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

Evermore Paints and Coatings Formula 5 Coating - Testing and Quality Assurance Project Plan (TQAPP)

Revision No. 0

August 4, 2000

U.S. EPA - U.S. Army ARDEC/ETO Interagency Agreement No.: DW21938366
U.S. Army TACOM-ARDEC NDCEE 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)

Evermore Paints and Coatings Formula 5 Coating – Testing and Quality Assurance Project Plan (TQAPP)

Revision No. 0

August 4, 2000

Distribution Statement "A" applies
Approved for public release; distribution is unlimited

U.S. EPA - U.S. Army ARDEC/ETO Interagency Agreement No.: DW21938366
U.S. Army TACOM-ARDEC NDCEE Contract No.: DAAE30-98-C-1050
Task No.: 208
SOW Task No.: 3

Submitted by

Concurrent Technologies Corporation
100 CTC Drive
Johnstown, PA 15904

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

SI to English Conversions

SI Unit	English Unit	Multiply SI by factor to obtain English
°C	°F	(1.80 E + 00), then add 32
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 = 1/1000 in.)	3.937 E + 01
m/s	ft/min	1.969 E + 02
kg/L	lbm/gal. (U.S.)	8.345 E + 00

List of Abbreviations and Acronyms

ACS	American Chemical Society
ANSI	American National Standards Institute
AOAC	Association of Official Analytical Chemists
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
CBD	Commerce Business Daily
CCEP	Coatings and Coating Equipment Program
CTC	Concurrent Technologies Corporation
DFT	dry film thickness
DI	deionized
DOI	distinctness-of-image
EPA	U.S. Environmental Protection Agency
ETF	Environmental Technology Facility
ETV	Environmental Technology Verification Program
GC/MS	gas chromatography/mass spectrometry
HAP	hazardous air pollutant
IR	infrared
MEK	methyl ethyl ketone
MSDS	Material Safety Data Sheet
NDCEE	National Defense Center for Environmental Excellence
NIST	National Institute for Standards and Technology
PLC	programmable logic controller
QA/QC	quality assurance/quality control
QMP	Quality Management Plan
RFT	request for technologies
SOP	standard operating procedure
TQAPP	Testing and Quality Assurance Project Plan
UV	ultraviolet
VOC	volatile organic compound
WBS	work breakdown structure

This page intentionally left blank.

1.0 INTRODUCTION

1.1 Purpose of the Evermore Paints and Coatings Formula 5 Coating - Testing and Quality Assurance Project Plan

The primary purpose of this document is to establish the Testing and Quality Assurance Project Plan for the Evermore Paints and Coatings' Formula 5 polyamide-epoxy-silicone modified coating. This 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 Evermore Paints and Coatings Formula 5 coating. 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 will meet or exceed the requirements of the American National Standards Institute/American Society for Quality Control (ANSI/ASQC), Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, ANSI/ASQC E-4 (1994) standard. All ETV CCEP Liquid Coating 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, data quality is known, and that the data are legally defensible and reproducible.

1.3 Logic and Organization of the Evermore Paints and Coatings Formula 5 Coating 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 recording, reviewing, and reporting 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 (QC) 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:

- Title Page
- TQAPP Approval Form
- 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 will indicate their agreement and common understanding of the project objectives and requirements by signing the TQAPP Approval Form for each liquid coating tested. Acknowledgment by each key person indicates commitment toward implementation of the plan (see Figure 1 of the Generic Liquid Coating 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 Formula 5 polyamide-epoxy-silicone modified coating. The Formula 5 coating was developed by Evermore Paints and Coatings. The Formula 5 coating is a water-reducible, architectural/industrial coating that is low in volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). The test data from this verification test will be compiled and used to develop a Verification Report. In addition, a Verification Statement will be developed from the data contained in the Verification Report. Evermore Paints and Coatings may use the Verification Statement as a marketing tool for the Formula 5 coating.

The criteria used to verify the performance of the Formula 5 coating are the VOC and HAP content and the quality and performance of the cured coating. Analysis methods used for these tests will follow American Society for Testing and Materials (ASTM) or similarly accepted methods.

The testing of the Formula 5 coating will be conducted on the Organic Finishing Line, in the Demonstration Factory operated by *CTC*. In addition, an outside laboratory will be providing support for the VOC/HAP analyses. 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 Liquid Coating 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 NDCEE Program to establish a demonstration factory capable of prototyping processes that will reduce or eliminate environmentally harmful materials used or produced in manufacturing. To accelerate the transition of environmentally friendly processes to the manufacturing base, *CTC* offers the ability to test processes and products on full-scale, commercial equipment. This demonstration factory is a major national asset. It includes a combination of organic finishing, cleaning, stripping, inorganic finishing, and recycle/recovery equipment. The organic finishing equipment in the demonstration factory will be available for the pilot-scale testing performed in this project, (e.g., surface pretreatment, wet spray, and cure ovens). Layouts of the *CTC* Demonstration Factory and the Organic Finishing Line are shown in Figures 1 and 2, respectively.

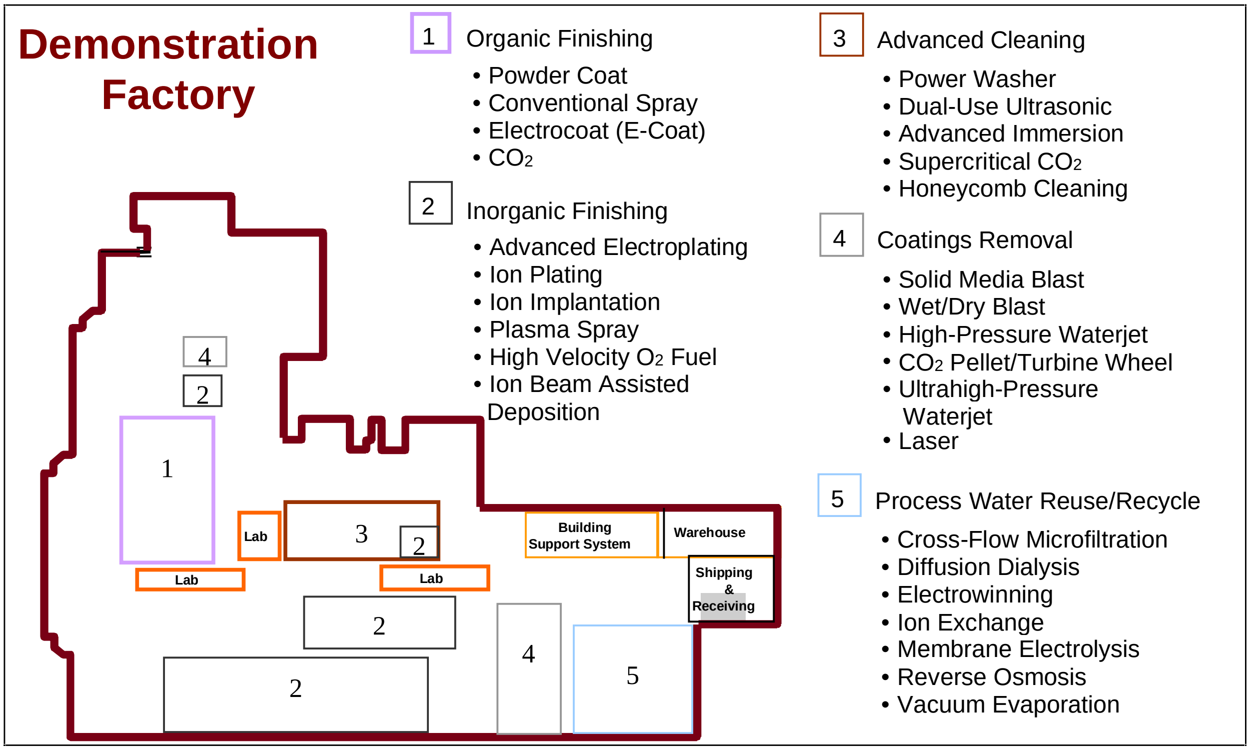


Figure 1. ***CTC*** **Demonstration Factory Layout**

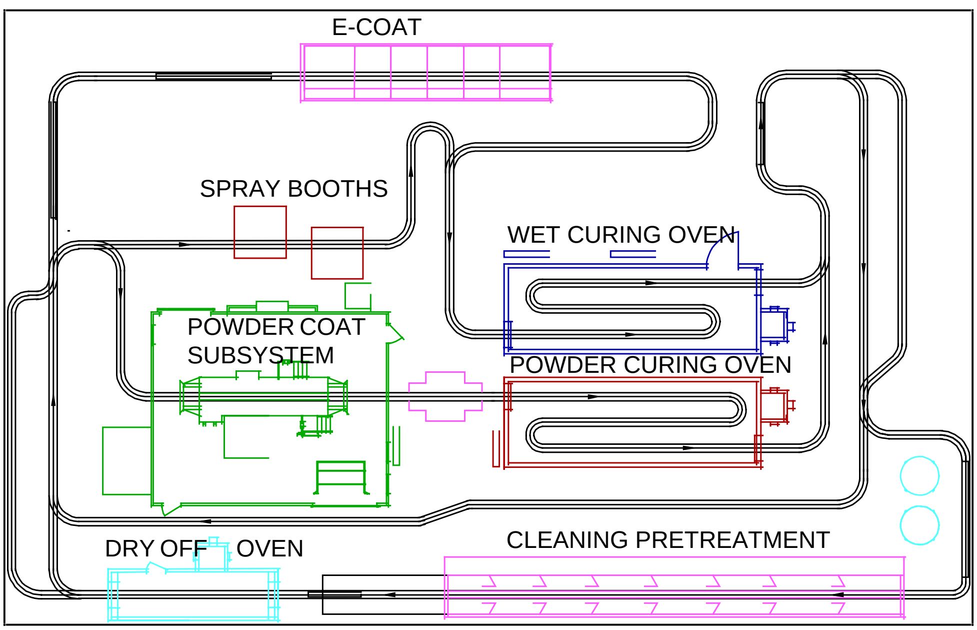


Figure 2. Demonstration Factory Organic Finishing Line

2.1.2 Laboratory Facilities

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

The VOC and HAP content analyses will be conducted at Advanced Technologies of Michigan, Inc., whose Director, Hiro Fujimoto, was involved in the development of the ASTM methods for determining VOCs in paints and related compounds. Hiro Fujimoto has also been involved in the development of test methods for HAPs and exempt solvents.

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 aspires to increase the use of more environmentally friendly technologies in products finishing in an effort to reduce emissions.

The primary criteria for verification of Formula 5 coating will be:

- Does the coating provide an environmental benefit in terms of reduced VOC/HAP content compared to existing regulatory limits?
- Does the coating provide a finish of acceptable quality and performance?

Based on the best available data, as presented by an unbiased third party, end-users will be able to determine whether the coating can provide them with a pollution prevention benefit while meeting the finish quality requirements of their application. This program intends to supply end-users with the unbiased technical data to assist them in this decision-making process.

The quantitative pollution prevention benefit in terms of reducing or eliminating VOC/HAP emissions depends on a multitude of factors; therefore, the Formula 5 coating will be applied per Evermore Paints and Coatings' instructions, and the resulting verification data will be representative of the exact conditions tested. To qualify the existence of an environmental benefit, this program will conduct a test to quantify the VOC/HAP content from the Formula 5 coating as a surrogate for measuring VOC/HAP emissions. VOC/HAP emissions that occur as a result of chemical reactions during curing cannot be quantified at this time due to the lack of an approved test method.

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 5):

- Obtain Evermore Paints and Coatings' concurrence with this TQAPP.
- Obtain *CTC* and EPA approval of this TQAPP.
- Conduct verification test of the Formula 5 coating.
- 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 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 remain constant throughout the testing. Critical factors will be listed as control (process) factors or response (coating product quality) factors (see Section 2.2.8).
• The TQAPP will identify the testing site.
• 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 this TQAPP will be strictly adhered to.
• 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:

- Evermore Paints and Coatings will identify the performance parameters to be verified and recommend the optimum equipment settings for application and curing.
- Standard test panels will be obtained to enable thorough testing of coating performance.
- A verification test will be completed to determine the performance of the Formula 5 coating.
- A statistically valid test program that efficiently accomplishes the required objectives will then be used to analyze the test results.

2.2.2 Verification Test Objectives

The objectives of the verification test performed per this TQAPP are to determine the VOC and HAP content and to verify the quality and performance of the Formula 5 coating. The coated test panels will be checked for dry film thickness (DFT), visual appearance, and the following analyses chosen by Evermore Paints and Coatings: specular gloss, MEK rub, tape adhesion, color, mandrel bend, pencil hardness, direct impact, color difference, abrasion resistance, weather resistance, salt-spray, and humidity resistance.

2.2.3 Standard Test Panel

The standard test panel to be used for this verification test 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 30.5 cm (12 in.) long, 10.2 cm (4 in.) wide and made of 22 gauge steel. The panels will be received treated with a zinc phosphate coating. Prior to being coated, five random test panels will be removed for pretreatment analysis. It has a 1/4 inch hole 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 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.

2.2.4 Coating Specification

The Formula 5 coating is a polyamide-epoxy-silicone modified coating. Formula 5 was developed as a high performance coating for architectural and industrial applications. Formula 5 is a water-reducible, two-component coating.

The ETV CCEP will prepare the two components from their constituents, per Evermore Paints and Coatings request and instructions. The ETV CCEP will prepare at least 10 gallons of the base component and at least 5 gallons of the activator component. The coating components will be stored in closed containers until they are mixed. The Formula 5 components will be mixed at a ratio of 2 parts base to 1 part activator. One batch of the Formula 5 coating will be mixed for each run and allowed to stand for 30 minutes. After the 30 minutes, coating samples will be taken to measure the coating temperature, viscosity, percent solids, and density. The coating measurements will be recorded on the paint batch worksheet. The batch of coating will then be connected to the fluid pump, which feeds the coating to an airless spray gun. After the coating has been applied, the standard test panels will be air dried for at least one hour followed by 3 days forced cure at 65.5 °C (150 °F).

2.2.5 Standard Coating Application Apparatus

The Formula 5 coating will be applied to the test panels using an airless spray gun, equipped with a 0.015 in. fluid tip. The application parameters for the airless spray gun, such as distance to the panels, application speed, number of passes, fluid delivery pressure, etc., will be determined during the start-up phase, prior to the verification test. The coating will be delivered to the airless spray gun at 2000 -3000 psi. The fluid delivery pump has a 30:1 pump ratio. The apparatus will be operated in one of the wet spray booths at *CTC*'s ETF facility. Appendix A shows the selected apparatus setup, and Appendix B, shows the testing location relative to the Organic Finishing Line. Testing will be performed in one of the liquid spray booths in *CTC*'s Demonstration Factory.

Standard test panels will be suspended from racks containing a single row of eight panels per rack, as shown in Appendix A, *Apparatus Setup*. The test panels will be fixtured on the rack to minimize movement during spraying. Fixturing consists of a flat bar that connects all eight hooks. The bar will minimize side-to-side rotation of the panels. A second bar is oriented near the bottom of the panels to prevent the bottom of the panels from moving away from the spray gun. 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 programmable logic controller (PLC) of the spraying mechanism will activate the motors that drive the linear motion translators. The translators will move both horizontally and vertically, enabling the application equipment to treat an area approximately 1.4 m by 1.4 m (4.5 ft. x 4.5 ft.). The panels will be automatically sprayed using vertical overlap of the spray pattern. The PLC will also trigger the pneumatic spray gun. During dwell time between passes, paint flow will be interrupted to minimize paint usage. Once the coating application is complete, the PLC will release the mechanical stop that maintains the position of the rack, enabling the overhead conveyor to move the next rack into position.

Before the test, a set of dummy panels will be coated to ensure that the equipment parameters are set correctly. Evermore Paints and Coatings may wish to assist in this step. The fluid delivery pressure will be monitored periodically throughout the test. The paint usage will be determined through gravimetric means and an in-line flow meter.

To help ensure proper equipment setup and operation, the Evermore Paints and Coatings is invited to participate in the startup phase of the testing and to observe the testing of the Formula 5 coating.

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 1 cm (0.4 in.) of water shall indicate that the system requires service and/or changing of the filters.

2.2.6 Design of Experiment

This TQAPP will verify the performance of the Formula 5 coating submitted by Evermore Paints and Coatings A mean value and variance (or standard deviation) will be reported for each critical response factor, and a default 95% confidence limit will be applied.

This verification test will consist of five runs with two racks of eight panels in a single row per run; therefore, a total of eighty panels will be coated and used for analysis of the coatings performance characteristics. The statistical analyses for all response factors will be carried out using Minitab statistical software.

2.2.7 Performance Testing

Evermore Paints and Coatings will provide the ETV CCEP with coating specifications and appropriate equipment settings. The ETV CCEP will not attempt to optimize test settings during the actual test runs; however, the Evermore Paints and Coatings will be able to fine tune the equipment settings during the startup phase of the testing. The ETV CCEP will provide the Evermore Paints and Coatings with a list of key non-critical test factors that may affect the critical response factors (i.e., test results).

All testing will be conducted on the standard test panels. All such tests will be performed per ASTM procedures (unless otherwise noted) and provide insight to the chemical and physical properties of the Formula 5 coating.

2.2.8 Critical and Non-critical Factors

In a designed experiment, critical and non-critical control factors must be identified. In this context, the term "critical" does not convey the importance of a particular factor. (Importance can only be determined through experimentation and characterization of the total process.) Rather, this term displays its relationship within the design of experiments. For the purposes of this TQAPP, the following definitions will be used for critical control factors, non-critical control factors, and critical response factors.

- Critical control factor – a factor that is varied in a controlled manner within a design of experiments matrix to determine its effect on a particular outcome of a system.
- Non-critical factors – factors that remain relatively constant or are randomized throughout the testing.
- Critical response factors – the measured outcomes of each combination of critical and non-critical control factors used in the design of experiments.

In this verification test, there is only one critical control factor, the coating itself. All other processing factors 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 example, for each coating application, parameters associated with pretreatment would remain constant, and, thus, be non-critical control factors; however, a parameter, such as adhesion, would be identified as a critical response factor and could vary from run to run.

Tables 2 through 4 identify the factors to be monitored during testing, as well as their acceptance criteria (where appropriate), data quality indicators, measurement locations, and measurement frequencies. The values in the Total Numbers column are based on the default test scenarios.

Table 2. Critical Control Factors

Critical Control Factor	Resin Type	Solvent Type	Cure Method	Target Industry
Formula 5 Coating	Polyamide-epoxy-silicone	Organics and Water	Air-dried (optional force cure)	Architectural/ Industrial

Table 3. Non-critical Control Factors

Non-critical Factor	Set Points/ Acceptance Criteria	Measurement Location	Frequency	Total Number for Each Test
Application Method Manufacturer/Model	Graco Airless w/ 0.015 in. tip	Factory floor	Once per test	1
Fluid Delivery Pressure	2000 - 3000 psi	Factory floor	Once each run	5
Products involved in Testing	Standard test panels	N/A	16 standard test panels per run	80 panels
Surface Area of Each Panel Coated	303-316 cm^2 (47-49 $in.^2$)	Top and right edge of panel	1 standard test panel	1
Zinc Phosphate Pretreatment Weight	$<1.0\ g/m^2$ variation in pretreatment	Random panels removed prior to being coated	5 Standard Test Panels	5
Ambient Factory Relative Humidity	≤ 10% variation in RH	In the factory	Once each run	5
Ambient Factory Temperature	≤ 5.0 °C variation in Temperature	In the factory	Once each run	5
Spray Booth Relative Humidity	≤ 10% variation in RH	Inside the spray booth	Once each run	5
Spray Booth Temperature	≤ 5.0 °C variation in Temperature	Inside the spray booth	Once each run	5
Spray Booth Air Velocity	≤ 0.2 m/s variation in velocity	Inside the spray booth	Three measurements each run	15
Distance to Panels	TBD at Startup	Factory floor	Once per test	1
Temperature of Panels, as Coated	≤ 5.0 °C variation in Temperature	Factory floor	Once per run	5
Horizontal Gun Traverse Speed	TBD at Startup	Factory floor	Once per test	1
Vertical Drop Between Passes	TBD at Startup	Factory floor	Once per test	1
Dwell Time Between Passes	TBD at Startup	Factory floor	Once per test	1
Density of Applied Coating	1138-1258 g/L (9.5-10.5 lb./gal)	Sample from coating pot	1 sample each run	5
Weight % Solids of Applied Coating	50-65%	Sample from coating pot	1 sample each run	5
Coating Temperature, as Applied	≤ 5.0 °C variation in Temperature	Sample from coating pot	1 sample each run	5
Coating Viscosity, as Applied	TBD at Startup	Sample from coating pot	1 sample each run	5
Paint Flow Rate	TBD at Startup	Factory floor	Once each run	5
Total Paint Flow	TBD at Startup	Factory floor	Once each run	5
Oven Temperature	65.2 - 65.8 °C (145 - 155 °F)	Factory floor	Once each run	5
Oven Cure Time	Forced cured for 3 days after a minimum of 1 hr. air dry	Factory floor	Once each run	5

TBD - To Be Determined

Table 4. Critical Response Factors

Critical Response Factor	Measurement Location	Frequency	Total Number
Environmental			
VOC Content of the Liquid Coating	see Section 2.2.9	5 samples each from base and activator components prepared for this test. The samples will be mixed by the outside laboratory immediately prior to analysis.	5
HAP Content of the Liquid Coating	see Section 2.2.9	5 samples each from base and activator components prepared for this test. The samples will be mixed by the outside laboratory immediately prior to analysis.	5
Quality/Performance (Mandatory)			
Dry Film Thickness (DFT)	From ASTM B 499 (magnetic)	9 points on each standard test panel	720
Visual Appearance	Entire test panel and entire rack	1 standard test panel per run and 1 per test	6
Quality/Performance (Optional)			
Specular Gloss	from ASTM D 523	3 points on 1 standard test panel per run	15
MEK Rub	from ASTM D 5402	1 randomly selected panel per run, 1 test per panel	5
Tape Adhesion[a]	from ASTM D 3359	1 randomly selected panel per run, 1 test per panel	5
Color[b]	from ASTM D 2244	1 randomly selected panel per run, 1 test per panel	5
Mandrel Bend	from ASTM D 522	1 randomly selected panel per run, 1 test per panel	5
Pencil Hardness[a]	from ASTM D 3363	1 randomly selected panel per run, 1 test per panel	5
Direct Impact	from ASTM D 2794	1 randomly selected panel per run, 1 test per panel	5
Color Difference[b]	from ASTM D 1729	1 randomly selected panel per run, 1 test per panel	5
Abrasion Resistance	From ASTM D 4060	1 randomly selected panel per run, 1 test per panel	5
Weather Resistance	From ASTM G 26	1 randomly selected panel per run, 1 test per panel	5
Salt Spray (1000 hrs)	from ASTM B 117	1 randomly selected panel per run, 1 test per panel	5
Humidity Resistance	From ASTM D 1735	1 randomly selected panel per run, 1 test per panel	5

[a] The adhesion and pencil hardness tests will be performed on the same panel.
[b] Both color analyses will be performed on the same panel.

Qualitative, non-critical control factors used in the verification tests include:

• Fluid pump ratio	30:1
• Flash time between coats	TBD at Startup
• Number of passes	TBD at Startup
• Spray pattern	TBD at Startup
• Number of coats	TBD at Startup
• Target DFT	2.0 to 3.0 mils

2.2.9 Determination of VOCs and HAPs

The VOC and HAP content of the liquid coatings will be determined by EPA Methods 24 and 311, which are EPA-accepted surrogates for measuring actual VOC and HAP emissions. To assist in VOC/HAP determinations and assessments, the vendor will be required to submit material safety data sheets (MSDSs) and coating composition information, including the following:

- Total volatile matter
- Coating density
- Solids content
- Water content (as appropriate)
- EPA-exempt solvents content
- Total VOC content
- Specific VOC/HAP identification
- Density of cured coating.

Bulk formulation tests will be performed to assess the quantity of VOCs/HAPs contained in the paint per EPA Method 24. EPA Method 24 requires three separate measurements to determine the total VOC content in the coating. First, the total volatile matter contained within the liquid coating will be determined via gravimetric analysis (ASTM D2369). Next, a Karl Fischer Titration (ASTM D4017 or E1064) will determine water content of the coating, and gas chromatography (ASTM D4457) will determine the amount of exempt solvents. The total VOC content is then calculated, per EPA Method 24, by subtracting the mass of water and mass of exempt solvents from the total volatile matter. Identification of the specific VOCs/HAPs contained in the paint will be performed using gas chromatography/mass spectrometry (GC/MS) per EPA Method 311. These analyses will be conducted at Advanced Technologies of Michigan, Inc.

2.3 Schedule

CTC uses standard tools for project scheduling. Project schedules are prepared in Microsoft Project or Primavera, which are accepted industry standards 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 verification testing of the Formula 5 coating.

Table 5. Estimated Schedule as of 8/4/00

ID	Name	Duration	Start Date	Finish Date
Task 1	Testing Startup	1d	TBD	TBD
Task 2	Verification Testing	2d	TBD	TBD
Task 3	Complete Data Analyses	20d	TBD	TBD
Task 4	Prepare Verification Report	30d	TBD	TBD
Task 5	Approval of Verification Report	60d	TBD	TBD
Task 6	Issue Verification Statement	15d	TBD	TBD

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

CTC employs a matrix organization, with program and line management, to perform projects. The laboratory supports the *CTC* Project Manager and the *CTC* Project Leaders by providing test data. Laboratory Analysts report to the *CTC* Laboratory Manager. The *CTC* Laboratory Manager coordinates with the *CTC* Project Leaders on testing schedules. The *CTC* Project Leaders are the conduit between the laboratory and the *CTC* Project Manager. The *CTC* Project Leaders answer directly to the *CTC* Project Manager. For the ETV CCEP, the *CTC* Project Leaders will be responsible for preparing the TQAPPs and the internal demonstration plans for each test.

The *CTC* QA Officer, who is independent of both the laboratory and the program, is responsible for administering *CTC* policies developed by the Quality Committee. These policies provide for, and ensure that quality objectives are met for each project. The policies are applicable to laboratory testing, factory demonstration processing, engineering decisions, and deliverables. The *CTC* QA Officer reports directly to *CTC* senior management and is organizationally independent of the project or program management activities.

The project organization chart, showing lines of responsibility and the specific *CTC* personnel assigned to this project, is presented in Figure 3. A summary of the responsibilities of each *CTC* participant, his/her applicable experience, and his/her anticipated time dedication to the project during testing and reporting is given in Table 6.

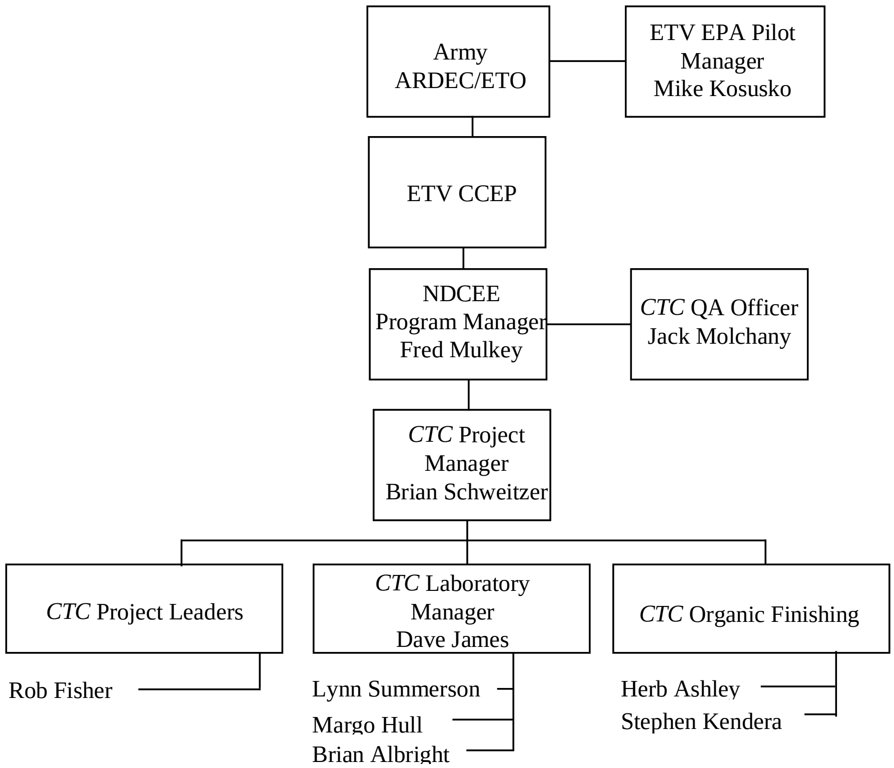


Figure 3. Project Organization Chart

Table 6. Summary of ETV CCEP Experience and Responsibilities

Key *CTC* Personnel and Roles	Responsibilities	Applicable Experience	Education	Time Dedication
Fred Mulkey – NDCEE Program Manager	Manages NDCEE Program Accountable to *CTC* Technical Services Manager and *CTC* Corporate Management	Laboratory Chemist and Manager (13 years) Project Quality Assurance (13 years) Project Management (12 years) Registered Environmental Manager	M.S., Chemistry B.S., Chemistry	5%
Brian Schweitzer – Manager, Process Engineering/ *CTC* Project Manager	Responsible for overall ETV CCEP technical aspects, budget, and schedule issues on daily basis Accountable to NDCEE Program Manager	Process Engineer (12 years) Project Manager, Organic Finishing (7 years)	B.S., Mechanical Engineering	50%
Jack Molchany – *CTC* QA Officer	Responsible for overall project QA Accountable to NDCEE Program Manager	Industrial QA/QC and (12 years) Quality Mgmt. /ISO 9000 (6 years) Environmental Compliance and ISO 14000 Management Systems (6 years) Certified Hazardous Materials Mgr.	B.S., Industrial Engineering	5%
Rob Fisher – Staff Process Engineer/ *CTC* Project Leader	Technical project support Process design and development Accountable to *CTC* Project Manager	Organic Finishing Regulations (5 years) Organic Finishing Operations (3 years) Professional Engineer	B.S., Chemical Engineering	50%
Herb Ashley – Finishing Engineer	Oversees daily operation of the Organic Finishing Line Provides technical project support. Accountable to *CTC* Project Manager	Organic Finishing Experience (28 years)		10%
Steve Kendera – Sr. Organic Finishing Technician	Performs day-to-day operations of the Organic Finishing Line Accountable to Finishing Engineer	Industrial Paint and Coatings Experience (26 years)		10%
Dave James – Process and Materials Characterization Manager/ *CTC* Laboratory Manager	Coordinates testing laboratory and technical data review Accountable to *CTC* Project Manager, NDCEE Program Manager	Environmental Engineering (17 years) Project/People Management (17 years) ISO 9000/14000 Management Systems (5 years) Certified Industrial Hygienist Certified Hazardous Materials Mgr. Registered Environmental Mgr.	M.S., Environmental Engineering B.S., Ecology	5%
Lynn Summerson – *CTC* Laboratory Leader/Statistical Support Staff	Laboratory analysis Accountable to Lab Manager	Industrial and Environmental Laboratory Testing (18 years)	M.S., Chemistry B.S., Chemistry	20%
Margo Hull – *CTC* Associate Laboratory Leader	Laboratory analysis Accountable to *CTC* Laboratory Manager	Organic/Inorganic Laboratory Testing (6 years)	B.S., Biology	10%
Brian Albright – *CTC* Assistant Laboratory Analyst	QC Analysis Accountable to *CTC* Laboratory Manager	Environmental and QC Testing (5 years)	B.S., Chemistry	10%

The *CTC* personnel specified in Figure 3 and Table 6 are responsible for maintaining communication with other responsible parties working on the project. The frequency and mechanisms for communication are shown in Table 7.

Table 7. Frequency and Mechanisms of Communications

Initiator	Recipient	Mechanism	Frequency
NDCEE Program Manager or *CTC* Project Manager	Army ARDEC/ETO and ETV EPA Pilot Manager	Written Report Verbal Status Report	Monthly Weekly
CTC Project Manager	NDCEE Program Manager	Written or Verbal Status Report	Weekly
CTC Laboratory Manager	*CTC* Project Manager	Data Reports	As generated
CTC QA Officer	NDCEE Program Manager	Quality Review Report	As required
ETV EPA Pilot Manager	Army ARDEC/ETO and *CTC*	On-Site Visit	At least once per year

Special Occurrence	Initiator	Recipient	Mechanism/ Frequency
Schedule or Financial Variances	NDCEE Program Manager or *CTC* Project Manager	Army ARDEC/ETO and ETV EPA Pilot Manager	Telephone call, with a written follow-up report as necessary
Major (will prevent accomplishment of verification cycle testing) Quality Objective Deviation	NDCEE Program Manager or *CTC* Project Manager	Army ARDEC/ETO and ETV EPA Pilot Manager	Telephone call with a written follow-up report

4.0 QUALITY ASSURANCE (QA) OBJECTIVES

4.1 General Objectives

The overall objectives of this ETV CCEP TQAPP are to verify the pollution prevention benefit of the Formula 5 coating and the quality and performance of its applied finish. 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 2 and 3 list the critical and non-critical control factors, respectively.

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

4.2 Quantitative Quality Assurance Objectives

Quality assurance parameters, such as precision, accuracy, and completeness, are presented in Tables 8 and 9. Table 8 presents the manufacturers' stated capabilities of the equipment used to measure non-critical control factors. The precision and accuracy parameters listed are relative to the true value to which the equipment measures. Table 9 presents the precision and accuracy parameters for the measurement equipment for the critical response factors. 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 Staff, *CTC* QA Officer, and laboratory personnel will coordinate efforts to calculate and interpret the test results.

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 used 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% to 120% 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.

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

Measurement	Method	Units	Precision	Accuracy[a]	Completeness
Fluid Delivery Pressure	Pressure Gauge	psig	±50.0	±5%	90%
Surface Dimensions of Each Panel Coated	Ruler	cm (in.)	±0.3 (±0.13)	±0.2 (±0.06)	90%
Zinc Phosphate Pretreatment Weight	ASTM B 767	g/m^2	±0.005	±0.01	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[b]	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% RPD	±1.0%	90%
Horizontal Gun Traverse Speed	Stopwatch	cm/s (in./sec)	±0.5	±0.5	90%
Vertical Drop Between Passes	Ruler	cm (in.)	±0.15 (±0.06)	±0.15 (±0.06)	90%
Dwell Time Between Passes	Stopwatch	seconds	±0.5	±0.5	90%
Density of Applied Coating	ASTM D 1475	g/l (lb/gal)	±0.6% RPD	±1.8%	90%
% Solids of Applied Coating	ASTM D 2369	%	±1.5% RPD	±4.7%	90%
Coating Temperature, as Applied	Thermometer	°C	±0.5	±0.2	90%
Coating Viscosity, as Applied	ASTM D 1200	seconds	±10% RPD	±10%	90%
Paint Flow Rate	Flow Meter	cm^3/min	±0.5% RPD	±0.5%	90%
Total Paint Flow	Flow Meter	cm^3	±0.5% RPD	±0.5%	90%
Oven Temperature	Thermocouple	°C	±2.2	±2.2	90%
Oven Cure Time	Stopwatch	seconds	±0.5	±0.5	90%

[a] Accuracy is presented as percent recovery of a standard, unless otherwise noted.
[b] ACGIH – American Conference of Governmental Industrial Hygienists, Inc. Accuracy and precision stated by the manufacturer for velocities ranging from 20–100 ft/min.
RPD - relative percent difference

Table 9. QA Objectives for Precision, Accuracy, and Completeness for All Critical Response Factor Performance Analyses

Measurement	Method	Units	Precision	Accuracy[a]	Completeness
VOC Content	EPA Method 24	g/l (lb/gal)	±0.6% RPD	±1.8%	90%
HAP Content	EPA Method 311	g/l (lb/gal)	±0.6% RPD	±1.8%	90%
DFT – Magnetic	ASTM B 499	mils[b]	20% RPD	10% True Thickness	90%
Visual Appearance	N/A	N/A	N/A	N/A	100%
Specular Gloss	ASTM D 523	gloss units	20%	±1.0	90%
MEK Rub	ASTM D 5402	Rating Units	One Rating Unit	N/A	90%
Tape Adhesion	ASTM D 3359	Rating Units	1 Rating Unit per 2 Samples	2 Rating Unit per 2 Samples	90%
Color	ASTM D 2244	ΔE Values	20%	1.0	90%
Mandrel Bend	ASTM D 522	Pass/Fail	All Pass or All Fail	N/A	100%
Pencil Hardness	ASTM D 3363	Hardness Scale	One Pencil Unit	One Pencil Unit	90%
Direct Impact	ASTM D 2794	Pass/Fail	All Pass or All Fail	N/A	100%
Color Difference	ASTM D 1729	Visual	N/A	N/A	100%
Abrasion Resistance	ASTM D 4060	mg	46%	90%	90%
Weather Resistance	ASTM G 26	Visual	N/A	N/A	100%
Salt Spray	ASTM B 117 (1000 hrs)	Visual	N/A	N/A	100%
Humidity Resistance	ASTM D 1735	Visual	N/A	N/A	100%

[a] Accuracy is presented as percent recovery of a standard, unless otherwise noted.
[b] 1 mil = 0.001 inch
N/A = Not Applicable
RPD - relative percent difference

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 test 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 tests conducted, by test type.

4.2.4 Impact and Statistical Significance Quality Objectives

All laboratory analyses will meet the accuracy, precision, and completeness requirements specified in Tables 8 and 9. The precision will also be checked on test panel replicates to determine whether a nonconformance exists as a result of limitations in the coating technology. If any nonconformance from TQAPP QA objectives occurs, the cause of the deviation will be determined by checking calculations, verifying the testing and measuring equipment, and performing a reanalysis. If an error in analysis is discovered, reanalysis of a new batch for a given trial 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 nonconformance may be beyond the control of the laboratory. If, given that laboratory quality control data are within specification and any nonconforming results occur, the results will be interpreted as the inability of the liquid coating 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

Liquid coatings will be used at vendor-recommended conditions or conditions otherwise established in agreement with the project stakeholders for each TQAPP. The data will be comparable from the standpoint that other testing programs could reproduce similar results using a specific TQAPP. Liquid coating and environmental performance will be evaluated using EPA, ASTM, and other nationally or industry-accepted testing procedures. Any reported process performance parameters will have been generated and evaluated according to standard best engineering practices.

Additional assurance of comparability will be derived 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. Experimental designs will be constructed such that projects will either have sufficiently large sample populations per trial or statistically significant fractional populations. The tests will be conducted at the paint and equipment supplier-recommended operating conditions. If the test data obtained from standard materials meet the quantitative QA criteria (precision, accuracy, and completeness), the measurements of the tested samples will be considered representative of the coating technologies under evaluation and used to interpret the outcomes relative to the specific project objectives.

4.4 Other QA Objectives

No other QA objectives have been identified 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, with the exception of the VOC and HAP content analyses. 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 Process Engineering, Process & Materials Characterization, and Factory Operations Line Groups. The *CTC* Testing Laboratory will perform analyses in the ETF Environmental Laboratory. The VOC and HAP content analyses will be performed by Advanced Technologies of Michigan, Inc. 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.

5.2 Site Description

Figure 1, in Section 2.1.1, illustrates the overall layout of *CTC*'s Demonstration Factory and the location of the process equipment that may be used for this TQAPP. The testing in this project involves the use of the pretreatment process with an associated dry-off oven, the liquid spray booths, and the wet cure oven.

5.3 Sampling Procedures and Handling

Samples of the base and activator materials will be shipped, unmixed, to the off-site laboratory for VOC and HAP content analyses. The samples will be shipped in containers for ground transportation.

Standard test panels will be used in this project. These will be pre-labeled with a unique alphanumeric identifier stamp. The experimental design uses 80 panels for the verification test (five runs with two racks per run and eight 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**
Ship Sample for VOC/HAP Content Analyses (OFF-SITE)		X
Numbering of the Panels		X
Arrange Panels on the Racks		X
Prepare the Coating	X	X
Setup the Application Equipment	X	
Take Coating Samples and Measurements		X
Load Coating in the Fluid Delivery System & Prime Equipment	X	
Perform Setup Trials (before first run only)	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

All test panels will be given to the laboratory for login and assigned 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 will also 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 at *CTC* 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. The laboratory analyses will begin within several days of coating application.

6.0 ANALYTICAL PROCEDURES AND CALIBRATION

Information regarding facility and laboratory testing and 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 Liquid Coating 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. Coating samples will be taken to the lab for density, and percent solids analyses. In addition, coating samples will be sent off-site for VOC and HAP content analyses.

The ambient temperature and relative humidity is measured both inside and outside the spray booth. Also, 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 Liquid Coating Protocol.

Finish Quality

A listing of the test methods and/or *CTC* work instructions for dry film thickness, specular gloss, MEK rub, tape adhesion, color, mandrel bend, pencil hardness, direct impact, color difference, abrasion resistance, weather resistance, salt-spray, and humidity resistance can be found in Appendices E and F.

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

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 Liquid Coating Protocol.

In addition to the information found in the Generic Liquid Coating 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 *CTC* QA Officer, who is independent of the *CTC* Project Manager. 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 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 Liquid Coating 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 Liquid Coating 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 Liquid Coating Protocol.

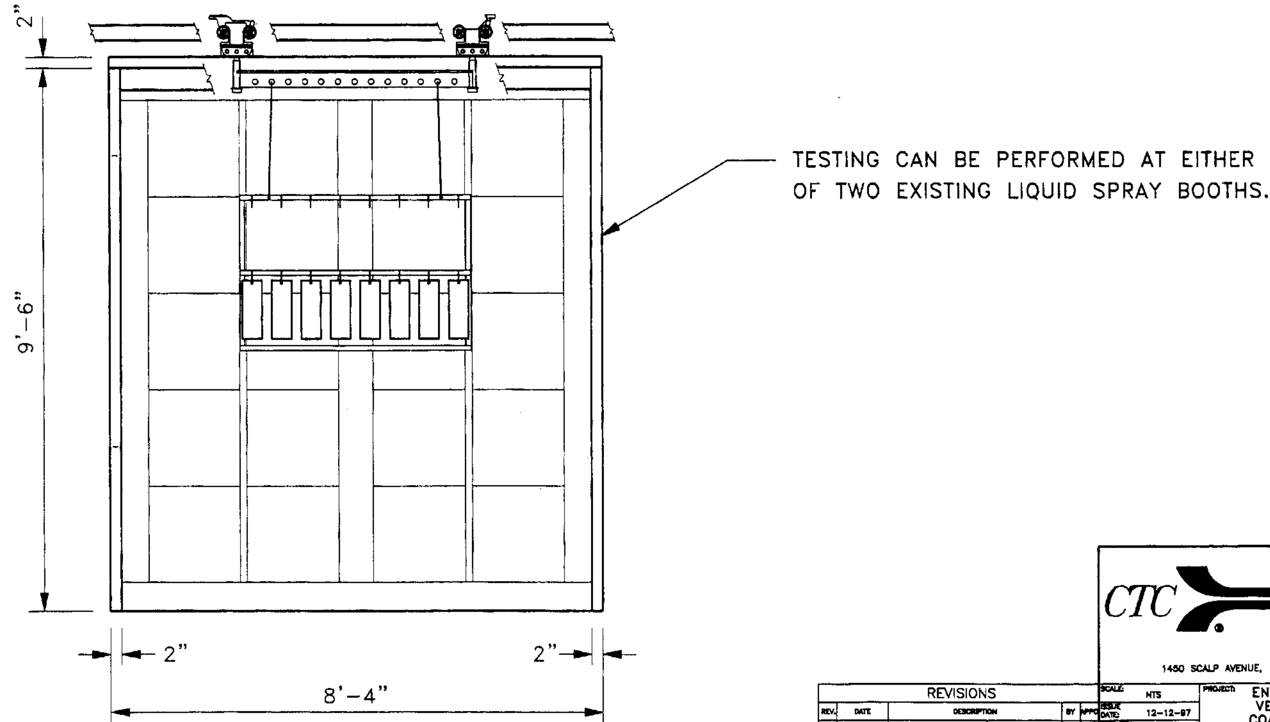
12.0 QUALITY CONTROL REPORTS TO MANAGEMENT

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 Liquid Coating Protocol.

APPENDIX A

Apparatus Setup

ELEVATION VIEW – LIQUID SPRAY BOOTH WITH TEST PRODUCT



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
CKD BY:	BD
CKD BY:	
APPD BY:	MAH

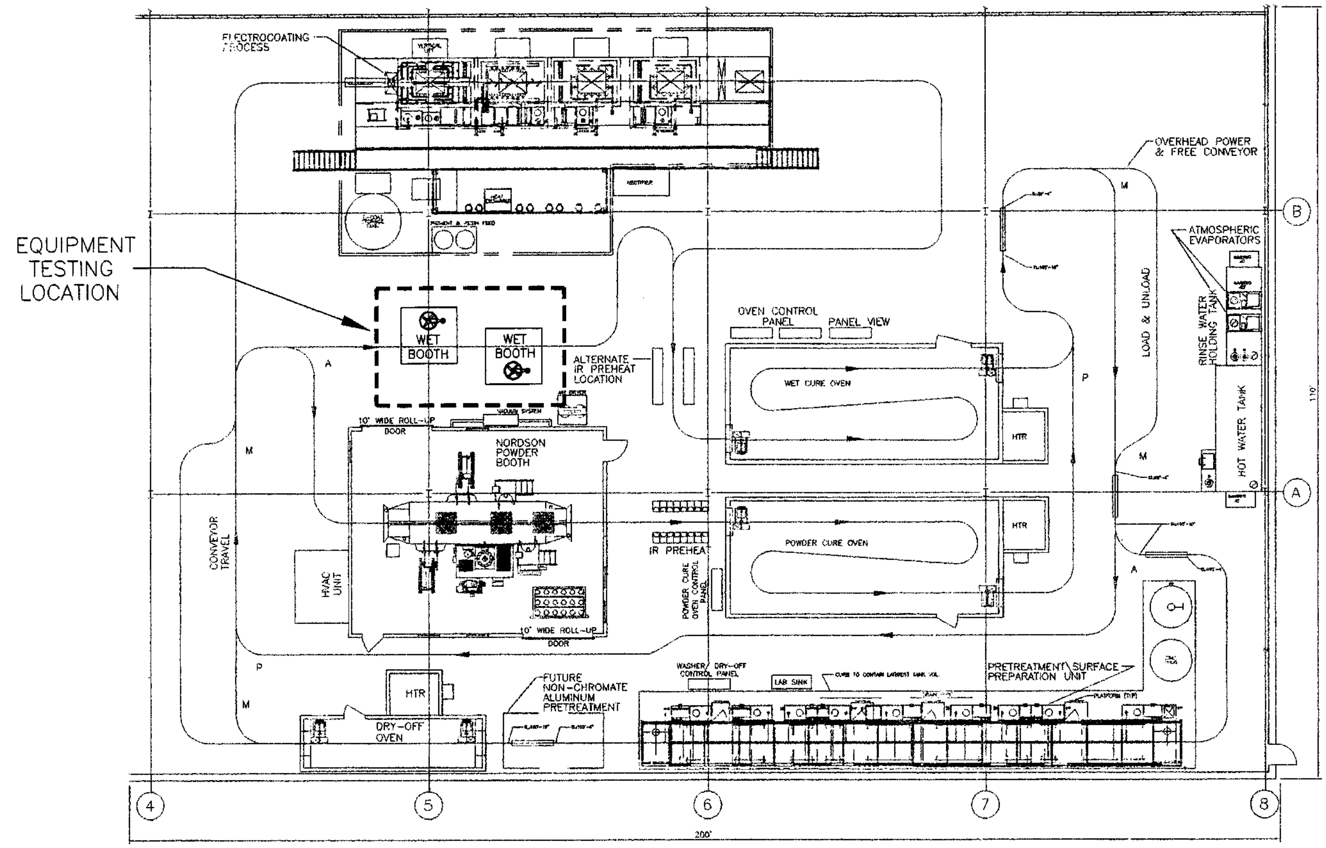
PROJECT: ENVIRONMENTAL TECHNOLOGY VERIFICATION COATINGS AND COATING EQUIPMENT PROGRAM

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
ISSUE DATE:	7-17-97
DRN BY:	HHH
CKD BY:	CMJ
CKD BY:	
APPD BY:	MSF

PROJECT: ENVIRONMENTAL TECHNOLOGY VERIFICATION COATINGS AND COATING EQUIPMENT PROGRAM

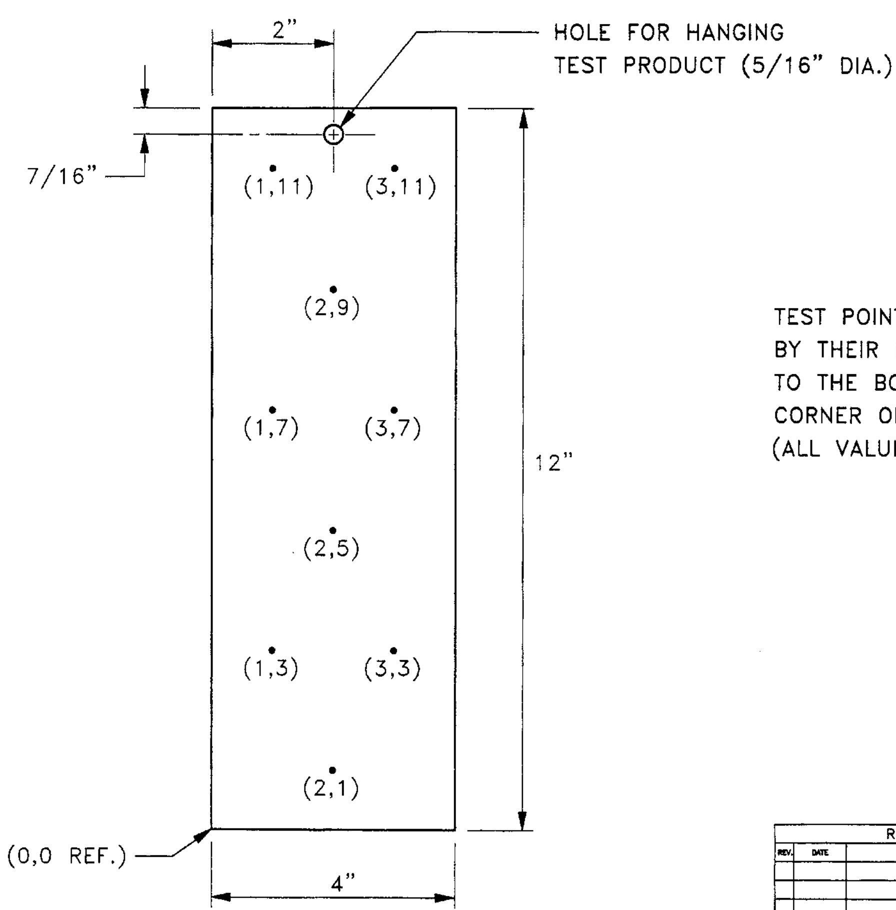
TITLE: LIQUID SPRAY EQUIPMENT TESTING LOCATION

DRAWING NO.: ETF-060-A03 REV. 0

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).

REVISIONS				
REV.	DATE	DESCRIPTION	BY	APPD

CTC Concurrent Technologies Corporation

1450 SCALP AVENUE, JOHNSTOWN, PENNSYLVANIA 15904

SCALE: NTS	PROJECT: ENVIRONMENTAL TECHNOLOGY VERIFICATION COATINGS AND COATING EQUIPMENT PROGRAM
ISSUE DATE: 12-12-97	
DRN BY: HHH	TITLE: TEST PRODUCT WITH MEASUREMENT LOCATIONS
CKD BY:	DRAWING NO.: ETF-060-A07 REV. 0
CKD BY:	
APPD BY:	

APPENDIX D

ASTM Methods

ASTM Methods

ASTM B 117	--	Standard Test Method of Salt Spray (Fog) Testing
ASTM B 499	--	Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method Nonmagnetic Coatings on Magnetic Basis Metals
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 522	--	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	--	Standard Test Method for Specular Gloss
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 1729	--	Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
ASTM D 1735	--	Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
ASTM D 2369	--	Standard Test Method for Volatile Content of Coatings
ASTM D 2244	--	Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates
ASTM D 2794	--	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	--	Standard Test Methods for Measuring Adhesion by Tape Test
ASTM D 3363	--	Standard Test Method for Film Hardness by Pencil Test
ASTM D 4017	--	Standard Test Method for Water in Paints and Paint Materials by Karl Fischer Method
ASTM D 4060	--	Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D 4457	--	Standard Test Method for Determination of Dichloromethane and 1,1,1-Trichloroethane in Paints and Coatings by Direct Injection into a Gas Chromatograph
ASTM D 5402	--	Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
ASTM E 1064	--	Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration
ASTM G 26	--	Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
EPA Method 24	--	Determination of Volatile Matter Content, Density, Volume Solids, and Weight Solids of Surface Coatings
EPA Method 311	--	Analysis of Hazardous Air Pollutant Compounds in Paints and Coatings by Direct Injection into a Gas Chromatograph