APPROVAL FORM

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Title: **ENVIRONMENTAL TECHNOLOGY VERIFICATION COATINGS AND COATING EQUIPMENT PROGRAM (ETV CCEP) ITW DEVILBISS FLG-631-318 HVLP SPRAY GUN - TESTING AND QUALITY ASSURANCE PROJECT PLAN (TQAPP)**

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

ITW DeVilbiss FLG-631-318 HVLP Spray Gun - Testing and Quality Assurance Project Plan (TQAPP)

Revision No. 0

December 15, 1998

Contract No. DAAA21-93-C-0046
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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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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Purpose of the ITW DeVilbiss FLG-631-318 HVLP Spray Gun - Testing and Quality Assurance Project Plan

The primary purpose of this document is to establish the Testing and Quality Assurance Project Plan (TQAPP) for the ITW DeVilbiss FLG-631-318 high volume-low pressure (HVLP) gravity feed spray gun. The objective of this TQAPP is to verify the performance of the FLG-631-318 HVLP spray gun when applying PPG Deltron 2000 DBC-4185 automotive basecoat. The format and guidelines for this TQAPP were established by the Environmental Technology Verification Coatings and Coating Equipment Program (ETV CCEP) HVLP Coating Equipment - Generic Testing and Quality Assurance Protocol, to which reference will be made frequently throughout this document as the Generic HVLP Equipment Protocol.

This ETV CCEP TQAPP will establish specific data quality requirements for all technical parties involved in the verification of HVLP coating equipment. All ETV CCEP TQAPPs will follow the format described below to facilitate independent reviews of project plans 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 will 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 HVLP Coating Equipment TQAPPs will be 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 FLG-631-318 HVLP Spray Gun 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 to be 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 *CTC* deliverables (see Section 1.4 of the Generic HVLP Equipment Protocol).

1.5 Approval Form

Key ETV CCEP personnel will indicate their agreement and common understanding of the project objectives and requirements by signing the TQAPP Approval Form for each piece of equipment tested. Acknowledgment by each key person indicates commitment toward implementation of the plan (see Figure 1 of the Generic HVLP Equipment Protocol for the template of the Approval Form).

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 ITW DeVilbiss FLG-631-318 HVLP gravity feed spray gun. This HVLP spray gun is designed for use in automotive refinishing. This test will examine the FLG-631-318's effectiveness at applying PPG Deltron 2000 DBC-4185 automotive basecoat. The test data from this verification test will be compiled and a Verification Report will be developed as an U.S. EPA document. In addition, a Verification Statement will be developed from the data contained in the Verification Report. ITW DeVilbiss may use the Verification Statement as a marketing tool for the FLG-631-318 HVLP spray gun.

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

The testing of the ITW DeVilbiss FLG-631-318 HVLP spray gun will be conducted on the Organic Finishing Line, in the Demonstration Factory operated by *CTC*. A drawing of the Apparatus Set-Up is shown in Appendix A, and a drawing of the Equipment Testing Location is shown in Appendix B. Also, Section 2.1.2 of the Generic HVLP Equipment Protocol provides a description of the Laboratory Facilities, which will provide testing and analysis support for this project.

2.1.1 Demonstration Factory Testing Site

CTC has been tasked under the National Defense Center for Environmental Excellence (NDCEE) Program to establish a demonstration factory capable of prototyping processes that will reduce or eliminate materials used or produced in manufacturing that are harmful to the environment. In order to speed the transition of environmentally friendly processes to the manufacturing base, *CTC* offers the ability to test processes and products on full-scale, commercial equipment. The coating equipment in the demonstration factory will be available for the testing in this project. Specifically, these include surface pretreatment, wet spray booths, and cure ovens. A layout of the *CTC* Demonstration Factory is shown below in Figure 1.

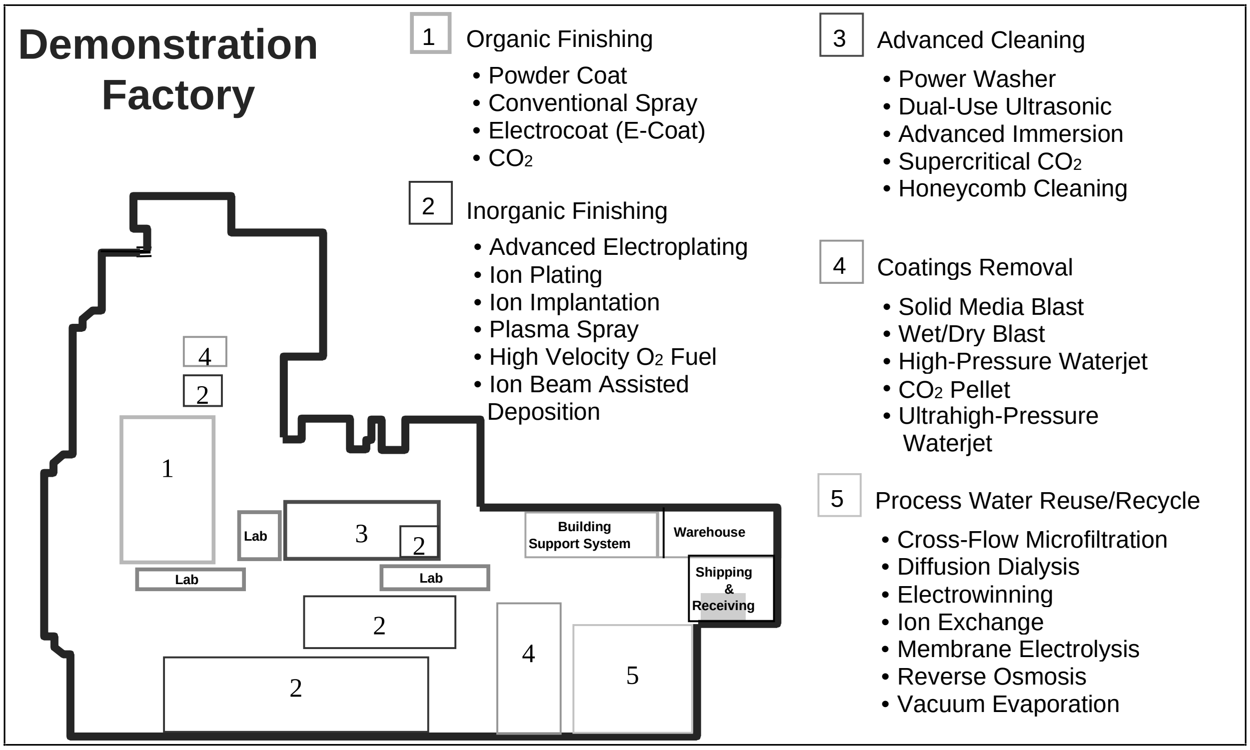


Figure 1. *CTC* Demonstration Factory Layout

2.1.2 Laboratory Facilities

Laboratory facilities available at *CTC* are described in Section 2.1.2 of the Generic HVLP Equipment Protocol.

2.1.3 Statement of Project Objectives

The overall objective of the ETV CCEP is to verify pollution prevention characteristics and/or performance of coatings and coating equipment technologies, and to make the results of the verification tests available to prospective technology users. The ETV CCEP promotes the use of more environmentally friendly technologies in products finishing in an effort to reduce emissions. The objective of this TQAPP is to establish the performance of the ITW DeVilbiss FLG-631-318 HVLP spray gun, which is designed for use in automotive refinishing. Where possible, analysis methods used for these tests will follow those developed by the American Society for Testing and Materials (ASTM).

The potential pollution prevention benefits of HVLP have encouraged regulators to require that end users only utilize equipment that is capable of meeting or exceeding the transfer efficiency of HVLP spray guns. HVLP was defined by the California South Coast Air Quality Management District Rule 1151 on June 13, 1997 as:

> *Equipment used to apply coatings by means of a spray gun which is designed to be operated and which is operated between 0.1 and 10 pounds per square inch gauge (psig) air pressure measured dynamically at the center of the air cap and at the air horns.*

This definition does not take into account input pressure or finish quality. If HVLP spray guns are to be used as they were intended, it is advantageous to verify that the equipment can provide the end-user with an acceptable finish while operating the equipment as designed. Therefore, this project will verify that ITW DeVilbiss FLG-631-318 HVLP spray gun provides the user with an acceptable quality finish, while operating under the current definition of HVLP.

From information gained during the testing of HVLP spray guns, the end-users may better determine if a particular HVLP spray gun would provide them with a pollution prevention benefit while meeting the finish quality requirements of their application. The end-users must 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 nearly impossible, and a test plan designed from a selection of these factors will provide data that is only representative of the exact conditions tested. However, in an effort to qualify the existence of an environmental benefit, this project will conduct a test that will enable a qualitative transfer efficiency comparison of HVLP guns with respect to a conventional air spray (CAS) gun baseline. The CAS baseline for the ITW DeVilbiss FLG-631-318 HVLP spray gun will be performed as per the PPG DBC-4185 Conventional Air Spray Gun Baseline - Testing and Quality Assurance Project Plan (TQAPP).

2.2 Technical/Experimental Approach and Guidelines

The following tasks are planned for this project (see estimated schedule in Section 2.3, Table 5):

- Approval of TQAPP by *CTC*, EPA and ITW DeVilbiss
- Conduct the performance testing of the HVLP spray gun
- Prepare and provide draft Verification Report to EPA
- Prepare and provide final Verification Report to EPA
- Prepare Verification Statement for approval and distribution

Table 1 describes the general guidelines and procedures that will be applied to this TQAPP.

Table 1. Overall Guidelines and Procedures Applied to this TQAPP

• A detailed description of each part of the test will be given. This will include a detailed Design of Experiments.
• 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 (coating product quality) factors (see Section 2.2.10 below).
• The TQAPP will identify the testing site.
• All testing will be under the control and close supervision of *CTC* representatives to ensure the integrity of the third party testing.
• The QA portions of the Generic HVLP Equipment Protocol will be strictly followed.
• A statistically significant number of samples will be analyzed for each critical response factor (see Table 4). 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:

- ITW DeVilbiss will provide the operating parameters for the optimum performance of the FLG-631-318 HVLP spray gun
- ITW DeVilbiss will provide the PPG Deltron 2000 DBC-4185 automotive base coat for the HVLP test and the CAS baseline tests
- The ETV CCEP will determine the CAS operating parameters from coating and gun manufacture information
- Standard test panels will be obtained which will enable thorough testing of coating equipment performance
- A statistically valid test program that efficiently accomplishes the required objectives will be utilized

2.2.2 Standard Test Panel

The standard test panel to be used for all tests is shown in Appendix C (Standard Test Panel). It is a flat cold rolled steel panel from ACT Laboratories, Inc. The cold rolled steel meets SAE 1008 specifications. The test panel is 12 inches long, 4 inches wide and made of 22 gauge steel. The panel is received unpolished and untreated. It has a 1/4 inch hole punched in one end so that it can be suspended from a hook. The standard test panels will be transported through the system on racks suspended from the overhead conveyor. A rack will hold up to eight test panels in a single row, as shown in Appendix A (Apparatus Set-up). The test panels will be fixtured on the rack to minimize movement during spraying. The fixturing consists of a flat bar that connects the hooks that will minimize side to side rotation of the panels and a second bar that prevents the bottom of the panels from moving away from the gun.

As a preparation for coating, the test panels will receive a zinc phosphate pretreatment. The pretreatment portion of the Organic Finishing Line in the *CTC* Demonstration Factory is a staged operation. The standard test panels will receive an alkaline clean followed by a deionized (DI) water rinse. Then the zinc phosphate is applied followed by another DI water rinse. A non-chromate sealer is then applied followed by another DI water rinse. The pretreatment concludes with a dry-off stage. Prior to being coated, one random test panel per run will be removed for pretreatment analysis.

The standard test panels will be used for analyzing dry film thickness (DFT), distinctness-of-image (DOI), gloss, visual appearance, and transfer efficiency (TE).

2.2.3 Coating Specification

The test coating chosen by ITW DeVilbiss must meet the following basic criteria:

- The substrate to be coated is SAE 1008 cold rolled steel
- The test panels are pre-treated with zinc phosphate
- The test coating must be sprayable by both HVLP and CAS
- The test coating must not contain lead or chromate
- The VOC content of the test coating must meet 5.0 pounds of VOC per gallon of coating as part of a base coat-top coat system, the limit established by the U.S. EPA's National Volatile Organic Compound Emission Standards for Consumer and Commercial Products, 40 CFR 59, Subpart B, Automobile Refinish Coatings, published September 11, 1998.

ITW DeVilbiss chose PPG Deltron 2000 DBC-4185 automotive base coat as the test coating for the FLG-631-318 HVLP spray gun. The test coating data sheet is shown in Appendix D (Coatings and Coating Equipment Product Data Sheets). This coating has a VOC content, as applied, of less than 6.6 pounds per gallon. This coating would be compliant when combined with a topcoat with a VOC content less than 4.2 pounds per gallon, such as PPG DCU 2082 clear coat. The test coating was chosen because it is a common coating used in automotive refinishing.

ITW DeVilbiss supplied the ETV CCEP with six (6) gallons of the test coating to complete the HVLP verification test and the CAS baseline tests. The ETV CCEP will prepare the test coating prior to each run, based on the coating manufacturer's specifications. The exact coating preparation procedures will be recorded. For comparison, the test coating will be prepared using the same procedures for the HVLP test and all CAS tests. ITW DeVilbiss recommends that the amount of coating in the gravity cup should not exceed .6 L, and that a minimum level of .366 L must be maintained in the cup at all times to ensure consistent fluid delivery flow rates. Therefore, due to the long pot life of the coating, a single batch will be mixed for the entire test. The gun, gravity cup, and batch container will be weighed as a system. The batch container will be kept closed unless refilling the gravity cup. The system will be weighed before and after each run to determine the amount of coating used during the run. The batch will be mixed in the laboratory at 1:1 proportions of the PPG DBC 4185 base coat and the PPG DT885 reducer. For this particular test, a total of

3.5 L of coating will be mixed (1.75 L of DBC 4185 to 1.75 L of DT885). All three coats will be applied to each rack before moving onto the next rack. Before each rack is coated, the gravity cup will be refilled to approximately .550 L. The gravity cup will be refilled on the factory floor during each run. Between runs, final weight measurements will be made, coating samples will be taken, the gravity cup will be refilled, and initial weight measurements will be made before reconnecting the cup and gun to the apparatus. The coating will be applied to a dry film thickness of 0.5-1.5 mils using 3 coats and 5 passes per coat. The flash time between coats will be 3 minutes. After the final coat, the panels will be allowed to air dry for at least 2 hours. For the purposes of this test, finish quality should not be sacrificed to obtain the "best" TE value. The fan pattern obtained at the target for this HVLP spray gun will be the same for each of the CAS guns during the baseline tests. The distance to target will be adjusted for each gun to obtain the same fan pattern.

2.2.4 Standard Apparatus

This TQAPP includes a standard apparatus set-up for the verification test. Appendix A shows the position of the test panels with respect to the spray booth as part of the standard apparatus set-up, and Appendix B shows the testing location of the wet spray booths relative to the Organic Finishing Line. All testing will be performed in the same wet spray booth in the *CTC* Demonstration Factory.

The standard test panels will be suspended from racks, containing a single row of up to eight (8) panels per rack. The test panels will be transported to the spray booth by an overhead conveyor. A mechanical stop mechanism will align the racks of test panels in the proper position relative to the spraying mechanism. Once the racks are in position, the spraying mechanisms programmable logic controller (PLC) will activate the motors that drive the linear motion translators. The translators will move both horizontally and vertically. This set-up will be able to cover an area approximately 4.5 feet by 4.5 feet. The panels will be automatically sprayed using vertical overlap of the spray pattern. The spraying mechanism's PLC will also control the triggering of the HVLP spray gun by way of a pneumatically actuated clamp. During dwell time between passes, paint flow will be interrupted to minimize paint usage. Once the spray application is complete, the mechanism's PLC will release the mechanical stop holding the rack so that the overhead conveyor can move the next rack into position.

The spray booth air filters will be changed prior to setting up the standard apparatus for each gun. The pressure drop across the filters will be checked prior to each run and at the end of the test. The pressure drop is monitored in the event that the filter bank system malfunctions. A pressure drop across the filter bank greater than 0.4 inches of water shall indicate that the system requires service. As a comparison, the spray booth air filter will also be changed before each CAS gun is setup and tested as part of the TE baseline. This will minimize the difference in the initial air booth velocity between the guns. The air booth velocity will be measured in close proximity to the panels. Although the air velocity through the booth exceeds 2.54 m/s (100 ft/min), the velocity measured near the panels will be lower due to the disruption of the air currents by the rack of panels.

2.2.5 Process Standards

Standard test panels will be used for the verification test and the CAS baseline tests. The preparation of the test coating will be the same for the HVLP test and all CAS baseline tests. The cure time and temperature for the test coating is listed in Table 3. The factory (ambient) conditions will be checked once during each run both inside the spray booth near the rack of panels and outside the spray booth in the flash off area. Operating parameters will be held relatively constant throughout each test. The pretreatment will be the same for all standard test panels.

2.2.6 Design of Experiment

This TQAPP will determine the performance characteristics of the ITW DeVilbiss FLG-631-318 HVLP spray gun. A mean value and variance (or standard deviation) will be reported for each critical response factor. A confidence and specification limit of 95% will be applied to these tests.

One random test panel will be removed for pretreatment analysis from each run. During the pretreatment of the test panels, an additional rack of eight panels will be pretreated with each run of twenty-four panels. These additional panels will be used as set-up panels for the test and to fill in the blank space left on the racks due to the pretreatment analysis. Therefore, a run will coat twenty-three (23) standard test panels used for determining TE and finish quality and one (1) pretreated panel that will only be used in the calculation of TE. Before the test, set-up panels will be coated to ensure that the equipment parameters are correct. The HVLP and CAS baseline tests will each consist of five (5) runs of three (3) racks of eight (8) standard test panels. This will enable both total and run-to-run variations to be determined for each response factor. The statistical analyses for all response factors will be performed using a statistical software package.

The FLG-631-318 HVLP spray gun will be operated using the standard apparatus set-up, as shown in Appendix A, and the optimum equipment parameters that were determined by ITW DeVilbiss. Coatings and coating equipment manufacturers commonly use flat steel panels to evaluate performance characteristics. Therefore, for the sake of reproducing these evaluations, flat steel panels will be used in this TQAPP. Coated standard test panels will be analyzed for DFT, DOI, gloss, TE, and visual appearance. For the TE analysis, the weight of all panels will be measured before being coated and again after being cured. The standard test panels will be suspended from hooks and automatically coated using an overlap of the spray pattern. The racks will contain fixturing to minimize the movement of the test panels. The fixturing will consist of a flat bar placed on the hooks, immediately behind the test panels, which will minimize the side-to-side rocking motion. Also, a second bar will be attached to the rack near the bottom of the panels, which will prevent the bottom of the test panels from moving away from the gun.

The FLG-631-318 HVLP spray gun will be mounted on the translator by clamping it to an arm that extends from the vertical translator's carrier plate. A pneumatically controlled cylinder will be attached to the handle of the spray gun that will automatically trigger the gun at predetermined points within the application pattern. The gun will use a fluid tip of 1.6 mm and a #3 air cap. The fan adjustment will be set at full open, and the dynamic output pressure at the air cap will be set to 5.0 psig. The input air pressure will be set during the set-up phase to obtain the desired output pressure. The input pressure will then be maintained throughout the test. The horizontal traverse speed of the gun will be set at 20 in./s (50.8 cm/s). The gun to target distance will be set at 6 in. (15.2 cm) and the vertical drop between passes will be set at 3.0 in. (7.6 cm).

2.2.7 Performance Testing

The ETV CCEP will consult the manufacturers' recommendations for key non-critical factors to be used for testing, including the coating specifications for gloss, VOC content, etc. Recommended equipment settings for the coating, such as input air pressure, paint flow rate, gun traverse speed, paint flash/dwell time, etc., will be obtained. The ETV CCEP will test these conditions prior to starting the verification test. These conditions may be modified to ensure proper gun performance. During the test, no attempt will be made to optimize the equipment.

Standard test panels will be used to measure equipment performance. The test panels will be used for DFT, DOI, gloss, TE and visual appearance analyses. The coating characteristics may be affected by other parameters of the testing process, such as pretreatment, apparatus set-up, and clean-up methods. Non-critical control factors will be monitored or held relatively constant for the verification test. 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. DOI will also be used to analyze the quality of the coating finish. TE measurements will be used to determine the qualitative comparison between the CAS baseline and the ITW DeVilbiss FLG-631-318 HVLP spray gun. The TE test will follow Procedure A of ASTM D 5286, with the following exception, the weight measurements will not be performed at the paint booth. Instead, the minimum necessary equipment, the gun and paint cup, will be disconnected from the set-up and transported to a calibrated laboratory balance. Although, every effort will be made to minimize the error caused by this process, a small amount of coating may be lost from the gun's air cap each time the system is disconnected from the apparatus. The visual appearance analysis will identify any abnormalities in the applied coating. The visual appearance analysis will use normal lighting to examine the surface of the painted panel. The panels 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, fibers, etc.). A comparison will be made from panel to panel, rack to rack, and run to run.

2.2.8 Quantitative Measurements

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, DOI and visual appearance.

By measuring DFT at several specified locations on the standard test panel, the uniformity of the applied coating can be determined. Measurements will be performed at nine locations on the coated surface of five random standard test panels per run. Appendix C displays the test panel with the measurement locations and numbered test sites. This gives a total of 45 DFT sites per run. These sites will be numbered and measurements will be taken accordingly. The measurements will be recorded and can be correlated to a specific site on each standard test panel for each test. The thickness measurement data will be used to evaluate not only the mean thickness across the test panel, but also the variation of the thickness and differences in the edge and central portions of the test panel.

The ETV CCEP will evaluate whether there is a potential environmental benefit for switching from CAS to HVLP spray guns. Therefore, TE values will be quantitatively measured for the FLG-631-318 HVLP spray gun. The TE values will be qualitatively compared against the CAS baseline TE values. The CAS baseline will use nearly identical test conditions as the HVLP test. These conditions include the same target dry film thickness, the same coating prepared to the same viscosity, similar ambient conditions, the same number of test runs, the same application pattern and the same curing procedures. The differences between the test will be the gun itself, the atomizing air pressure, the paint flow rate, and the gun traverse speed. The CAS baseline will consist of two pressure feed guns and a gravity feed gun. The CAS baseline tests will use identical procedures for preparing the test coating. The CAS baseline tests will also meet the same coating finish requirements established for the HVLP test, except DOI. A qualitative comparison will then be made to determine if HVLP spray guns have a potentially higher TE than CAS guns.

2.2.9 Participation

The Demonstration Factory at *CTC* provides a unique capability for demonstrating and evaluating full-scale manufacturing process applications. Full-scale processing and testing can be carried out on any of the process technologies within the Demonstration Factory without concern for the many problems associated with trying to do these same tests on manufacturing lines. Because of this existing capability, these tests will be performed at the Demonstration Factory. The ETV CCEP personnel will be responsible for performing all necessary tests and demonstrations required for performance evaluation and full-scale validation.

2.2.10 Critical and Non-Critical Factors

For the purposes of this TQAPP, the following definitions will be used for critical control factors, non-critical control factors, and critical response factors. A critical control factor is a factor that is varied in a controlled manner within the design of experiments matrix 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 the 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 control factor (spray gun).

For this project, the critical control factors, non-critical control factors, and critical response factors are identified in 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 metal surface pretreatment will remain constant and thus be non-critical control factors, while a parameter such as gloss is identified as a critical response factor.

For this TQAPP, the only critical control factor is the ITW DeVilbiss FLG-631-318 HVLP spray gun (see Table 2). The recommended optimum air input pressure, gun traverse speed, etc. for the FLG-631-318 HVLP spray gun is shown in Table 3. The critical response factors to be measured are shown in Table 4. The time will be recorded with each measurement of the critical response and non-critical control factors.

The measurements for coating temperature and viscosity, and the samples used for coating density, VOC content and percent solids, will be taken immediately before the coating is transferred to the gravity cup. The *CTC* work instructions for these measurements are found in Appendix F

The DFT measurements will follow ASTM B 499 (Magnetic). Thickness measurements will be taken on the standard test panel as shown in Appendix C. Measurements using the magnetic method will be done on each coated standard test panel. From this data, an overall DFT and a DFT variation across the standard test panel will be reported. The purpose of this comparison is to verify that a uniform DFT has been applied to the standard test panels.

The HVLP cap air pressure will be measured with a pressure gauge supplied by ITW DeVilbiss. ITW DeVilbiss must show proof that the gauge has been certified and calibrated. In addition, the ETV CCEP personnel will verify the calibration of the pressure gauge in the *CTC* calibration laboratory.

The DOI analysis will closely follow Method B of ASTM D 5767, except that the sliding combed shutter is replaced by a rotating, eight-bladed disc.

ACT Laboratories, Inc. will perform the DOI analyses for this test. ACT Laboratories, Inc. uses an ATI Systems, Inc Model 1864 SQC Portable Appearance Data Collector.

The TE test will follow ASTM D 5286 except that the gun and paint cup will be disconnected from the apparatus set-up and transported to the lab for the weight measurements. A TE value will be determined for each run and on a run-to-run basis.

The values in the Total Number column reflect the experimental design of coating twenty-four (24) standard test panels in each of five (5) runs.

Table 2. Critical Control Factors

Critical Control Factor	Fluid Tip	Fluid Valve	Air Cap	Fan Pattern
ITW DeVilbiss FLG-631-318 HVLP Spray Gun	1.6 mm (0.063 in.)	N/A	#3	15.2 cm (6 in.)

Table 3. Non-Critical Control Factors

Non-Critical Factor	Set Points/ Acceptance Criteria	Measurement Location	Frequency	Total Number for Each Test
Input Air Pressure	20-30 psig (output at 5 psig)	Factory floor	Continuous	N/A
Products involved in Testing	Standard Test Panels	N/A	24 Standard Test Panels per run	120 Standard Test Panels
Zinc Phosphate Pretreatment Weight	2.1 - 2.7 g/m^2	Random panel removed prior to the spray booth	1 Standard Test Panel per run	5
Surface Area of Each Panel Coated	297-323 cm^2 (46-50 in^2)	Top and right edge of panel	1 Standard Test Panel per test	1
Ambient Factory Relative Humidity	< 60% RH	Factory floor	Continuous	N/A
Ambient Factory Temperature	21.1 – 26.7°C	Factory floor	Continuous	N/A
Spray Booth Relative Humidity	< 60% RH	Inside the wet spray booth	Once each run	5
Spray Booth Temperature	21.1 – 26.7°C	Inside the wet spray booth	Once each run	5
Spray Booth Air Velocity	0.2-0.5 m/s (40-100 ft/min)	Factory floor	Once per test	1
Distance to Panels	15.0-15.5 cm (5.9-6.1 in.)	Factory floor	Once per test	1
Temperature of Panels, as Coated	21.1 – 26.7°C	Factory floor	Once per run	5
Horizontal Gun Traverse Speed	50.7-50.9 cm/s (20$\pm$3/8 in./s)	Factory floor	Once per test	1
Vertical Drop Between Passes	7.4-7.9 cm (2.9-3.1 in.)	Factory floor	Once per test	1
Dwell Time Between Passes	5 sec	Factory floor	Once per test	1
VOC Content of Applied Coating	719-791 g/l (6.0-6.6 lb./gal)	Sample from coating pot	1 sample each run	5
Density of Applied Coating	911-1031 g/l (7.6-8.6 lb./gal)	Sample from coating pot	1 sample each run	5
Wt.% Solids of Applied Coating	12-27%	Sample from coating pot	1 sample each run	5
Coating Temperature, as Applied	21.1 – 26.7°C	Sample from coating pot	1 sample each run	5
Coating Viscosity, as Applied	40-45 sec (#2 Ford Cup)	Sample from coating pot	Before and after run	10
Cure Time	2 hours	Factory floor	Once each run	5

Table 4. Critical Response Factors†

Critical Response Factor	Measurement Location	Frequency	Total Number for Each Test
Cap Air Pressure	Cap and air horns	Once per test	1
Overall Dry Film Thickness (Magnetic methods)	9 points in a lattice pattern on each coated face of the Standard Test panel	9 points on each of 5 Standard Test Panels per run, 5 runs	225
Dry Film Thickness Variation	Calculated from magnetic dry film thickness data	Variation on individual panels and variation from run to run	N/A
Distinctness of Image (DOI)	from ASTM D 5767 Test Method B*	3 points on each of 5 Standard Test Panels per run, 5 runs	75
Gloss	from ASTM D 523	3 points on each of 5 Standard Test Panels per run, 5 runs	75
Visual Appearance	Entire test panel and entire rack	1 per Standard Test Panel and 1 per run	125
Transfer Efficiency (TE)	from ASTM D 5286	Once per run	5

† See Sections 2.1.3 and 2.2 for the environmental basis on which these factors relate.
* Except that the sliding combed shutter is replaced by a rotating, eight-bladed disc.

Other factors used to test the FLG-631-318 HVLP spray gun include:

- Equipment Preparation — See attached Product Data Sheet
- Flash Time Between Coats — 3 minutes
- Spray Pattern — Ellipse, 15.2 cm high, 15.2 cm from gun
- Number of passes — 5 passes
- Target Dry Film Thickness — 0.5-1.5 mils in 3 coats

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 5 shows the estimated schedule for the testing of the ITW DeVilbiss FLG-631-318 HVLP spray gun.

Table 5. Estimated Schedule as of 12/14/98

ID	Name	Duration	Start Date	Finish Date
Task 1	Verification test	5d	TBD	TBD
Task 2	Prepare Verification Report	30d	TBD	TBD
Task 3	Approval of Verification Report	60d	TBD	TBD

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Project organization and responsibilities and a summary of ETV CCEP personnel experience is shown below in Table 6.

Table 6. Summary of ETV CCEP Experience and Responsibilities

Key *CTC* Personnel and Roles	Responsibilities	Applicable Experience	Education	Time Dedication for Phase
Dave Roberts NDCEE Program Manager	Directs NDCEE Program. Accountable to *CTC* Technical Services Director and *CTC* Corporate Management.		BS Mechanical Engineering	5%
Brian Schweitzer Technical Project Manager	Responsible for overall ETV CCEP technical aspects, budget, and schedule issues on daily basis. Accountable to NDCEE Program Manager.	Process Engineer (9 years) Project Manager, Organic Finishing (4 years)	BS Mechanical Engineering	50%
Jack Molchany QA Officer	Responsible for overall project QA. Accountable to NDCEE Program Manager	QA/QC and Industrial Operations (10 years) Quality Management and ISO 9000 (4 years) Environmental Compliance and ISO 14000 Management Systems (4 years)	BS Industrial Engineering	5%
Rob Fisher Staff Process Engineer/ Technical Project Leader	Technical project support. Process design & development. Accountable to Project Manager.	Organic Finishing Regulations (5 years)	BS Chemical Engineering	50%
Melissa Klingenberg Staff Process Engineer/ Technical Project Leader	Technical project support. Process design & development. Accountable to Project Manager.	Process Engineer, Inorganic Finishing (5 years) Organic Finishing (1 year)	BS Chemistry/ Biology M.S. MSEP	50%
Herb Ashley Finishing Engineer/ Factory Operations Lead	Oversees day-to-day operation of Organic Finishing Line. Provides technical project support. Accountable to Project Manager.	Organic Finishing Experience (26 years)		10%
Stephen Kendera Sr. Organic Finishing Technician	Performs day-to-day operations of the Organic Finishing Line. Accountable to Finishing Engineer	Industrial Paint and Coatings Experience (25 years)		10%
Fred Mulkey Manager, Laboratory Operations	Project TQAPPs. Coordinates testing lab and technical data review. Accountable to Project Manager, NDCEE Program Manager.	Laboratory Chemist and Manager Project Quality Assurance Project Management (10 years)	MS Chemistry, BS Chemistry	5%
Tammy Powers Associate Laboratory Leader	Laboratory analysis Accountable to Lab Manager	Environmental and Municipal Laboratory Testing (7 years)	BS Biology	10%
Lynn Summerson Laboratory Leader	Laboratory analysis Accountable to Lab Manager	Industrial and Environmental Laboratory Testing (17 years)	MS Chemistry	20%
Brian Albright Assistant Laboratory Analyst/ Pretreatment Operator	QC Analysis Accountable to Lab Manager	Environmental and QC Testing (3 years)	BS Chemistry	10%
ACT Laboratories, Inc Independent Coatings Analysis Laboratory	Distinctness-of-Image Analyses	American Association for Laboratory Accreditation for Automotive and Industrial Coatings Testing		<5%

In addition, the following individuals will have certain responsibilities during the testing phase:

Table 7. Responsibilities During Testing

Position	Responsibility
Project Manager	Overall coordination of personnel and budget
QA Officer	Internal audits of process operations and lab analyses
Lab Manager	Oversight and coordination of laboratory analyses
Task Leader	Overall coordination of testing activities and personnel roles
Finishing Technician	Process set-up and operation of tests
Lab Analyst	Process measurements and lab analyses

4.0 QUALITY ASSURANCE (QA) OBJECTIVES

4.1 General Objectives

The overall objective of this TQAPP is to establish the performance of the ITW DeVilbiss FLG-631-318 HVLP spray gun relative to the transfer efficiency improvement over a CAS baseline. This objective 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 HVLP spray gun's 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 E (ASTM Methods).

4.2 Quantitative Quality Assurance Objectives

Quality assurance parameters such as precision and accuracy are presented in Tables 8 and 9. Table 8 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 9 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.

The statistical support engineer, QA Officer, and laboratory personnel will coordinate efforts to determine the manner in which test results and QA objectives will be interpreted in a statistical sense.

Table 8. QA Objectives for Precision, Accuracy and Completeness for All Non-Critical Control Factor Performance Analyses

Measurement	Method	Units	Precision	Accuracy	Completeness
Input Air Pressure	Pressure gauge	psig	±0.2 psig	±5%	90%
Products involved in Testing	Standard Test Panels	# of panels	±0	±0%	100%
Zinc Phosphate Pretreatment Weight	ASTM B 767	g/m^2	±0.005	±0.01	90%
Surface Area of Each Panel Coated	Ruler	cm^2 (in^2)	±0.023 (±0.004)	±0.023 (±0.004)	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%
Spray Booth Relative Humidity	Thermal Hygrometer	RH	±3% of full scale	±3% of full scale	90%
Spray Booth Temperature	Thermal Hygrometer	°C	±3% of full scale	±3% of full scale	90%
Spray Booth Air Velocity	per ACGIH	m/s (ft/min)	±0.03 (±5)	±0.03 (±5)	90%
Distance to Panels	Ruler	cm (in.)	±0.15 (±0.06)	±0.15 (±0.06)	90%
Temperature of Panels, as Coated	IR Thermometer	°C	±0.5%	±1.0%	90%
Horizontal Gun Traverse Speed	Stopwatch	cm/s (in/sec)	±0.001%	±0.001%	90%
Vertical Drop Between Passes	Ruler	cm (in.)	±0.15 (±0.06)	±0.15 (±0.06)	90%
Dwell Time Between Passes	Stopwatch	seconds	±0.001%	±0.001%	90%
VOC Content of Applied Coating	ASTM D 3960	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%
% Solids of Applied Coating	ASTM D 2369	%	±1.5%	±4.7%	90%
Coating Temperature, as Applied	Thermometer	°C	±0.5	±0.2	90%
Coating Viscosity, as Applied	ASTM D 1200	seconds	±10%	±10%	90%
Cure Time	Stopwatch	minutes	±0.001%	±0.001%	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 9. QA Objectives for Precision, Accuracy and Completeness for All Critical Response Factor Performance Analyses

Measurement	Method	Units	Precision	Accuracy	Completeness
Test Cap Air Pressure	Equipment specifications	psig	(1)	(1)	90%
Dry Film Thickness (DFT) -- Magnetic	ASTM B 499	mils(2)	20%	10% true thickness	90%
DFT Variation	N/A	N/A	N/A	N/A	N/A
Distinctness of Image (DOI)(3)	ASTM D 5767 Method B	DOI Units	20%	± 3	90%
Gloss	ASTM D 523	gloss units	20%	$\pm 0.3s$	90%
Visual Appearance	N/A	N/A	N/A	N/A	N/A
Transfer Efficiency (TE)	ASTM D 5286 Test Method A	%	25%(4)	rsd $\leq$ 20%(4,5)	90%

(1) To be provided by HVLP vendor
(2) 1 mil = 0.001 inch
(3) Performed by ACT Laboratories, Inc.
(4) Unknown according to ASTM D 5286
(5) 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 8 and 9). Reference materials will be evaluated using the same methods as for the actual test specimens. Calculations for precision, accuracy, etc. are contained in the Generic HVLP Equipment Protocol.

4.2.2 Precision

The experimental approach of this TQAPP specifies the exact number of test panels to be coated. The analysis of replicate test panels 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 8 and 9 above. 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 operation of 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 the laboratory quality control data are within specification and a non-conforming result occurs, the non-conformance will be interpreted as the inability of the coating equipment to produce parts meeting the performance criteria under the given set of experimental conditions.

4.3 Qualitative QA Objectives: Comparability and Representativeness

4.3.1 Comparability

The FLG-631-318 HVLP spray gun will be operated at the optimum conditions recommended by the manufacturer. The data obtained will be comparable from the standpoint that the TE data from the CAS baseline can be compared to a reasonable significance. In addition, other programs could 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 panels used in these tests will be compared to the performance data and to other applicable end-user and industry specifications. The specifications will be used to verify the performance of the ITW DeVilbiss FLG-631-318 HVLP spray gun. 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 per run or otherwise statistically significant fractional populations. The runs will be conducted at optimum conditions based on the manufacturers' and the paint suppliers' literature and verified by set-up testing. If the test data meets the quantitative QA criteria (precision, accuracy, and completeness), then the samples will be considered representative of the HVLP spray gun 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 panel evaluation methods and predictability of factors affecting the quality of the laboratory testing of panels, the quality control of test panel qualifications is expected to fall within acceptable levels. Comparison of response factors will be checked for run to run process variations.

5.0 SITE SELECTION AND SAMPLING PROCEDURES

5.1 Site Selection

This project will be executed at *CTC*, in Johnstown, PA, and *CTC* personnel will perform all processing and testing. The site for application and evaluation will be at the *CTC* Demonstration Factory in the Environmental Technology Facility (ETF), under the direct control of the Engineering, Statistical Support, and Organic Finishing Line Groups. The *CTC* Testing Laboratory will perform analyses in the ETF Environmental Laboratory. Application of the coating involves transporting test panels via an automatic conveyor through the Organic Finishing Line. The test panels will be pretreated within the seven-stage pretreatment process in the Organic Finishing Line and then painted in the first of the two wet spray booths. Test panels will be evaluated after curing and cooling.

The experimental design involves applying a coating according to verified optimum conditions. The test panels will be sampled and analyzed to generate performance data.

5.2 Site Description

Figure 1, in Section 2.1.1, illustrates the overall layout of the Demonstration Factory and the location of the process equipment that will be used for this project. This project involves the use of the pretreatment process with an associated dry-off oven, a wet spray booth, and the wet cure oven.

5.3 Sampling Procedures and Handling

Standard test panels will be used in this project. These will be pre-labeled by stamping them with a unique alphanumeric identifier. The experimental design uses 120 samples for the TE test (5 runs with 3 racks per run and 8 panels per rack).

A factory operations technician and laboratory analysts will process the test panels according to a pre-planned sequence of stages, which includes those identified in Table 10.

Table 10. Process Responsibilities

Procedure	Operations Technician	Laboratory Analyst
Numbering of the Panels		X
Shot-Blast the Panels	X	
Pretreatment Panels with zinc phosphate		X
Initial Weight of Panels		X
Remove 1 Panel/Run for Pretreatment Analysis		X
Arrange Panels on the Racks		X
Prepare the Coating	X	X
Setup the HVLP Gun	X	
Take Coating Samples and Measurements		X
Load Coating in the Gravity Cup & Prime Gun	X	
Perform Setup Trials (before first run only)	X	
Initial Weight of Gun and Cup	X	X
Apply Coating to the Panels	X	
Take Process Measurements		X
Cure the Panels	X	
Wrap and Stack Panels for Transfer to the Lab	X	

A laboratory analyst will record the date and time of each run and the time each measurement was taken. When the panels are removed from the racks, they will be separated by a layer of packing material, and stacked for transport to the laboratory. The laboratory analyst will process the test panels through the laboratory login prior to performing the required analyses.

5.4 Sample Custody, Storage and Identification

The test panels will be delivered to the laboratory for login and given a unique laboratory ID number. The analyst delivering the test panels will complete a custody log indicating the sampling point IDs, sample material IDs, quantity of samples, time, date and analyst's initials. The product evaluation tests also will be noted on the custody log. The laboratory's sample custodian will verify this information. Both personnel will sign the custody log to indicate transfer of the samples from the coating processing area to the laboratory analysis area. The laboratory sample custodian will log the test panels into a bound record book; store the test panels under appropriate conditions (ambient room temperature and humidity); and create a work order for the various laboratory departments to initiate testing. Testing will begin within several days of coating application.

6.0 ANALYTICAL PROCEDURES AND CALIBRATION

Information regarding facility and laboratory testing, calibration procedures, product quality procedures, standard operating procedures for calibrations, and non-standard methods that will be used for this project can be found in Section 6.0 of the Generic HVLP Equipment Protocol.

Process Measurements

Four solutions (the remaining three are water rinses) in the zinc phosphate pretreatment line are titrated to determine if the chemical concentrations are within the specified ranges. Chemicals are added, if necessary. After the panels are pretreated, one random panel per run is taken to the lab for weight analysis of the zinc phosphate coating.

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

The ambient temperature and relative humidity is measured both inside and outside the spray booth. The temperature of the panels is measured prior to starting each test run.

All equipment used in the above analyses are calibrated according to Table 11 of the Generic HVLP Equipment Protocol.

Finish Quality

The ASTM Methods and *CTC* work instructions for dry film thickness, gloss, distinctness-of-image and transfer efficiency can be found in Appendices E and F.

The equipment used for these analyses are calibrated according to Table 12 of the Generic HVLP Equipment Protocol.

7.0 DATA REDUCTION, VALIDATION, AND REPORTING

Information pertaining to raw data handling, preliminary data package validation, final data validation, data reporting and archival, and the Verification Statement can be found in Section 7.0 of the Generic HVLP Equipment Protocol.

The method for calculating %TE has been redefined (per ASTM 767) to consider the TE per panel. By this method, the formula is as follows:

$$\text{TE (\%)} = \frac{\text{(average weight gain of panels in run) x 100}}{\text{(weight of paint sprayed/24)}}$$

An example calculation is included below:

$$\text{TE (\%)} = \frac{\text{1.1 g x 100}}{\text{52.8 g/24}}$$

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

$$\text{TE (\%)} = 50$$

8.0 INTERNAL QUALITY CONTROL CHECKS

Information pertaining to *CTC's* internal quality program, types of QA checks performed, and a summary of basic and specific QA checks to be performed can be found in Section 8.0 of the Generic HVLP Equipment Protocol.

In addition to the information found in the Generic HVLP Equipment Protocol, the following specific QC/QA checks will be performed during this test.

Internal QA audits will be performed of the testing and laboratory analyses by the ETV CCEP's QA Officer, who is independent of the project's manager. These audits will check that processes are completed per the approved written documentation, both internal and external. The QA audits will also check that the laboratory data is handled properly.

The QC checks that are performed by the laboratory personnel may include analyzing un-coated panels for dry film thickness to verify that the instrument has not drifted from zero, performing duplicate analyses on the same samples, and performing calibration checks of the laboratory equipment. 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.

9.0 PERFORMANCE AND SYSTEM AUDITS

Information pertaining to the performance and system audits to be performed can be found in Section 9.0 of the Generic HVLP Equipment Protocol.

10.0 CALCULATION OF DATA QUALITY INDICATORS

Information pertaining to the calculation of data quality indicators such as precision, accuracy, completeness and other project specific indicators can be found in Section 10.0 of the Generic HVLP Equipment Protocol.

11.0 CORRECTIVE ACTION

Information pertaining to routine and non-routine corrective actions that may be required during this project can be found in Section 11.0 of the Generic HVLP Equipment Protocol.

12.0 QUALITY CONTROL REPORTS TO MANAGEMENT

Information pertaining to the quality control reports that the ETV CCEP will deliver to Program Management can be found in Section 12.0 of the Generic HVLP Equipment Protocol.

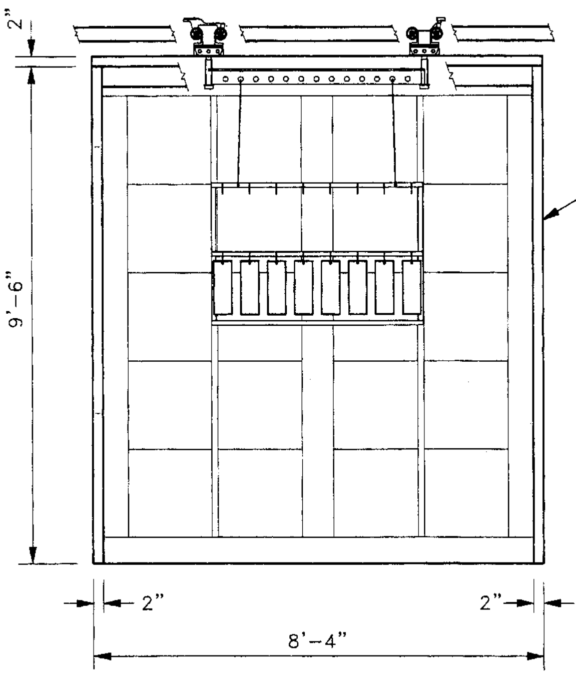
REFERENCES

There are no technology specific references for this TQAPP.

APPENDIX A

Apparatus Set-Up

ELEVATION VIEW – LIQUID SPRAY BOOTH WITH TEST PRODUCT



REV.	DATE	DESCRIPTION	BY	APP'D

CTC Concurrent Technologies Corporation
1450 SCALP AVENUE, JOHNSTOWN, PENNSYLVANIA 15904

SCALE: NTS
ISSUE DATE: 12-12-97
DRN BY: HHH
CKD BY: BD
APP'D BY: MA

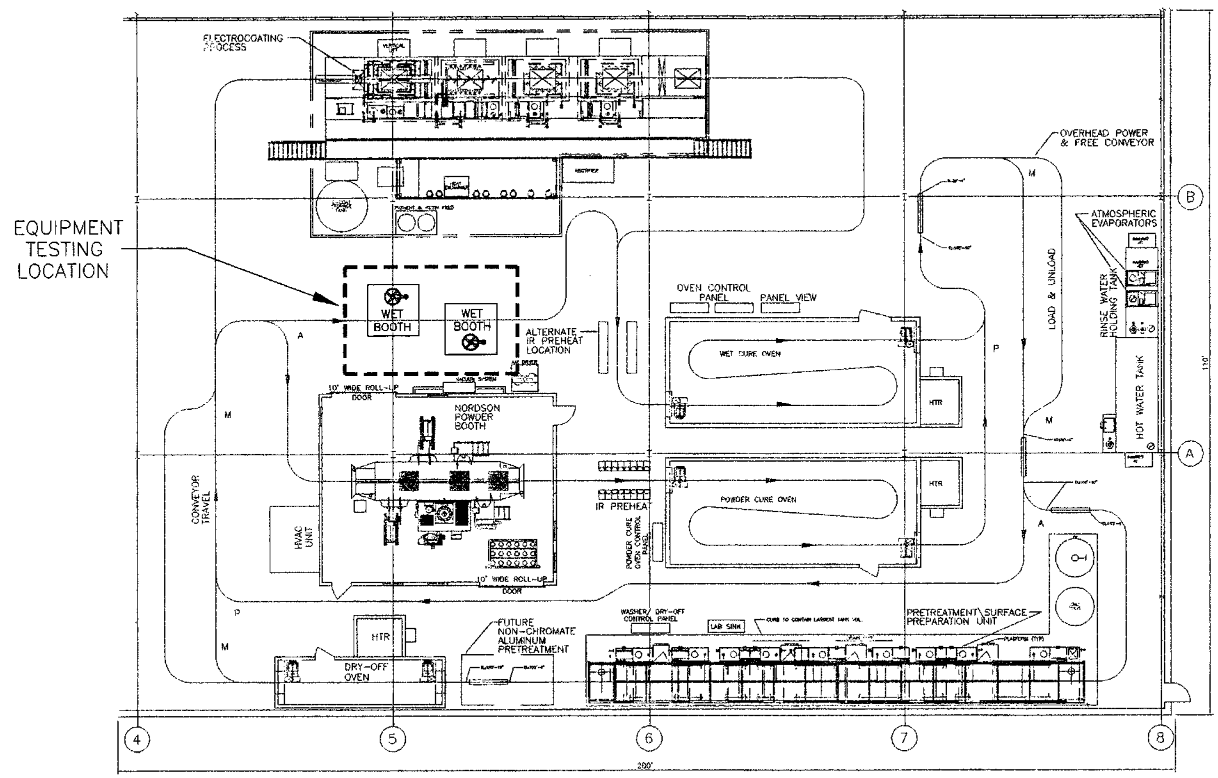
PROJECT: ENVIRONMENTAL TECHNOLOGY VERIFICATION COATINGS AND COATING EQUIPMENT PROGRAM

TITLE: TEST SET-UP DETAILS

DRAWING NO.: ETF-060-A08 REV. 0

APPENDIX B

Equipment Testing Location



CTC **Concurrent Technologies Corporation**

1450 SCALP AVENUE, JOHNSTOWN, PENNSYLVANIA 15904

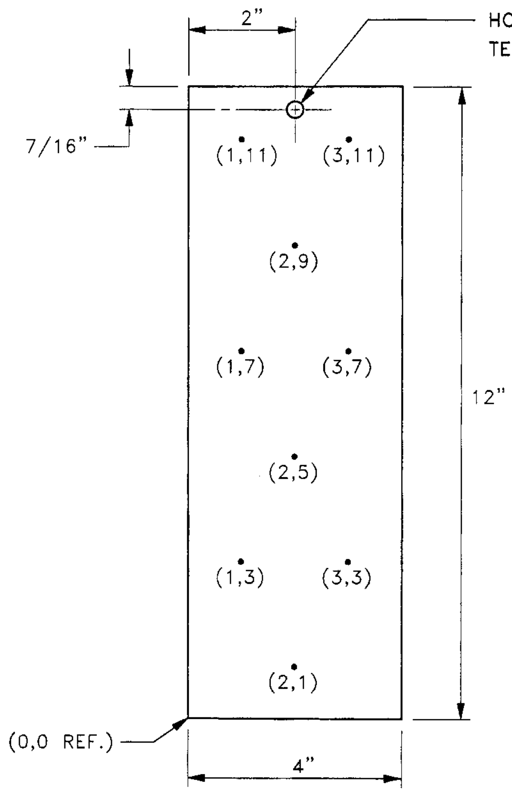
REVISIONS			
REV.	DATE	DESCRIPTION	BY APPD

SCALE: NTS	PROJECT: ENVIRONMENTAL TECHNOLOGY VERIFICATION COATINGS AND COATING EQUIPMENT PROGRAM		
ISSUE DATE: 7-17-97			
DRN BY: HHH	TITLE: LIQUID SPRAY EQUIPMENT TESTING LOCATION	DRAWING NO.: ETF-060-A03 REV. 0	
CKD BY: CMJ			
CKD BY:			
APPD BY: MSF			

APPENDIX C

Standard Test Panel

STANDARD TEST PRODUCT



TEST POINTS ARE INDICATED BY THEIR POSITION RELATIVE TO THE BOTTOM LEFT HAND CORNER OF THE PANEL. (ALL VALUES ARE IN INCHES).

CTC Concurrent Technologies Corporation

1450 SCALP AVENUE, JOHNSTOWN, PENNSYLVANIA 15904

REVISIONS				
REV.	DATE	DESCRIPTION	BY	APPD

SCALE: NTS
ISSUE DATE: 12-12-97
DRN BY: HHH

PROJECT: ENVIRONMENTAL TECHNOLOGY VERIFICATION COATINGS AND COATING EQUIPMENT PROGRAM

TITLE: TEST PRODUCT WITH MEASUREMENT LOCATIONS

DRAWING NO.: ETF-060-A07 REV. 0

APPENDIX D

Coatings and Coating Equipment Product Data Sheets

APPENDIX E

ASTM Methods

ASTM Methods

ASTM B 499	--	Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
ASTM D 523	--	Standard Test Method for Specular Gloss
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 D 1475	--	Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products
ASTM D 2369	--	Standard Test Method for Volatile Content of Coatings
ASTM D 3960	--	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D 5286	--	Standard Test Methods for Determination of Transfer Efficiency Under General Production Conditions for Spray Application of Paints
ASTM D 5767	--	Standard Test Methods for Instrumental Measurement of Distinctness-of-Image Gloss of Coating Surfaces

APPENDIX F

CTC Work Instructions

Index to *CTC* Work Instructions

	--	Job Safety Analysis for Grit Blast Booth
0926.005	--	Pre-treatment System Operation (equipment)
0926.001	--	Pretreatment Line Operation (testing)
0926.018	--	Wet Spray Booth Operation
0931.017	--	Cold Rolled Steel Coating Weights
0931.012	--	Viscosity
0931.001	--	Density
0931.013	--	Determination of Weight Percent Solids of Paint
0931.014	--	Determination of Transfer Efficiency for the Spray Application of Paint
0931.019	--	Gloss of Organic Coatings
0931.020	--	Measurement of Coating Thickness by the Magnetic Method