 points on each of 5 parts per group per run	2,400
DFT Variation	Calculated from eddy current dry film thickness data	Variation on individual part and variation from run to run	N/A
Gloss	From ASTM D 523	12 points on each of 5 parts per group per run	2,400
Visual Appearance	Entire test part	1 per part and 1 per group	320
Transfer Efficiency	From ASTM D 5286	One per part	280

† See Sections 2.1.3 and 2.2 for the environmental basis on which these factors relate.

Other factors used to test the Laser Touch ™ Beta Model include:

- Spray Gun — Accuspray Model 19 HVLP
- Equipment Preparation — IWRC
- Fan Pattern — Set by painter
- Solvent Type — V66V55 Catalyst/ MAK R6K30 Solvent
- Number of coats — 1 coat
- Target dry film thickness — 0.8 to 1.5 mil
- Overlap — 50%
- Target gloss — 80 units out of 100 at an angle of 20°

2.3 Schedule

CTC uses standard tools for project scheduling. Project schedules are prepared in Microsoft Project, which is an accepted industry standard for scheduling. Project schedules show the complete work breakdown structure (WBS) of the project, including technical work, meetings and deliverables. Table 6 shows the estimated schedule for the testing of the Laser Touch™ Beta Model targeting device.

Table 6: Estimated Schedule as of 9/16/99

ID	Name	Duration	Start Date	Finish Date
Task 1	Draft and revise TQAPP for Laser Touch™ Beta Model	25d	2/1/1999	8/10/1999
Task 2	Approval of TQAPP	5d	8/16/1999	10/8/1999
Task 4	Verification Testing	15d	10/18/1999	11/31/1999
Task 6	Complete Data Analyses	15d	11/31/1999	12/17/1999
Task 5	Prepare Verification Report	30d	12/17/1999	2/4/2000
Task 6	Approval of Verification Report	60d	2/4/2000	4/28/2000
Task 7	Issue Verification Statement	15d	4/28/2000	5/19/2000

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Concurrent Technologies Corporation (*CTC*), which operates the ETV CCEP, employs a matrix organization, with program and line management. The laboratory supports the ETV CCEP Technical Project Manager and ETV CCEP Technical Project Leader by providing test data. The ETV CCEP Laboratory Leader report to the *CTC* Laboratory Manager. The ETV CCEP Laboratory Leader coordinates with the ETV CCEP Technical Project Leader on testing schedules. The ETV CCEP Technical Project Leader is the conduit between the *CTC* laboratory, IWRC, and the ETV CCEP Technical Project Manager. The ETV CCEP Technical Project Leader answers directly to the ETV CCEP Technical Project Manager. The ETV CCEP Technical Project Leader is responsible for preparing this TQAPP.

The ETV CCEP QA Officer, who is independent of both the *CTC* laboratory and the ETV CCEP program, is responsible for administering policies developed by the *CTC* Quality Committee. These policies provide for, and insure that quality objectives are met for each project, and cover laboratory testing, factory demonstration processing, engineering decisions, and deliverables. The ETV CCEP QA Officer reports directly to the NDCEE Program Director.

The Iowa Waste Reduction Center (IWRC) is a nonprofit organization, with a Director, program and line management. The Senior Research Technician manages the applied research and training facilities. The Research Assistants working on this particular project will report to the Senior Research Technician. The Senior Research Technician, who will be the Technical Project Leader for the IWRC, will coordinate with the Director and Program Manager to meet project goals and overcome obstacles. The IWRC Technical Project Leader is the conduit between the applied research facility, the PAC^2E facility, and the IWRC Director. The IWRC Technical Project Leader answers directly to the IWRC Director. For the Laser Touch™ Beta Model testing, the IWRC Technical Project Leader will be responsible for preparing the TQAPP and the internal demonstration plans for each test.

Additionally, the IWRC QA Officer is responsible for administering quality control procedures developed within this TQAPP. These procedures provide for, and insure that, quality objectives are met for each project, and cover laboratory testing, factory demonstration processing, engineering decisions, and deliverables. The IWRC QA Officer reports directly to the ETV CCEP QA Officer.

A summary of the responsibilities of each ETV CCEP and IWRC participant, their applicable experience, and their anticipated time dedication to the project during testing and reporting is given in Table 7.

Table 7. Summary of ETV CCEP and IWRC Experience and Responsibilities

Key Personnel and Roles	Responsibilities	Applicable Experience	Education	Time Dedication for Phase
Dave Roberts NDCEE Program Director	Directs NDCEE Program. Accountable to *CTC* Executive Director and *CTC* Corporate Management.		BS Mechanical Engineering	5%
Brian Schweitzer Process Engineering Manager/ ETV CCEP Technical Project Manager	Responsible for overall ETV CCEP technical aspects, budget, and schedule issues on daily basis. Accountable to NDCEE Program Director.	Process Engineer (11 years) Project Manager, Organic Finishing (6 years)	BS Mechanical Engineering	25%
Jack Molchany ETV CCEP QA Officer	Responsible for overall project QA. Accountable to NDCEE Program Director	QA/QC and Industrial Operations (11 years) Quality Management and ISO 9000 (5 years) Environmental Compliance and ISO 14000 Management Systems (5 years)	BS Industrial Engineering	5%
Rob Fisher Staff Process Engineer/ ETV CCEP Technical Project Leader	Technical project support. Process design & development. Accountable to Technical Project Manager.	Organic Finishing Regulations (6 years)	BS Chemical Engineering	25%
Melissa Klingenberg Staff Process Engineer/ ETV CCEP Technical Project Engineer	Technical project support. Process design & development. Accountable to Technical Project Manager.	Process Engineer, Inorganic Finishing (6 years) Organic Finishing (2 year)	BS Chemistry/ Biology MS MSEP	<5%
Dave James Process & Materials Characterization Manager/ ETV CCEP Laboratory Manager	Coordinates testing lab and technical data review. Accountable to Technical Project Manager, NDCEE Program Director.	Environmental Engineering (17 years) Project/People Management (17 years) ISO 9000/14000 Management Systems (5 years)	MS Environmental Engineering BS Ecology	<5%
Lynn Summerson ETV CCEP Laboratory Leader	Laboratory analysis Accountable to Laboratory Operations Manager	Industrial and Environmental Laboratory Testing (18 years)	MS Chemistry	10%
John Konefes Director, IWRC	Directs IWRC Responsible for oversight of IWRC operations Accountable to the Dean of the College of Natural Sciences, University of Northern Iowa	Director of the IWRC (13 years) Certified Hazardous Materials Manager	BS Fish & Wildlife Biology MS Environmental Engineering &Zoology	< 5 %
Christine Twait Program Manager, IWRC	Technical project support. Assist in Process Design & Development Accountable to Director, IWRC	Program Manager (4 years) Environmental Specialist (2 years)	BS Economics MPA Public Administration	< 5%
Rick Klein IWRC Facility Manager/ IWRC Senior Research Technician/ IWRC Technical Project Leader	Responsible for overall operations of the PAC^2E Facility Coordinates IWRC activities Operates test site Accountable to Director, IWRC	Senior Research Technician (7 years) Facilities Manager (8 Years) STAR Program Manager (3 years)	AS General Technology/ Environmental Engineering	25%
Jeff England IWRC QA Officer	Responsible for IWRC's overall project QA Accountable to Director, IWRC	Research Assistant (3 years) IWRC QA Leader (1 Year)	BS Physics	100 %
Omar Blanco IWRC Laboratory Manager	Responsible for data collection and laboratory analysis Accountable to Director, IWRC	Graduate Assistant (1 year) Research Assistant (2 years)	BS Civil Engineering	100 %
Bill Zimmerle IWRC Statistical Support	Responsible for statistical interpretation of test results and QA objectives	Waste Reduction Specialist (2 Years) Research Assistant (3 Years)	BS Biology	< 10 %
IWRC Research Assistants	Assists with data collection and laboratory analysis	Varies	N/A	25%

The ETV CCEP and IWRC personnel specified in Table 7 are responsible for maintaining communication with other responsible parties working on the project. The frequency and mechanisms for communication are shown in Table 8.

Table 8. Frequency and Mechanisms of Communications

Initiator	Recipient	Mechanism	Frequency
NDCEE Program Manager or ETV CCEP Technical Project Manager	EPA Project Manager	Written Report Verbal Status Report	Monthly Weekly
ETV CCEP Technical Project Manager	NDCEE Program Manager	Written or Verbal Status Report	Weekly
CTC Laboratory Manager	ETV CCEP Technical Project Manager and ETV CCEP Technical Project Leader	Data Reports	As Generated
ETV CCEP Technical Project Leader	ETV CCEP Technical Project Manager	Written or Verbal Status Report	Weekly
IWRC Staff	ETV CCEP Technical Project Leader	Verbal Status Report	Weekly
IWRC Staff	*CTC* Laboratory Manager	Data Reports	As Generated
IWRC QA Officer	ETV CCEP QA Officer	Written and Verbal Reports	As Required
ETV CCEP QA Officer	NDCEE Program Manager	Quality Review Report	As Required
EPA Project Manager	*CTC*	On-Site Visit	At Least Once per Year

Special Occurrence	Initiator	Recipient	Mechanism/ Frequency
Schedule or Financial Variances	NDCEE Program Manager or ETV CCEP Technical Project Manager	EPA Project Manager	Telephone Call, Written Follow-up Report as Necessary
Major (will prevent accomplishment of verification cycle testing) Quality Objective Deviation	NDCEE Program Manager or ETV CCEP Technical Project Manager	EPA Project Manager	Telephone Call with Written Follow-up Report

In addition, the individuals listed in Table 9 will have certain responsibilities during the testing phase:

Table 9. Responsibilities During Testing

Position	Responsibility
ETV CCEP Technical Project Manager	Overall coordination of testing
ETV CCEP QA Officer	Audits of verification testing operations and laboratory analyses
ETV CCEP Technical Project Leader	Overall coordination of reporting and data review
IWRC Facility Manager	Coordinates testing at IWRC facilities.
IWRC Laboratory Manager	Responsible for sampling and laboratory analyses
IWRC QA Officer	Responsible for QA objectives
Statistical Support	Coordinates interpretation of test results
Research Assistants	Record data and assist with verification testing

4.0 QUALITY ASSURANCE OBJECTIVES

4.1 General Objectives

The overall objectives of the verification testing are to establish the performance of the Laser Touch™ Beta Model targeting device by establishing the transfer efficiency improvement of a manual spray application system and by documenting finish quality. These objectives will be met by controlling and monitoring the critical and non-critical factors, which are the specific QA objectives for this TQAPP. Tables 3 and 4 list the critical and non-critical control factors, respectively. Results from this verification testing will then be disseminated to prospective end-users.

The analytical methods that will be used for coating evaluations are adapted from ASTM Standards, or equivalent. The QA objectives of the project and the capabilities of these test methods for product and process inspection and evaluation are synonymous because the methods were specifically designed for evaluation of the coating properties under investigation. The methods will be used as published, or as supplied, without major deviations unless noted otherwise. The specific methods to be used for this project are attached to this document as Appendix H (ASTM Methods).

4.2 Quantitative Quality Assurance Objectives

Quality assurance parameters such as precision and accuracy are presented in Tables 10 and 11. Table 10 presents the manufacturers' stated capabilities of the equipment used for measurement of non-critical control factors. The precision and accuracy parameters listed are relative to the true value that the equipment measures. Table 11 presents the precision and accuracy parameters for the critical response factors. The precision and accuracy are determined using duplicate analysis and known standards and/or spikes and must fall within the values found in the specific methods expressed.

IWRC and the ETV CCEP will coordinate efforts to statistically interpret test results and QA objectives.

Table 10. QA Objectives for Precision, Accuracy and Completeness for All Non-Critical Control Factor Performance Analyses

Measurement	Method	Units	Precision	Accuracy	Completeness
Dynamic Input Air Pressure	Pressure gauge	psig	±0.2 psig	±5%	90%
Product Involved in Testing	Standard Test Parts	N/A	N/A	N/A	100%
Pretreatment/Cleaning	Water break	Pass/Fail	N/A	N/A	90%
Ambient Factory Relative Humidity	Thermal Hygrometer	RH	±3% of full scale	±3% of full scale	90%
Ambient Factory Temperature	Thermal Hygrometer	°C	±3% of full scale	±3% of full scale	90%
Booth Relative Humidity	Thermal Hygrometer	RH	±3% of full scale	±3% of full scale	90%
Booth Temperature	Thermal Hygrometer	°C	±3% of full scale	±3% of full scale	90%
Spray Booth Air Flow	per ACGIH	m/s (ft/min)	±0.03* (±5)	±0.03* (±5)	90%
Temperature of Parts as Coated	IR Thermometer	°C	±0.5%	±1.0%	90%
Distance to Parts	Ruler	cm (in.)	±0.15 (±0.06)	±0.15 (±0.06)	90%
VOC Content of Applied Coating	ASTM D 2369	g/ℓ (lb/gal)	±0.6%	±1.8%	90%
Density of Applied Coating	ASTM D 1475	g/ℓ (lb/gal)	±0.6%	±1.8%	90%
Wt.% Solids of Applied Coating	ASTM D 2369	%	±1.5%	±4.7%	90%
Coating Temperature, as Applied	Thermometer	°C	±0.5 °C	±0.2 °C	90%
Coating Viscosity as Applied	ASTM D 1200	seconds	±10%	±10%	90%
Oven Temperature	Thermocouple	°C	±2.2 °C	±2.2 °C	90%
Oven Cure Time	Analog/Digital Timer	minutes	±0.01%	±0.01%	90%

ACGIH - American Conference of Governmental Industrial Hygienists, Inc.
* Accuracy and Precision stated by the manufacturer for velocities ranging from 20-100 ft/min

Table 11. QA Objectives for Precision, Accuracy and Completeness for All Critical Response Factor Performance Analyses

Measurement	Method	Units	Precision	Accuracy	Completeness
Test Cap Air Pressure	Gauge	psig	±0.2 psig	±5%	90%
Dry Film Thickness – Eddy Current	ASTM D 1400	mils(1)	20%	10% true thickness	90%
DFT Variation	N/A	N/A	N/A	N/A	N/A
Gloss	ASTM D 523	gloss units	20%	±0.3	90%
Visual Appearance	N/A	N/A	N/A	N/A	N/A
Transfer Efficiency	ASTM D 5286 Test Method A	%	25%(2)	rsd ≤ 20%(2,3)	90%

(1) 1 mil = 0.001 in.
(2) Unknown according to ASTM D 5286
(3) rsd =relative standard deviation
N/A = Not Applicable

4.2.1 Accuracy

Standard reference materials, traceable to national sources such as the National Institute for Standards and Technology (NIST) for instrument calibration and periodic calibration verification, will be procured and utilized where such materials are available and applicable to this project. For reference calibration materials with certified values, acceptable accuracy for calibration verification will be within the specific guidelines provided in the method if verification limits are given. Otherwise, 80-120 percent of the true reference values will be used (see Tables 10 and 11). Reference materials will be evaluated using the same methods as for the actual test specimens. Calculations for precision, accuracy, etc. are contained in Section 10.0.

4.2.2 Precision

The experimental approach of this TQAPP specifies the exact number of test parts to be coated. The analysis of replicate test parts for each coating property at each of the experimental conditions will occur by design. The degree of precision will be assessed based on the agreement of all replicates within a property analysis group.

4.2.3 Completeness

The laboratory strives for at least 90 percent completeness. Completeness is defined as the number of valid determinations expressed as a percentage of the total number of analyses conducted, by analysis type.

4.2.4 Impact and Statistical Significance Quality Objectives

All laboratory analyses will meet the accuracy and completeness requirements specified in Tables 10 and 11. The precision requirements also should be achieved; however, a non-conformance may result from the analysis of replicates due to limitations of the coating technology under evaluation, and not due to processing equipment or laboratory error. Regardless, if any non-conformance from TQAPP QA objectives occurs, the cause of the deviation will be determined by checking calculations, verifying the test and measurement equipment, and re-analysis. If an error in analysis is discovered, re-analysis of a new batch for a given run will be considered and the impact to overall project objectives will be determined. If the deviation persists despite all corrective action steps, the data will be flagged as not meeting the specific quality criteria and a written discussion will be generated.

If all analytical conditions are within control limits and instrument and/or measurement system accuracy checks are valid, the nature of any non-conformance may be beyond the control of the laboratory. If, given that laboratory quality control data are within specification, any non-conforming results occur, the results will be interpreted as the inability of the coating equipment undergoing testing to produce parts meeting the performance criteria at the given set of experimental conditions.

4.3 Qualitative QA Objectives: Comparability and Representativeness

4.3.1 Comparability

The Laser Touch™ Beta Model targeting device will be operated per Laser Touch and Technologies, LLC's recommendations. The data obtained will be comparable from the standpoint that the TE data from Runs 1 and 2 can be compared to a reasonable significance. In addition, other programs should be able to reproduce similar results using this technology-specific TQAPP. Coating and environmental performance will be evaluated using EPA, ASTM and other nationally or industry-wide accepted testing procedures as noted in previous sections of this TQAPP. Process performance factors will be generated and evaluated according to standard best engineering practices.

Standard test parts used in these tests will be compared to the performance criteria and to other applicable end-user and industry specifications. The specifications will be used to verify the performance of the Laser Touch™ Beta Model targeting device. Additional assurance of comparability comes from the routine use of precision and accuracy indicators as described above, the use of standardized and accepted methods and the traceability of reference materials.

4.3.2 Representativeness

The limiting factor to representativeness is the availability of a large sample population. An experimental design has been developed so that this project will either have sufficiently large sample populations or otherwise statistically significant fractional populations. The tests will be conducted at optimum conditions based on the manufacturers' and the paint suppliers' literature and verified by setup testing. If the test data meets the quantitative QA criteria (precision, accuracy, and completeness) then the samples will be considered representative of the Laser Touch™ Beta Model targeting device and will be used for interpreting the outcomes relative to the specific project objectives.

4.4 Other QA Objectives

There are no other QA objectives as part of this evaluation.

4.5 Impact of Quality

Due to the highly controllable nature of the test part evaluation methods and predictability of factors affecting the quality of the laboratory testing of parts, the quality control of test part qualifications is expected to fall within acceptable levels. Comparison of response factors will be checked for process variations.

5.0 SITE SELECTION AND SAMPLING PROCEDURES

5.1 Site Selection

This project will be executed at the IWRC PAC^{2}E facility, in Cedar Falls, IA. IWRC personnel will perform all processing and testing. Application of the coating involves transporting test parts via an automatic conveyor through the PAC^{2}E facility.

The experimental design involves applying a coating according to the manufacturers' recommended optimum conditions. The test parts will be sampled and analyzed to generate performance data.

5.2 Site Description

A diagram of the PAC^{2}E facility is attached as Appendix A, which shows the location of the process equipment that will be used for this project. This project involves the use of the wet spray booth and the wet cure oven.

5.3 Sampling Procedures and Handling

Standard test parts will be used in this project. These will be pre-labeled by engraving them with a unique alphanumeric identifier. The experimental design uses 280 samples for the TE test (10 painters, two runs per painter, 2 groups of parts per run, 7 parts per group). IWRC staff will process the test parts according to a pre-planned sequence of stages.

The date and time of each test, and the time measurements are taken, will be recorded. When the parts are removed from the conveyor, they will be separated by a layer of packing material, and stacked for transport to the laboratory. An IWRC laboratory staff member will process the test parts through the laboratory login prior to performing the required analyses.

5.4 Sample Custody, Storage and Identification

The test parts will be labeled and logged into the laboratory record sheets. The test parts will remain in the custody of IWRC, unless a change of custody form has been completed. The change of custody form should include a signature from IWRC, the test part ID (identification) number, the date of custody transfer, and the signature of the individual to whom custody was transferred. Laboratory analyses may only begin after each test part is logged into the laboratory record sheets. The product evaluation tests also will be noted on the laboratory record sheet. Testing will begin within several days of coating application. Except for the gloss measurements that will be conducted after all other testing is completed.

6.0 ANALYTICAL PROCEDURES AND CALIBRATION

6.1 Facility and Laboratory Testing and Calibration

The IWRC shall maintain a record of calibrations and certifications for all applicable equipment. Testing and measuring equipment shall be calibrated prior to the verification test and after the verification test analyses are complete.

6.1.1 Facility Testing and Calibration

Calibration procedures within the PAC^2E facility shall be recorded. Certified solutions and reference materials traceable to NIST shall be obtained as appropriate to ensure the proper equipment calibration. Where a suitable source of material does not exist, a secondary standard is prepared and a true value obtained by measurement against a technical-grade NIST-traceable standard.

After the paint is mixed, the temperature and viscosity of the coating will be measured. In addition, coating samples will be taken to the lab for density, VOC content, and percent solids analyses.

Like the standard test parts, the solids pans will be labeled with an identification number and letter. The labeling scheme for the pans should match the following model: XxNN

Where:

X = letter
N = number
Example = Aa01

The first and second letter is a batch number and is specific to a single batch of paint. The number designates the individual pans. Two separate solids pans will be used for each batch of coating and the values obtained will be averaged.

The pans will be pre-treated as specified by the ASTM standard for determining volatile content of coatings (ASTM D 2369). The data required for the solids test is recorded on the paint batch worksheet.

The percent of solids is calculated as:

$$N = ((W2 - W1) / S) \times 100$$

where:

- W1 = the weight of the dish
- W2 = weight of dish plus specimen after heating
- S = Specimen weight (Sy1 - Sy2)
- Sy1 = Syringe before dispensing paint
- Sy2 = Syringe after dispensing paint

The ambient temperature and relative humidity is measured both inside and outside the spray booth. Also, the temperature of one part per run is measured prior to starting each test run.

All equipment used for these analyses will be calibrated according to Tables 12 and 13.

6.1.2 Laboratory Testing and Calibration Procedures

The analytical methods performed at IWRC are adapted from standard ASTM, MIL-SPEC, EPA, Association of Official Analytical Chemists (AOAC) and/or industry protocols for similar manufacturing operations. Initial calibration and periodic calibration verification are performed to insure that an instrument is operating sufficiently to meet sensitivity and selectivity requirements. At a minimum, all equipment are calibrated before use and are verified during use and/or immediately after each sample batch. Standard solutions are purchased from reputable chemical supply houses in neat and diluted forms. Where certified and traceable to NIST reference materials and solutions are available, the laboratory purchases these for calibration and standardization. Data from all equipment calibrations and chemical standard certificates from vendors are stored in laboratory files and are readily retrievable. No samples are reported in which the full calibration curve, or the periodic calibration check standards, are outside method performance standards. As needed, equipment will be sent off-site for calibration or certification.

The listing of ASTM Methods for dry film thickness, gloss, and transfer efficiency can be found in Appendices H. All equipment used for these analyses are calibrated according to Tables 12 and 13.

6.2 Product Quality Procedures

Each apparatus that will be used to assess the quality of a coating on a test part is set up and maintained according to each manufacturer's, and/or the published reference method's, instructions. Actual sample analysis will take place only after setup is verified per the reference method and the equipment manufacturer's instructions. As available, samples of known materials with established product qualities are used to verify that a system is functioning properly. For example, traceable thickness standards are used to calibrate the dry film thickness instrument. Applicable ASTM methods are listed in Appendix H.

6.3 Standard Operating Procedures and Calibration

Tables 12 and 13 summarize the methods and calibration criteria that will be used for the evaluation of the coatings. Each analysis shall be performed as adapted from published methods and references, such as ASTM and EPA, and from accepted protocols provided by industrial suppliers.

Table 12. Non-Critical Control Factor Testing and Calibration Criteria

Non-Critical Factor	Method	Method Type	Calibration Procedure	Calibration Frequency	Calibration Accept. Criteria(1)
Input Air Pressure	Factory gauge	Pressure gauge	Comparison to NIST-traceable standard	Annually	±5 psig
Products Involved in Testing	Standard Test Parts	N/A	N/A	N/A	N/A
Pretreatment/ Cleaning	ASTM B 767	Water break	Comparison to NIST-traceable standard	With each use	80-120%
Surface Area of Each Part	Ruler	Ruler	Inspect for damage, replace if necessary	With each use	Lack of damage
Ambient Factory Relative Humidity	Thermal Hygrometer	Thermal Hygrometer	Sent for calibration or certification	Annually	N/A
Ambient Factory Temperature	Thermal Hygrometer	Thermal Hygrometer	Sent for calibration or certification	Annually	N/A
Spray Booth Relative Humidity	Thermal Hygrometer	Thermal Hygrometer	Sent for calibration or certification	Annually	N/A
Spray Booth Temperature	Thermal Hygrometer	Thermal Hygrometer	Sent for calibration or certification	Annually	N/A
Spray Booth Air Velocity	per ACGIH	Anemometer	Sent for calibration or certification	Annually	N/A
Distance to Parts	Ruler	Ruler	Inspect for damage, replace if necessary	With each use	Lack of damage
Temperature of Parts, as Coated	IR Thermometer	IR Thermometer	Sent for calibration or certification	Annually	N/A
VOC Content of Applied Coating	ASTM D 2369	Volatile content	Comparison to NIST-traceable standard	With each batch of paint	±0.003 g
Density of Applied Coating	ASTM D 1475	Weight	Comparison to NIST-traceable standard	With each batch of paint	±0.003 g
% Solids of Applied Coating	ASTM D 2369	Weight	Comparison to NIST-traceable standard	With each batch of paint	±0.003 g
Coating Temperature, as Applied	Thermometer	Thermometer	Comparison to NIST-traceable standard	Annually	±1 °C
Coating Viscosity, as Applied	ASTM D 1200	#4 Ford Cup	Comparison to NIST-traceable standard	Prior to each test	±10%
Oven Cure Time	Stopwatch	Stopwatch	Sent for calibration or certification	Annually	N/A

(1) As a percent recovery of a standard.
N/A = Not Applicable

Table 13. Critical Response Factor Testing and Calibration Criteria

Critical Measurement	Method Number(1)	Method Type	Calibration Procedure	Calibration Frequency	Calibration Accept. Criteria(2)
Test Cap Air Pressure	Factory gauge	Pressure gauge	Comparison to NIST-traceable standard	Annually	±5 psig
Dry film Thickness	ASTM D 1400	Eddy Current	Comparison to NIST-traceable standard	Verify calibration after each run	90-110%
Dry Film Thickness Variation	N/A	N/A	N/A	N/A	N/A
Gloss	ASTM D 523	Glossmeter	Comparison to NIST-traceable standard	Verify calibration after each run	90-110%
Visual Appearance	N/A	Visual	N/A	N/A	N/A
Transfer Efficiency	ASTM D 5286 Test Method A	Weight	Comparison to NIST-traceable standard	Verify calibration prior to each use	±3.0 g

(1) Listing of ASTM methods to be used is provided in Appendix H.
(2) As a percent recovery of a standard.
N/A = Not Applicable

6.4 Non-Standard Methods

The IWRC will not use any non-standard methods for this project. However, for methods which are non-standard (i.e., no commonly accepted or specified method exists or no traceable calibration materials exist), procedures will be performed according to the manufacturer's instructions or to the best capabilities of the equipment and the laboratory. This information will be documented. The performance will be judged based on the manufacturer's specifications, or will be judged based on in-house developed protocols. These protocols will be similar or representative in magnitude and scope to related methods performed in the laboratory, which do have reference performance criteria for precision and accuracy. For instance, if a non-standard quantitative chemical procedure is being performed, it should produce replicate results of +/- 25 relative percent difference and should give values within +/- 20 percent of true or expected values for calibration and percent recovery check samples. For qualitative procedures, replicate results should agree as to their final evaluations of quality or performance (i.e., both should either pass or both should fail if sampled together from a properly functioning process). The intended use and any limitations would be explained and documented for a non-standard procedure.

7.0 DATA REDUCTION, VALIDATION, AND REPORTING

7.1 Raw Data Handling

7.1.1 Variables used in analysis

CS - The mass of (wet) coating sprayed
%S - The percent of the coating which is non-volatile (solids)
SS - The mass of coating solids sprayed is equal to (CS x %S) / 100
SD - The mass of solids deposited
TE - Transfer efficiency is equal to (SD / SS) x 100, expressed as a percentage

The accuracy of the TE values can be calculated based on the accuracy of each of the measurements involved. Random errors propagate as follows.

7.1.2 Error in solids content.

The solids content is the difference between two masses, the wet mass and the dry mass of the paint. The procedure specifies four measurements to be made, mass of the empty pan (EP), mass of the full syringe (FS) the mass of the empty syringe (ES) and the mass of the pan with the deposited solids (PS).

$$\%S = (PS - EP) / (FS-ES) \times 100$$

Since two measurements are made in the numerator and the denominator, the total uncertainty in each of these values is the sum of the uncertainties, or 2 x 0.0005g. Since between 200 and 300 mg of coating is used in the test, this uncertainty becomes negligible compared to the numerator uncertainty. Only about 50-100 mg of solids remain in the pan after drying, making the numerator value uncertain by a maximum of 2%. Therefore, the solids content reported can be safely reported as within 2% of the actual value.

7.1.3 Error in mass deposited.

The mass of the solids deposited on the standard test parts is measured by weighing the part before and after spraying. The scale used has an accuracy of +/- 0.1g. The mass of solids typically deposited on the parts in a single spraying application is on the order of 20g. Since two weight measurements must be made, and each contains an uncertainty of 0.1g, the total uncertainty in a worst case scenario is 0.2g. The uncertainty in the mass deposited, is +/- 1 %.

The scale used to weigh the painting equipment is accurate to +/- 0.1g. Typically more than 20 g of paint is used to paint a test part, making the uncertainty a maximum of 1%.

7.1.4 Calculation of transfer efficiency.

SD is the weight of the part after spraying and curing, minus the weight of the bare part. SS is the product of CS and %S divided by 100. The transfer efficiency is calculated as below:

$$TE\ \% = (SD / SS) \times 100$$

Raw data will be generated and collected by the analysts at the bench and/or process level. Process data is recorded into a process log during factory operations. Bench data will include original observations, printouts and readouts from equipment for sample, standard and reference QC analyses. Data will be collected both manually and electronically. At a minimum, the date, time, sample ID, instrument ID, analyst ID, raw signal or processed signal, and/or qualitative observations will be recorded. Comments to document unusual or non-standard observations also will be included on the forms as necessary. Raw data will be processed manually by the analyst, automatically by an electronic program, or electronically after being entered into a computer. The analyst will be responsible for scrutinizing the data according to specified precision, accuracy, and completeness policies. Raw data bench sheets, calculations and data summary sheets will be kept together for each sample batch. From the documented procedures and the raw data bench files, the steps leading to a final result may be traced.

The method for calculating %TE has been redefined (per ASTM D 5286) to consider the TE per group. By this method, the formula is as follows:

$$TE\ (\%) = \frac{(\text{average weight gain of parts in a group}) \times 100}{(\text{total weight of paint sprayed per group} \times \text{percent solids}) / 7}$$

An example calculation is included below:

$$TE\ (\%) = \frac{1.1\text{ g} \times 100}{(30.8\text{g} \times 0.5) / 7}$$

$$TE\ (\%) = \frac{110\text{ g}}{2.2\text{ g}}$$

$$TE\ (\%) = 50$$

7.2 Preliminary Data Package Validation

The generating analyst will assemble a preliminary data package. This package will contain the QC and raw data results, calculations, electronic printouts, conclusions and laboratory sample tracking information. The ETV CCEP Laboratory Leader will review the entire package and may also check sample and storage logs, standard logs, calibration logs, and other files, as necessary, to insure that tracking, sample treatments and calculations are correct. After the package has been peer reviewed in this manner, a preliminary data report will be prepared. The entire package and final report will be submitted to the ETV CCEP Laboratory Manager.

7.3 Final Data Validation

The ETV CCEP Laboratory Manager shall be ultimately responsible for all final data released from this project. The ETV CCEP Laboratory Manager will review the final results for adequacy to project QA objectives. If the manager suspects an anomaly or non-concurrence with expected or historical performance values, with project QA objectives, or with method specific QA requirements of the laboratory procedures, he will initiate a second review of the raw data and query the generating analyst at the IWRC and the ETV CCEP Laboratory Leader about the non-conformance. Also, he will request specific corrective action. If suspicion about data validity still exists after internal review of laboratory records, the ETV CCEP Laboratory Manager may authorize a re-analysis. If sufficient sample is not available for re-testing, a re-sampling will occur. If the sampling window has passed, or re-sampling is not possible, the ETV CCEP Laboratory Manager will flag the data as suspect and notify the Technical Project Manager. The ETV CCEP Laboratory Manager will sign and date the final data package.

7.4 Data Reporting and Archival

7.4.1 Calculation of DFT and variation

The DFT gauge has a stated accuracy of 0.1 mil. Since the DFT measurements and DFT variation calculations are intended for use as quality assurance measures only in this phase of testing, no analysis other than reporting the expected accuracy is required. DFT measurements will be made at several locations on each part. The location of each measurement is indicated in Appendix B.

7.4.2 Interpretation of the numerical results

The overall accuracy of the test data will allow calculation of TE to within a few percent. The largest uncertainty lies in the mass-used values, which contain a random error of about 2%, due to the solids calculation. The mass-deposited values are estimated to be within 1% and an overall accuracy of 3% leaves a reasonable margin. Under these conditions, a consistent increase of transfer efficiency of 2% or more is a mathematically valid improvement, and an increase of 5% should be clearly identifiable.

7.4.3 Evaluation of the Laser Touch™ Beta Model

The numerical calculations suggest that a 2% increase in overall transfer efficiency is a greater increase than could be accounted for by statistical variations alone. Thus a 2% increase could be deemed an 'improvement' and the Laser Touch™ Beta Model's performance classified as 'statistically significant.' An increase of 5% or more would qualify as a "significant improvement".

A report signed and dated by the ETV CCEP Laboratory Manager will be submitted to the ETV CCEP Technical Project Manager, the ETV CCEP QA Officer, the EPA QA Officer, and other technical principals involved in the project. The ETV CCEP Technical Project Manager will decide on the validity of the data and will make any interpretations with respect to project QA objectives. The final laboratory report will contain the lab sample ID, date reported, date analyzed, the analyst, the procedures used for each parameter, the process or sampling point identification, the final result and the units. The *CTC* Environmental Laboratory will retain the data packages at least 10 years. The ETV CCEP Technical Project Manager or the NDCEE Program Director will forward the results and conclusions to EPA in their regular reports for final EPA approval of the test data. This information will be used to prepare the Verification Report, which will be published by the *CTC*. Once the Verification Report is developed, it will be reviewed by ETV CCEP Staff, *CTC*, IWRC, and EPA Technical Peer Reviewers, Laser Touch and Tecnologies, LLC, and the EPA Technical Editor. The revised document will then be approved by the EPA and *CTC* prior to being published.

7.5 Verification Statement

CTC will also prepare a Verification Statement from the information contained in the Verification Report. After receiving the results and conclusions from the ETV CCEP Technical Project Manager or the NDCEE Program Director, the EPA will approve the Verification Report and Verification Statement. Only after agreement by the equipment provider, will the Verification Statement be disseminated.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 Types of QA Checks

IWRC shall follow published methodologies, wherever possible, for testing protocols. Laboratory methods shall be adapted from Federal Specifications, Military Specifications, ASTM Test Methods, and supplier instructions. The IWRC shall adhere to the QA/QC requirements specified in these documents. IWRC shall perform the testing and QA/QC verification outlined in Tables 10 and 11 (Precision, Accuracy, Completeness) and Tables 13; therefore, these tables should be referred to for the method-specific QA/QC that will be performed.

8.2 Basic QA Checks

Worksheets will be used to record the various data required by this project. Each worksheet will contain the name of the process with which it is associated, as well as blanks for the date, the name of the staff member immediately responsible for carrying out the measurements, and the associated data. Worksheets for each of the following categories will be defined.

- Painter background and experience
- Daily ambient conditions
- Paint batch information
- Hourly variables
- Part information

At the end of each experiment, or at the end of the work day, all worksheets for that date will be collected, double-checked for completeness, and filed into a dated folder. This data will be entered into a computer for analysis.

In addition, data sheets will be developed for cure oven setup and default gun setup. The data sheets will contain the information required to set up these devices consistently each day. Example worksheets and data sheets are located in Appendix F.

Thermometers and thermocouples are checked against NIST-certified thermometers at two temperatures or are certified themselves. Balances are calibrated by an outside organization using standards traceable to NIST. IWRC performs in-house, periodic verifications with certified weights. IWRC keeps records of the verification activities and calibration certificates. The balances are checked prior to use with certified weights.

8.3 Specific Checks

Uncoated parts will be analyzed for dry film thickness to verify that the instrument has not drifted from zero, duplicate analyses on the same samples will be performed, and calibration checks of the laboratory equipment will be performed. IWRC laboratory personnel will also check any referenced materials and equipment as available and specified by the referenced methodology and/or the project-specific QA/QC objectives. IWRC laboratory records will be maintained with the sample data packages and/or in centralized files, as appropriate. To insure comparability, the IWRC laboratory will carefully control process conditions and perform product evaluation tests consistently for each specimen. The specific QA checks listed in Tables 10, 11, 13, and 14 provide the necessary data to determine if process control and product testing objectives are being met. ASTM, Federal, and Military methods that are accepted in industry for product evaluations, and supplier-endorsed methods for process control, are used for all critical measurements, thus satisfying the QA objective. A listing of the ASTM methods that will be used for this TQAPP is included in Appendix H.

The ETV CCEP QA Officer, who is independent of the ETV CCEP project management, will perform QA audits of the testing and laboratory analyses to supplement IWRC's QC checks. These audits will check that processes are completed as per the approved written documentation, both internal and external. The QA audits will also check that the laboratory data is handled properly.

The calibration checks generally consist of calibrating the equipment (if applicable), checking the calibration against a secondary standard, analyzing samples, rechecking the calibration, analyzing more samples, etc. The calibration is also checked against the secondary standard at the completion of an analysis series. If, at any time, the equipment falls out of calibration, all samples analyzed since the last good calibration check will be re-analyzed after the equipment is re-calibrated.

Runs in the paint may trap solvent in the thicker regions of the applied coating and distort the transfer efficiency values. Parts with visible runs or sags will not be used for experimental data analyses. Removal of these parts from the sample population will be recorded along with the exact reason for removal.

9.0 PERFORMANCE AND SYSTEM AUDITS

IWRC has developed a system of internal audits to monitor both program and project performance. These include monthly staff meetings and reports, university reporting, financial statements, and EPA reviews and advisory meetings.

ISO Internal Audits

While IWRC has not specifically implemented ISO 9000 or ISO 14000, the organization has identified the environmental aspects of its activities, products, and services (an integral part of an environmental management system (EMS)). Also, pollution prevention and continuous improvement are key components of IWRC's commitment to small business and the environment.

On-Site Visits

The EPA Project Officer may visit IWRC for an on-site visit during the execution of this project. All project, process, quality assurance, and laboratory testing information will be available for review.

Performance Audits

ETV CCEP staff will internally audit the testing performed at IWRC. The EPA may audit IWRC during this project. All project, process, quality assurance, and laboratory testing information will be made available per the ETV CCEP's and/or EPA's auditing procedures.

Technical Systems Audits

A listing of all coating equipment, laboratory measuring and testing devices, and procedures, coating procedures, a copy of the approved ETV QMP, and the approved ETV CCEP QMP will be given to the ETV CCEP QA Officer for this project. The QA Officer will conduct an initial audit, and additional audits thereafter according to the ETV CCEP QMP, of demonstration and testing activities. The results of this activity will be forwarded to EPA in reports from the Program Manager or the Technical Project Manager.

Audits of Data Quality

IWRC laboratory peer review constitutes a process whereby two IWRC analysts review raw data generated during testing. After data are reduced, they undergo review by ETV CCEP laboratory management. For this TQAPP, the ETV CCEP laboratory management will spot-check 10 percent of the project data by performing a total review from raw to final results. This activity will occur in addition to the routine ETV CCEP review of all data. Records will be kept to show which data have been reviewed in this manner.

10.0 CALCULATION OF DATA QUALITY INDICATORS

10.1 Precision

Duplicates will be performed on separate, as well as on the same sample source, depending on the method being employed. In addition, the final result for a given test may be the arithmetic mean of several determinations on the part or matrix. In this case, duplicate precision calculations will be performed on the means. The following calculations will be used to assess the precision between duplicate measurements.

Relative Percent Difference (RPD) = [(C1 - C2) x 100%] / [(C1 + C2) / 2]

where: C1 = larger of the two observations
C2 = smaller of the two observations

Relative Standard Deviation (RSD) = (s/y) x 100%

where: s = standard deviation
y = mean of replicates.

10.2 Accuracy

Accuracy will be determined as percent recovery of a check standard, check sample or matrix spike.

For matrix spikes and synthetic check samples:

Percent Recovery (%R) = 100% x [(S - U)/T]

where: S = observed concentration in spiked sample
U = observed concentration in un-spiked sample
T = true value of spike added to sample.

For standard reference materials (srm) used as calibration checks:

% R = 100% x (C_m / C_{srm})

where: C_m = observed concentration of reference material
C_{srm} = theoretical value of srm.

10.3 Completeness

Percent Completeness (%C) = 100% x (V/T)

where: V = number of determinations judged valid
T = total number of determinations for a given method type.

10.4 Project Specific Indicators

Process control limit: range specified by supplier for a given process parameter.

11.0 CORRECTIVE ACTION

11.1 Routine Corrective Action

Routine corrective action will be undertaken in the event that a parameter in Tables 10, 11, or 13, is outside the prescribed limits specified in these tables, or when a process parameter is beyond specified control limits. Examples of non-conformances include invalid calibration data, inadvertent failure to perform method-specific QA tests, process control data outside specified control limits, failed precision and/or accuracy indicators, and so on. Such non-conformances will be documented by IWRC staff on a standard laboratory form. Corrective action will involve taking all necessary steps to restore a measuring system to proper working order and summarizing the corrective action and results of subsequent system verifications on a standard form. Some non-conformances will be detected while analysis or sample processing is in progress, and can be rectified in real time at the bench level. Others may be detected only after a processing trial and/or sample analyses are completed. Typically, these types of non-conformances will be detected at the ETV CCEP laboratory management level of data review. In all cases of non-conformance, the ETV CCEP laboratory management will consider repeating the sample analysis as one method of corrective action. If insufficient sample is available, or the holding time has been exceeded, complete re-processing may be ordered to generate new samples if a determination is made by the Technical Project Manager that the non-conformance jeopardizes the integrity of the conclusions to be drawn from the data. In all cases, a non-conformance will be rectified before sample processing and analysis continues. If corrective action does not restore the production or analytical system causing a deviation from the ETV CCEP QMP, the IWRC will contact the ETV CCEP Technical Project Manager, who will then contact the EPA Project Officer. In cases of routine non-conformance, EPA will be notified in the NDCEE Program Director’s or the ETV CCEP Technical Project Manager’s regular report to the EPA Project Officer. A complete discussion will accompany each non-conformance.

11.2 Non-Routine Corrective Action

While not anticipated, activities such as internal audits by the IWRC QA Leader, and on-site visits by the ETV CCEP QA Officer and/or the EPA Project Officer, may result in findings that contradict deliverables in the ETV CCEP QMP. In the event that non-conformances are detected by bodies outside the IWRC laboratory organizational unit, as for routine non-conformances, these problems will be rectified and documented prior to processing or analyzing further samples or specimens.

12.0 QUALITY CONTROL REPORTS TO MANAGEMENT

As shown in Table 7 (Summary of ETV CCEP and IWRC Experience and Responsibilities), the ETV CCEP QA Officer is independent of the ETV CCEP project management team. It is the responsibility of the ETV CCEP QA Officer to monitor ETV CCEP verification tests for adherence to project specific QMPs and TQAPPs. The IWRC Facility Manager monitors the operation of the IWRC laboratory on a daily basis and will provide comments to the ETV CCEP QA Officer to facilitate his activities. The ETV CCEP QA Officer will audit the operation records, laboratory records, and laboratory data reports and provide a written report of his findings to the ETV CCEP Technical Project Manager and to the ETV CCEP laboratory management. The ETV CCEP Technical Project Manager will insure that these reports are included in his report to EPA. The ETV CCEP laboratory management will be responsible for achieving closure on items addressed in the report. Specific items to be addressed and discussed in the QA report include the following:

- General assessment of data quality in terms of general QA objectives in Section 4.1
- Specific assessment of data quality in terms of quantitative and qualitative indicators listed in Section 4.2 and 4.3
- Listing and summary of all non-conformances and/or deviations from the ETV CCEP TQAPP
- Impact of non-conformances on data quality
- Listing and summary of corrective actions
- Results of internal/external QA audits
- Closure of open items from last report or communications with EPA in current reporting period
- Deviations or changes in the ETV CCEP QMP
- Limitations on conclusions, use of the data
- Planned QA activities, open items for next reporting period.

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APPENDIX A

Test Location

APPENDIX B

Standard Test Parts

APPENDIX C

Apparatus Set-up

APPENDIX D

Coating Product Data Sheets

APPENDIX E

Spray Gun Product Data Sheets

APPENDIX F

Data Collection Sheets

APPENDIX G

Laser Touch™ Classroom Content

APPENDIX H

ASTM Methods

ASTM Methods

ASTM D 523 -- Standard Test Method for Specular Gloss

ASTM B 557 -- Standard Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

ASTM B 767 -- Standard Guide for Determining Mass Per Unit Area of Electrodeposited and Related Coatings by Gravimetric and Other Chemical Analysis Procedures

ASTM D 1200 -- Standard Test Method for Viscosity by Ford Viscosity Cup

ASTM E 1251 -- Standard Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plate, Unipolar Self-Initiating Capacitor Discharge

ASTM D 1400 -- Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base.

ASTM D 1475 -- Standard Test Method for Density of Liquid Coatings, Inks, and Related Products.

ASTM D 2369 -- Standard Test Method for Volatile Content of Coatings

ASTM D 5286 -- Standard Test Method for Determination of Transfer Efficiency Under General Production Conditions for Spray Application of Paint.