Air Force Corrosion Control Facility Reference Guide

This guide is intended for reference purposes only. It does not supersede or take precedence over cited documents herein. This document does not supersede applicable laws and regulations.

Other federal, state, and local regulations may apply that are not reference herein. Check with your fire, safety, bio-environmental, and other agencies prior to design of your facility. Overseas locations also need to check country laws and regulations to insure conformity.

The Corrosion Control Facility Reference Guide (CCFRG) is a living document and will be periodically reviewed, updated, and made available to users via Air Force Corrosion Prevention & Control Office (AFCPCO) in the Air Force Portal.

Questions concerning technical content should be directed to AFRL/RXSSR, 325 Richard Ray Blvd, Robins AFB GA 31098-1639. (Phone: DSN 468-3284) (Email: afcorr@robins.af.mil)

Table of Contents

Section

1

I. Introduction

Facility design is a complex issue with no easy interpretation of the laws and regulations. When building a facility that utilizes hazardous materials (i.e. paints, thinners, and cleaning solutions), the process is even more complex. ***This guide is intended for reference purposes only.*** It does not supersede or take precedence over cited documents herein. This document does not supersede applicable laws or regulations. This document should be used in conjunction with UFC 4-211-02, which was updated to make recommendations from the AF CCFRG mandatory.

Other federal, state, and local regulations may apply that are not referenced herein. Check with your fire, safety, bio-environmental, and other agencies prior to design of your facility. Overseas locations also need to check country laws and regulations to insure conformity.

The Corrosion Control Reference Facility Guide (CCFRG) is a living document and will be periodically reviewed, updated, and made available to users via the Air Force Portal.

This Corrosion Control Facility Design Guide provides basic guidance and criteria for constructing Air Force corrosion control facilities. Previous experience has shown that field-level aircraft maintenance personnel are frequently assigned key positions of responsibility to provide input into the design process for local corrosion control facilities. However, in many cases, these personnel do not have sufficient resources, training, or experience to adequately meet these responsibilities. This Facility Design Guide is intended to help personnel in this situation better understand corrosion control facility requirements and design criteria so they can provide complete and accurate input into the design process.

It is equally important to construct a facility that not only meets the operational needs of the user, but also complies with the vast array of federal, state, and local, environmental, safety and occupational health requirements. Unfortunately, it is a difficult and often very confusing task to determine which laws, regulations and standards apply to each individual corrosion control facility. Therefore, it is absolutely essential that all applicable base agencies be involved in the facility design process as early as possible.

The three agencies that typically have the greatest input into designing a corrosion control facility are the Environmental Management, Fire Protection, and Bioenvironmental Engineering sections. Although it is important that these agencies get involved in the design process as early as possible, it is equally important that active and continuous communication channels be maintained throughout the entire design and construction process. Without active involvement from these agencies, as well as the user, it is very likely that the completed corrosion control facility will not meet expectations.

A. Objective

This guide is intended to help the user identify facility design requirements contained in Air Force, Department of Defense, Occupational Safety and Health Administration (**OSHA**), Environmental Protection Agency (**EPA**), and National Fire Protections Agency (**NFPA**) policies, instructions, standards and technical orders. The primary objective of this guide is to provide a format that consolidates those significant requirements that are unique to corrosion control facilities into a single document. The information contained in this guide is not intended to address all of the requirements applicable to designing a corrosion control facility. Instead, it is intended to address those requirements which are unique to corrosion control facilities, and is specifically intended to address those requirements that have been overlooked or misunderstood during the design of previous corrosion control facilities.

Note: The requirements addressed in this guide are minimum standards and may need to be modified to meet unique or particularly stringent state, local, or base requirements.

B. Obtaining Referenced Documents

Not all documents referenced in this guide are available via websites. Some are only available in paper form; while others must be purchased from the preparing activity. This situation is particularly true for National Fire Protection Association (NFPA) and American National Standards Institute (ANSI) documents. These references may be purchased at the respective websites. Before purchasing copies of these documents, it is recommended that the local Civil Engineering function and Fire Protection branches be contacted to determine if they have copies available for base-wide use.

Note: Some links to reference documents will open the document's homepage versus the actual PDF file. This will allow the user to view the latest version of the referenced documents. The official source for Military Handbooks is the Document Automation and Production Service (DAPS) ASSIST web site. At this website, type in the Military Handbook number in the Document number box (see sample below). This will bring up a list of documents, select the document you wish to view.

It is also highly recommended that an account with the Construction Criteria Base (**CCB**) be established. To establish an account go to **www.ccb.org**. Construction Criteria Base (CCB) is an extensive electronic library of construction guide specifications, manuals, standards and many other essential criteria documents, published on the Internet and on a set of eight CD-

ROM discs or one DVD by the non-profit National Institute of Building Sciences (**NIBS**). The CD-ROMs and website will allow you to have all the MIL-HDBKs available to you.

Several of the MIL-HDBKs have been superseded by Unified Facilities Criteria (UFC) Technical Publications. UFCs were developed by a Tri-service committee which is comprised of representatives from the three military services and the Department of Defense. These UFCs can be found at Whole Building Design Guide (**WBDG**) using the Search CCB link.

C. Corrosion Control Facility Description

The typical corrosion control facility is usually not a single facility. Therefore, it is impossible to describe a typical corrosion control facility. At many bases/units, the various corrosion control functions are adequately performed in several different facilities. Only a very small number of units/bases have a single facility where all major corrosion control functions are performed. A single facility capable of supporting all corrosion control functions is certainly an ideal situation and generally contributes to a more effective unit/base corrosion control program. However, it is not the intent of this guide to mandate the construction of a single facility to house all corrosion control functions. It would be unreasonable and certainly not cost effective for a unit/base to design a consolidated facility if a particular corrosion control function is currently being performed in a suitable existing facility (i.e. an indoor wash rack). Instead of addressing design requirements for a consolidated corrosion control facility, this guide will instead concentrate on the significant design requirements needed to meet the most common federal and Air Force environmental, safety, fire, and occupational health regulations and standards applicable to individual corrosion control functions.

Although each corrosion control function will be addressed separately, many facility design requirements apply to more than one corrosion control function. Therefore, to reduce duplication in this manual, these general requirements will be grouped together and addressed in one section.

D. Initial Funding Issues

1. Unexpected Ventilation System Costs

A significant number of corrosion control facilities designed and constructed in recent years have failed to meet mandatory federal, state, and local occupational health and safety, environmental, and fire requirements. As a result, many Air Force bases have been forced to deal with expensive facility modifications and long delays in getting new corrosion control facilities operational. There are many different reasons for these problems, but one recurring issue has been the unexpected cost of the facility's ventilation system. A typical corrosion control facility requires a very complex, and therefore costly ventilation system to ensure the facility complies with applicable environmental, fire protection, and occupational health requirements. Since this ventilation system is far more expensive than the systems typically required on other facilities, it is common for this extra expense to be overlooked when funding is first being sought for the corrosion control facility. This situation can lead to the facility being significantly under-funded, which may necessitate changing the scope of the project and reducing or eliminating other features in the facility late in the design process.

In many cases, features that are eliminated to fund the costly ventilation system (i.e. fall protection cables) have dramatically reduced the operational usefulness of the facility. In some cases, these changes have created shortfalls in mandatory equipment or facility features that have made it difficult for the base to get required facility permits and open the facility on-schedule. To help eliminate this situation, it is absolutely crucial that a statement be included on the **DD Form 1391**, and consequent Statement of Work, the industrial ventilation systems requirements description and cost, which should include;

- Identification of all significant contaminant sources that require ventilation control.
- Consideration on how the facility is to be used or expanded in the future. It may be possible to initially specify fans that are capable of handling future nees at minimal increased cost.
- Identification of all required industrial ventilation system/s (e.g. paint booth, abrasive blast booth, paint mixing room, etc.) and approximate size that best suits the work piece and operations.
- Listing of any local air quality requirements that may impact the design and cost of the system (e.g., existing Title V permit).

A statement noting that part of the facility requirements includes the mandatory need for mechanical ventilation to remove paint particulates and solvent vapors. The inclusion of this statement, as well as including the costs for the system (including the acceptance test and associated report), as a separate line item in the facility cost estimate will help ensure that adequate funds are allocated for this extremely costly requirement. An example of a statement that might be included on the **DD Form 1391** and consequent Statement of Work is show below:

"Mechanical ventilation is required for a Walk-in Spray Paint Booth (approximately 8ft by 10 ft by 20 ft) to remove paint particulates and solvent vapors from the corrosion facility. The base is currently under a Title V Major Air Source Operating Permit; contact the Base air Program Manager for details on local air quality requirements. Upon facility completion, an independent ventilation expert must access the mechanical ventilation system effectiveness. The ventilation expert shall provide a detailed ventilation system acceptance/discrepancy report."

2. Source Permitting and Modeling Costs

Another significant cost frequently overlooked during development of the **DD Form 1391** has been the funds required for facility air-emission source permitting and modeling after construction has been completed. Requirements for the facility air-emission source permitting and modeling can be located in the EPA Title V, which is administered by each state. This expense should also be included as a separate line item on the **DD Form 1391**

Attachment 3: DD Form 1391

1. COMPONENT CONTROL **A&T(A)1610**	FY ____MILITARY CONSTRUCTION PROJECT DATA	2. DATE ***(YYYYMMDD)***	REPORT SYMBOL **DD-**

3. INSTALLATION AND LOCATION	4. PROJECT TITLE

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COS T **($100)**

9. COST ESTIMATES

ITEM	UM	QUANTITY	UNIT COST	COST **($000)**

10. DESCRIPTION OF PROPOSED CONSTRUCTION

DD FORM 1391, JUL 1999 PREVIOUS EDITION IS OBSOLETE PAGE NO.

It is absolutely essential to ***clearly state all justification*** information on the **DD Form 1391**. It is important to remember that information on the **DD Form 1391** will be used by higher high levels of management to reach decisions that will impact the approval of the project.

3. Construction and Operating Permits

Many different types of permits must be obtained before beginning construction on the facility. Additionally, various types of permits must also be obtained prior to putting the facility into operation. These permitting requirements can be very complex and can vary greatly from state to state. The local Civil Engineering and Environmental Management functions typically have overall responsibility to obtain all permits that are applicable for construction and operation of the Corrosion Control Facility. Specific requirements in this area exceed the scope of this Facilities Guide and will not be addressed in detail. Contact the local authority for current information.

E. Applicable Environmental Standards

1. Federal

[Ref: **AFI 32-7040**, **AFI 32-7061**, & **AFI 32-7062**]

Many different federal environmental standards and regulations significantly impact the design of a Corrosion Control Facility. This vast array of requirements exceeds the scope of this guide and will not be covered in significant detail. For more information of environmental standards and regulations, contact your local environmental engineer and bioenvironmental office. During the planning stage of the corrosion facility, planners will complete a General Conformity applicability analysis before completion of the Environmental Impact Analysis Process (EIAP) to allow incorporation of its information into the EIAP. Federal actions must conform to the approved State Implementation Plan (SIP) until the State modifies the SIP or EPA approves the SIP. [**AFI 32-7040**, **AFI 32-7061**, & **AFI 32-7062**]

a. Clean Air Act

[Ref: 40 CFR Chapter I, Subchapter C, **AFI 32-7040**, & **AFI 32-1054**]

The Clean Air Act (CAA) is the major Federal statute [40 CFR Chapter I] governing the quality of ambient air and permitting releases to the air. There are several programs in the CAA that may have significant impacts or restrictions on the corrosion facility. One main way that the air quality is assured is the new source review (NSR) program. NSR program requires operators of certain types of air pollution-emitting facilities to apply for permission to build in certain areas to prove that the air will not result in worse air quality. These new major sources must not upset the established national ambient air quality standards (NAAQS) and may be required to implement Best Available Control Technology (BACT) to reduce hazardous air pollutants (HAPs) to Lowest Achievable Emission Rates (LAER). There are three types of permits issued under the NSR Program. The permits are Prevention of Significant Deterioration (PSD), nonattainment area NSR, and minor source NSR. The permit is based basically on the threshold values of regulated pollutants. [**AFI 32-7040**]

One air standard that might be of particular importance is the *National Emission Standards for Hazardous Air Pollutants for Source Categories: Aerospace Manufacturing and Rework Facilities* (commonly called the Aerospace NESHAP). This EPA standard applies to facilities that are a "major source" of hazardous air pollutants (HAP) and are involved in the manufacture or rework of commercial, civil, or military aerospace vehicles. (A "*major source*" of HAPs is defined as a facility or group of aerospace facilities within a contiguous area that emits or has the potential to emit 10 tons per year or more of any listed HAP or 25 tons per year or more of any combination of listed HAP) The local Environmental Management function will use many references, such as a NESHAP flow chart (figure 1) to determine if the proposed facility has the potential to be designated as a *major source*. This important determination will provide key information on whether or not Aerospace NESHAP requirements will apply to the facility, and will have very significant bearing on many design requirements for the facility.

It is important to note that many bases have elected to comply with NESHAP requirements even if they are not currently legally required to do so. Although the decision to voluntarily elect to comply with NESHAP requirements might initially lead to expensive facility design requirements, it ensures the facility will already be NESHAP compliant if circumstances change at the base and the facility is required to comply with NESHAP requirements at a later date.

b. Clean Water Act

[Ref: 40 CFR Chapter I, Subchapter D, N, and O & **AFI 32-7041**, **AFI 32-1054**]

The Clean Water Act (CWA) is the primary Federal statue [40 CFR Chapter I] governing the quality of the Nation's water. It prohibits the discharge of any pollutant into navigable waters without a permit. Review the National Pollutant Discharge Elimination System Permits (NPDES) permits, the installation of the Spill Prevention, Control and Countermeasures (SPCC) and related documents pertaining to water quality. Also, remember that the Storm Water Pollution Prevention Plan (SWPPP) may need to be reviewed or updated. If the construction disturbs one or more acres, a completed SWPPP and submission of Notice of Intent (NOI) must be timely. [**AFI 32-7041**]

Wastewater discharges from Federally Owned Treatment Works (FOTWs) that is a point source into waters of United States require a NPDES permit. Discharges to Publicly Owned Treatment Works (POTWs) are considered as secondary discharges and are regulated by the POTW authority. POTW authority may have applicable regulations, permits, and agreements. [**AFI 32-7041**]

c. Resource Conservation and Recovery Act

[Ref: 40 CFR Chapter I, Subchapter I, **AFI 32-7041**, **AFI 32-7042**, & **AFI 32-1054**]

The Resource Conservation and Recovery Act (RCRA) is the broadest and widest waste law [40 CFR Chapter I, Subchapter I]. It manages waste included in a variety of other Federal statues such as Toxic Substances Control Act (TSCA), Used Oil Recycling Act, CAA, CWA, and Occupational Safety and Health Act. RCRA regulates solid waste (SW) and hazardous waste (HW) under the concept known as "cradle to grave". Many routine aircraft maintenance operations produce HW because of RCRA's definition. The hazardous waste management plan (HWMP) covers issues such as training, characterization, accumulation, treatment, recycling, inspections, and disposal of HW. [**AFI 32-7042**] One area that might be overlooked is industrial wastewater. Governmental regulations may prohibit discharging such wastewater into domestic wastewater or other non-industrial sewer systems. Pretreatment may not be practical also resulting in the wastewater to be managed under RCRA. [**AFI 32-7041**]

The bulk of what has to be done as RCRA is actually found in the Hazardous and Solid Waste Amendment (HSWA) that was pasted in 1984. Care must be taken with RCRA regulations found in 40 CFR Chapter I, Subchapter I, Parts 260-281. In some activities, the generator can become the transporter or the treatment, storage, and disposal (TSD) facility based on HW duties and activities. This can have a major impact on training and the HWMP. Be sure to coordinate with local environmental engineers and bioenvironmental personnel for complete RCRA understanding.

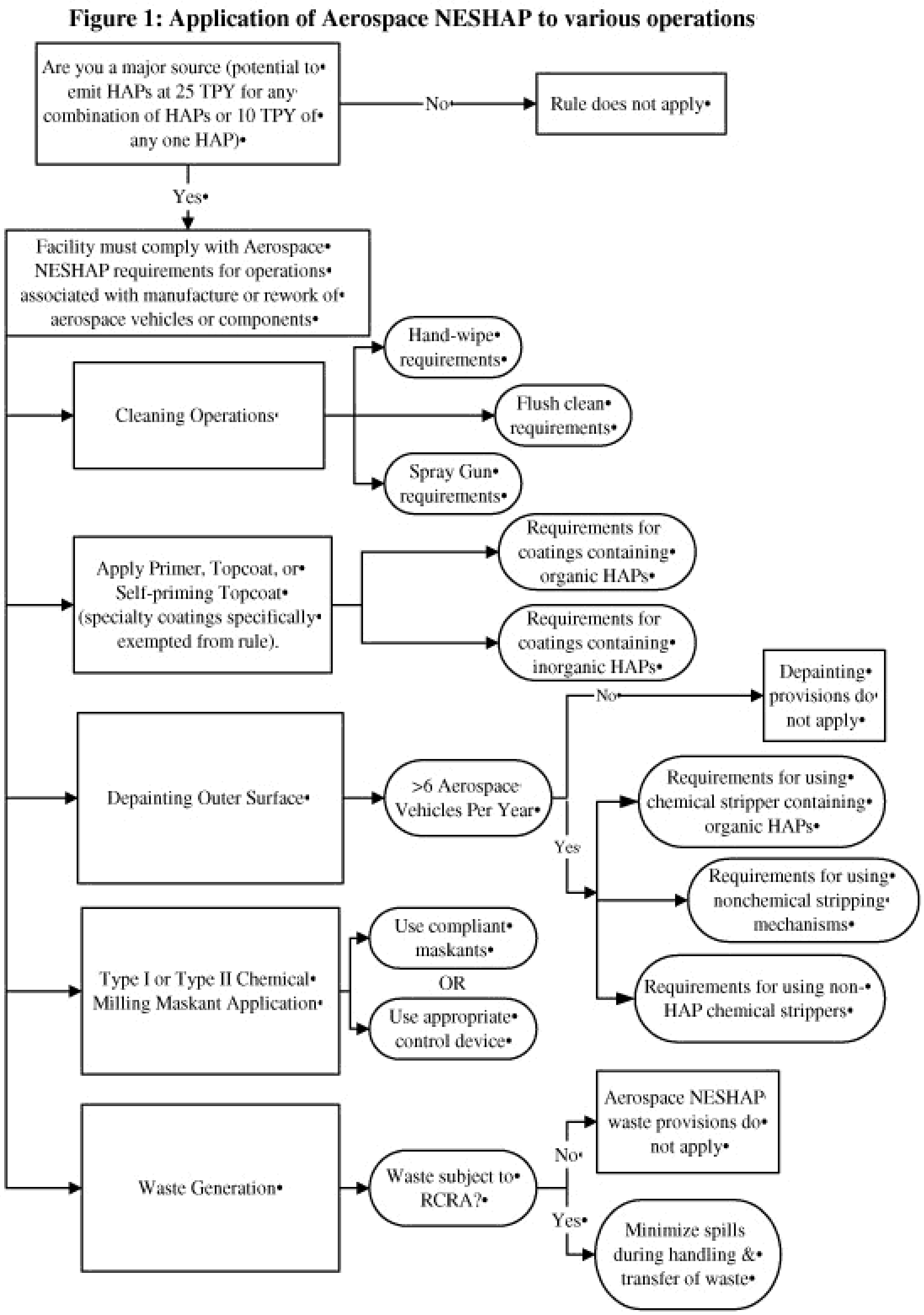
2. State

In addition to meeting various federal laws, regulations and standards, the facility will also be required to comply with many different requirements mandated by the state the facility is located. Unfortunately, individual state environmental programs sometimes vary greatly. Therefore, it is important for local base agencies assisting in the design process to have access to the most current information. This type of information that is specific to each state can be found at the following website: **http://www.rmis.com/db/lawepa.htm**. Given the wide variety of applicable environmental quality requirements, it is imperative to consult with the base Environmental Management function as early as possible to ensure compliance with all the relevant federal, state and local environmental laws/regulations.

3. Local

More focus is being placed on the impact of local regulations through the Public Owed Treatment Works (POTW). Local systems are under tighter demands for drinking water, water usage, and sewer treatment. Industry programs many times focus only on the end-of-pipe solutions, which only handles wastewater pollutants. Yet, facilities that work with local regulators can help reduce pollution and waste cost. Ensure that local regulations are reviewed to prevent construction delays and reduce potential construction retrofits.

Figure 1: Application of Aerospace NESHAP to Various Operations



General Corrosion Control Facility

Section
2

II. General Corrosion Control Facility

A. General Facility Requirements

[Ref: **AFH 32-1084**]

General construction issues of the facility should follow **UFC 4-211-02**, *Corrosion Control and Paint Finishing Hangers*. Many factors must be considered when deciding what type of corrosion facility is required to meet the operational needs of the unit or base. The type and size of aircraft, level of maintenance required, and suitability of existing facilities are only a few of the key considerations. As stated in **AFH 32-1084** *"* Specific workloads vary from base to base, but the **minimum required facilities** include a wash rack, shop space for complete corrosion treatment and painting removable aircraft parts and ground support equipment, and a corrosion approved facility to perform aircraft maintenance painting."

B. Basic Functional Requirements

[Ref: **AFH 32-1084** & **UFC 4-211-02**]

Basic function requirements have been incorporated into UFC 4-211-02 for Countless local variables such as manpower, workload, and level of capability required, and existing capabilities make it impossible to establish specific functional requirements for unit/base-level Corrosion Control Facilities. **AFH 32-1084** states: "The number and size of corrosion control facilities is the minimum size required to accommodate the largest aircraft serviced and workload required to support the Air Force corrosion control concept."

C. Space Criteria

1. Minimum Interior Dimensions

[Ref: **AFH 32-1084** & **UFC 4-211-02**]

To determine the interior dimensions of the Corrosion Control facility, use the dimensions of the largest aircraft that will occupy the facility plus an additional 3m (10 ft) on each side of aircraft to facilitate maintenance stands, etc. Do not overlook tail heights, the height and width of door, openings, structural protuberances in facilities, and the turn radius of tow vehicles connected to aircraft. **AFH 32-1084** and **UFC 4-211-02** provides a means to determine minimum interior dimension requirements for an aircraft corrosion control hangar.

In addition to the clearances in **AFH 32-1084** and **UFC 4-211-02**, the depth of the door and exhaust plenum is required to properly size the hangar bay. The equation T = 1/5H defines this depth where H is the height of aircraft at its highest point plus 1.6m (5 ft). Note that the depth (T) does not include the thickness of the structure of the door or the filter media.

2. Impact of Maintenance Stands and Other Support Equipment

[Ref: **AFH 32-1084**]

One important factor frequently overlooked during the design phase of Corrosion Control Facilities is the importance of deciding very early in the facility design process what type of maintenance stands that will be installed or used in the facility. Decisions concerning how personnel will access all areas of the aircraft have a profound impact on the size and shape of the facility, and therefore must be addressed as part of the overall facility design process. Unfortunately, it is not uncommon for extensive design modifications to be required to accommodate large maintenance stands or other types of support equipment. In situations where these design modifications were not identified early enough, overall usefulness of the facility has been degraded.

3. Authorization for Additional Workspace

[Ref: **AFH 32-1084**]

The need for additional covered workspace (hangar space) to accommodate corrosion control workload is specifically addressed in **AFH 32-1084**. If the corrosion control workload exceeds the capability provided by the covered workspace allocated by Table 7.1 or paragraph 7.3, special authorization for one additional covered workspace is granted. An excessive corrosion control workload occurs with some combinations of numbers and types of aircraft, environmental and climatic factors, and the availability of scheduled depot maintenance. It is also important to note that the additional workspace must be provided as a single aircraft space because of isolation requirements driven by fire, occupational health, and environmental restrictions associated with most corrosion control functions.

4. Dual-Use Facilities

[Ref: Various MAJCOM Corrosion Survey Reports]

In previous years, some units/bases designed facilities with the intention of utilizing them in a "dual-use" capacity. These facilities were most commonly designed to alternately accommodate both the primary corrosion control maintenance function and the fuel-cell repair function. Without exception, facilities designed with this intended purpose did not adequately meet the specific requirements of the individual maintenance functions, or were over-utilized by one function to the extreme detriment of the other function. Fortunately, this design philosophy has largely been abandoned, but the potential may still exist for this issue to resurface. Therefore, any unit that is contemplating the design of a dual-use facility should contact the AFCPCO for additional information.

5. Over-Complication of Facility Requirements

Units are cautioned to avoid over-complication of facility design requirements. The addition of optional features, such as filtration or interlock systems that greatly exceed federal, state and local requirements, have created significant operational problems in many existing facilities. These optional features were generally extremely complicated, cutting-edge technology, that in many cases, had reliability and maintainability problems. These complicated systems were usually added with the intention of improving health, safety, or environmental compliance; frequent system malfunctions negatively impacted the facility's ability support mandatory operational requirements.

D. Minimum Requirements for Specific Corrosion Control Facilities

[Ref: **AFH 32-1084**]

1. Aircraft Wash Facility

The basic aircraft wash facility will be equipped with heating, hot and cold water, electric power, compressed air and a waste disposal system for oils, alkalis, salts, hydroxides and other industrial waste products generated by aircraft cleaning. See **MIL HDBK 1138**, *Wastewater Treatment Systems ,* for the types of oil-water separators required for aircraft wash racks. See also, **AFI 32-1054**, **AFI 32-7040**, **AFI 32-7041**, **UFC 3-260-02**, and **AFI 32-7042**.

2. Aircraft Corrosion Control Paint Hangar

The basic aircraft corrosion control paint hangar will be equipped with hot and cold water, electricity, compressed air, waste disposal, and environmental controls necessary to meet EPA, OSHA, and state and local requirements. See **MIL HDBK 1138**, **AFI 32-1054**, and **UFC 4-211-02**.

3. Ventilation For Control of Air Contaminates and Flammable Vapors

[Ref: **UFC 4-211-02**, **NFPA 33**, & ANSI Z9.2,4,7]

For information on ventilation requirements refer to **UFC 4-211-02**. To avoid atmospheric downwash, all stacks must be designed to meet the minimum stack height requirements of 40 CFR 51.00 (ii).

4. Plumbing

[Ref: UFC 4-211-02]

For information on plumbing requirements refer to UFC 4-211-02.

5. Compressed Air

[Ref: UFC 4-211-02]

For information on compressed air requirements refer to UFC 4-211-02.

Quick connection fittings for shop air and breathing air should be different for each service and not be compatible with each other. Breathing air must meet the requirements by OSHA for a minimum Grade D air. Intake air for breathing air should be located in an uncontaminated and comfortable temperature area.

6. Lighting

[Ref: UFC 4-211-02**&** **UFC 3-530-01**]

Interior lighting in the main hangar bays should provide 1076 lux (100 footcandles) measured 0.76 meters (30 inches) above the floor. Metal halide fixtures should be used and exterior lighting should be high-pressure sodium vapor where practical and in accordance with **UFC 3-530-01**, *Interior and Exterior Lighting and Controls*.

7. Electrical Installations

[Ref: UFC 4-211-02**,** **UFC 3-520-01**, **&** **NFPA 70**]

Electrical systems should be in accordance with **UFC 3-520-01**, *Interior Electrical Systems* and UFC 4-211-02.

8. Corrosion Control Shops

The basic corrosion control shop will have electricity, hot and cold water, compressed air, waste disposal, and ventilation for the paint booth.

9. Deluge Rinse Capability (Bird Baths)

[Ref: **T.O. 1-1-691** **&** **UFC 3-260-02**]

Although not covered in detail in this guide, an automatic deluge rinse capability can play an important role in the corrosion prevention and control program of units based close to salt water or units that regularly fly low-level flights over salt water. This capability is typically provided by installation of appropriate water delivery and containment/drainage systems that are located in a taxiway area for use by aircraft immediately following return from flight. These installations provide multiple jet sprays of fresh water to cover the entire aircraft exterior surface to rinse off salt and water-soluble contaminants. They provide an expedient means of meeting the clear water rinse requirements contained in **T.O. 1-1-691**. Since design and construction requirements for this capability varies greatly at individual bases, they will not be addressed in this guide. However, general information may be obtained by contacting the AFCPCO or visiting our website at **Air Force Corrosion Prevention & Control Office**. This is a secure site so; you must have military access to view this site.

UFC 3-260-02, Section 8, *Airfield Geometric Design, Other Airfield Pavements*, also is an excellent reference for guidance on aircraft rinse facility design and equipment placement.

E. General Construction Information

The following general information is applicable many different types of facilities that are used to house or support the various base-level corrosion control functions.

1. Industrial Waste Treatment System

[Ref: UFC 4-211-02]

Refer to UFC 4-211-02for industrial waste treatment.

2. Basic Layout

[Ref: **AFOSHSTD 91-501**]

Proper layout, spacing, and arrangement of equipment, machinery, passageways, and aisles are essential to safe and orderly operations, and to avoid congestion. A good layout can best be achieved in the design stage, with recommendations from the user, Base Ground Safety, Fire Protection, Bioenvironmental Engineering (BEE), and Civil Engineering (CE) representatives. All interior walking and working surfaces, which are part of the means of egress, shall comply with the requirements of National Fire Protection Association (NFPA) 101, *The Life Safety Code*. For guidance on walking surfaces, fixed stairs and portable/fixed ladders to be utilized in the facility refer to **AFOSHSTD 91-501**, *Air Force Consolidated Occupational Safety Standard*.

a. Hygiene Facilities/Sanitation

[Ref: **UFC 4-211-02**]

1) Drinking Water

An adequate supply of drinking water shall be provided in all places of employment. Cool water shall be provided during hot weather.

2) Toilets

[Ref**: UFC 4-211-02**]

Restroom facilities shall be provided in all places of employment. Refer to UFC 4-211-02for addition information.

b. Administration Areas

Sufficient private office space should be provided in the facility to enable shop supervisors, who are typically senior non-commissioned officers or equivalent civilian personnel, to prepare paperwork, counsel subordinates, and perform other associated supervisory responsibilities. These offices should be located adjacent to the respective work areas. Offices should also be acoustically treated to minimize noise levels.

c. Support Areas

[Ref: UFC 4-211-02]

Support areas typically include break rooms, storage areas, supply/janitorial closets, and mechanical rooms. A break room should be provided that is large enough to comfortably accommodate the number if personnel working on each shift.

Storage areas include required space to store and issue tools, equipment, and supplies. The area designated to support these functions should be centrally located within the facility to allow easy access from the main work area. An area to store and issue publications and technical manuals should also be centrally located to provide easy access to all shop personnel.

d. Tool Crib

This area needs to be large enough to house equipment and materials. Examples include but are not limited to individual tool kits, paint guns, pressure pots, PE equipment, air hoses, water hoses, sanders, vacuums, paint filter replacements, and bench stock. This additional room is needed because of new tool controls in many locations.

e. Stencil Room

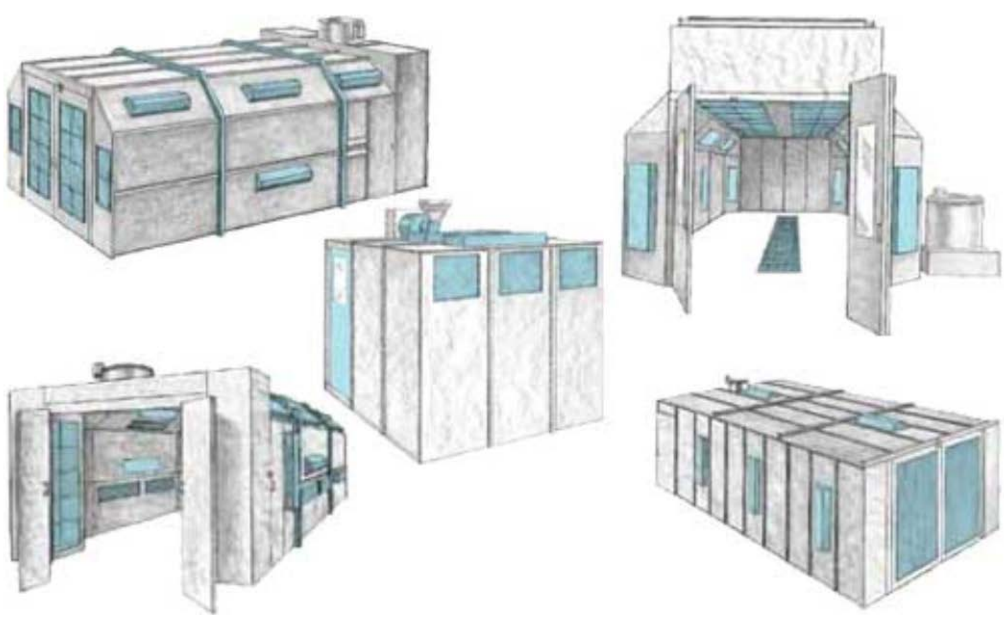
The area will be used primarily to house computerized stencil making equipment. This will help facilitate speed and area to properly generate necessary templates and space to perform detailed work.

f. Fire Protection

[Ref: UFC 4-211-02, **UFC 3-600-01**, **ETL 02-15**, & **ETL 98-8**]

Extensive fire protection systems are mandatory for virtually all facilities that house corrosion control functions. It is absolutely critical the fire protection systems be designed for individual hazards, functions, and facilities in accordance with many different specific references. Some of the basic fire protection references are: UFC 4-211-02, **UFC 3-600-01**, **ETL 02-15**, and **ETL 98-8**. However, these documents also reference many applicable NFPA Codes. The vast array of very specific and absolutely critical design requirements for fire protection systems exceeds the scope of this Facilities Guide and will not be addressed in detail. Therefore, it is essential that the local Civil Engineering and Fire Protection functions be consulted to ensure all fire protection requirements applicable to specific corrosion control functions and facilities are met.

Paint Spray Booths



Spray painting of an entire aircraft is permitted only in hangars specifically designed for this purpose.

Section 3

III. Spray Paint Booths

A. Paint Spray Booths General Information

[Ref: **OSHA 1910.107**, UFC 4-211-02& **NFPA 33**]

OSHA defines a "Spray Booth" as a powered-ventilated structure provided to enclose or accommodate a spraying operation to confine and limit the escape of spray, vapor, and reside and to safely conduct or direct them to an exhaust system. [**OSHA 1910.107** & **NFPA 33**] This definition applies equally to large aircraft corrosion control paint hangars or smaller "walk-in" booths used to paint removable aircraft components and support equipment. Therefore, all design requirements are also equally applicable.

There are numerous types and configurations of paint spray booths to consider. The most common types are water-wash and dry-spray. The most common configurations are cross draft; downdraft, and semi-downdraft. The advantages and disadvantages of each particular booth should be closely evaluated before a final decision is made.

Various aspects of booth construction and installation are regulated by the National Electric Code (NEC 516), Uniform Fire Code (**UFC 4500**), National Fire Protection Association (**NFPA 33**), Uniform Mechanical Code (UMC 1107) and various state, local, DoD, and Air Force Regulations. A fully functional and usable facility must meet all the standards and regulations. If it is anticipated that powder coatings may be applied in the paint booth in the future, unique requirements may be applicable, Contact the AFCPCO for specific information.

1. Types

a. Air-Water Wash

[Ref: **T.O. 1-1-8**, UFC 4-211-02 & **OSHA 1910.107**]

An air-water wash spray booth is designed to minimize airborne paint particles entering exhaust ducts through use of a water curtain. The water is supplied from a tank and is constantly circulated through the system while the booth is being used. One of the disadvantages of a water wash paint booth is that upon replacement with fresh water, the paint-contaminated water likely requires handling as hazardous waste. A paint sludge removal system may be installed to help reduce the amount of hazardous waste that must be disposed of before it may be discharged to a municipal treatment plant [UFC 4-211-02]. A water wash spray booth will remove up to 95% of paint residue before it is exhausted. However, many locales may have efficiency requirements greater than 95%.

b. Dry

[Ref: **T.O. 1-1-8**, **OSHA 1910.107** & **40 CFR Part 63**]

A dry booth uses filters instead of water to extract airborne paint particles before they enter the exhaust ducts. A dry spray booth is relatively low in cost and is generally easier to install than an air- water wash booth. These booths are available with various types of filters, sizes and materials. It is important to note that applicable environmental regulations may dictate the number of filter banks required for a particular locale.

2. Configurations

Regardless of the size or type of the booth, they consist of one of three basic configurations for directing airflow.

a. Cross-draft

In a typical cross-draft booth, the air enters through filters in the front of the booth and is exhausted through filters in the back of the booth. Airflow is parallel to the floor. This type of ventilation system is usually the least expensive and is the most common type used on Air Force installations. This type of booth generally provides effective, consistent ventilation. However, the horizontal movement of the air makes it very important that the painter be positioned correctly to avoid having paint-laden air directed toward him or her.

b. Downdraft

Downdraft booths are designed to let air enter through filters in the ceiling of the booth and leave through metal grating in the floor. Airflow is vertical to the floor. In most situations, this vertical airflow is more effective than the horizontal airflow in a cross-draft booth at removing paint-laden air from the vicinity of the painter. Air is immediately drawn toward to the floor instead of potentially being drawn toward the painter. This would appear to make downdraft booths ideal for all situations. However, one significant disadvantage to vertical airflow is that it can be significantly impeded by large objects located between the floor and ceiling (i.e. aircraft wings and horizontal stabilizers). This situation can create large areas under these horizontal surfaces where airflow is virtually stagnant. For this reason, downdraft booths are usually better suited for smaller booths than they are for aircraft corrosion control paint hangars.

Another factor that must be considered is these booths are usually more expensive to build than cross-draft booths because they require either building a pit beneath the booth or raising the floor by some means. The operating expenses with a downdraft booth are also usually higher because these systems typically draw more air.

c. Semi-down Draft

In a semi-downdraft booth, air enters through filters in the ceiling near the front of the booth and is exhausted through filters in the back of the booth. This type of booth can be used where it is not practical to extract from an under-floor pit. Semi-downdraft booths offer some compromise between the cross-draft and downdraft configurations. Therefore, they share the advantages and disadvantages associated with each configuration. Their use on Air Force installations or industry is not widespread.

B. Spray Paint Booth Design Requirements

Most aspects of booth design are regulated by many different codes and standards. Some of the most common are: **OSHA 1910.107**, **NFPA 33** and **NFPA 69**, and ANSI 9.3 and 9.7. Some of the more significant requirements in these references or requirements frequently overlooked are listed below:

C. General Construction Requirements

[Ref: **OSHA 1910.107** & **NFPA 33**, unless otherwise noted]

A. Aluminum shall not be used for structural support member or the walls or ceiling of a spray booth. Aluminum shall also not be used for ventilation ductwork.

B. Each spray booth shall be separated from the other operations by not less than 3 feet (915 mm), or by a greater distance, or by such partition, wall, or floor/ceiling assembly having a minimum fire resistance rating of 1 hour.

C. A clear space of not less than 3 ft (915 mm) shall be maintained on all sides of the spray booth. This clear space shall be kept free of any storage or combustible construction.

Exception: This requirement shall not prohibit locating a spray booth closer than 3 ft (915 mm) to or directly against an interior partition, wall or floor/ceiling assemble that has a fire resistance rating of not less than 1 hour, provided the spray booth can be maintained and cleaned.

D. Enclosed spray booths and spray rooms shall be provided with at least one means of egress that meet the requirements of NFPA 101, *Life Safety Code.*

1. Walls, Ceilings, Floors and Doors

[Ref: **OSHA 1910.107**, **AFI 91-203**, **UFC 4-211-02** & **NFPA 33**]

A. The interior surfaces shall be smooth and continuous without edges and otherwise designed to prevent pockets that can trap residues, and designed to facilitate ventilation and cleaning. [**NFPA 33**] (Note: This requirement mandates that non-corrugated materials be used for interior wall construction and all pipes, electrical conduit and ventilation ductwork be furred-in behind approved construction material) [**T.O. 1-1-8**]

B. Walls and ceilings that intersect or enclose a spray area shall be constructed of noncombustible or limited-combustible materials or assemblies and shall be securely and rigidly mounted or fastened. [**AFI 91-203**, **NFPA 33**]

C. Distribution or baffle plates, if installed to promote an even flow of air through the booth or cause the deposit of overspray before it enters the exhaust duct, shall be of noncombustible material and readily removable or accessible on both sides for cleaning. These types of plates shall not be located in exhaust ducts.

D. The floor of the spray area shall be constructed of noncombustible material, limited-combustible material, or combustible material that is completely covered by noncombustible material. [**NFPA 33**]

2. Electrical Requirements

[Ref: **NFPA 33** & **NFPA 70**]

When selecting electrical wiring, lighting, and equipment for paint spray booths, safety considerations are extremely complex and must be followed exactly. Electrical wiring and utilization equipment shall meet all applicable requirements of Articles 500, 501, 502, 505, and 516 of **NFPA 70**, *National Electrical Code*. **NFPA 33** provides very detailed information on how to determine the designation of electrical areas Classes and Divisions applicable to various types and configurations of spray booths. Since this information is so critical and is subject to frequent change, it is highly recommended that the latest revision to **NFPA 33** be consulted before any construction projects are started. However, some general information is listed below:

A. All metal parts of spray booths exhaust ducts, and piping systems conveying flammable or combustible liquids or aerated solids shall be properly electrically grounded in an effective and permanent manner.

B. The electrical equipment shall be interlocked with the ventilation of the spraying area so that the equipment cannot be operated unless the ventilation fans are in operation.

C. All electrical wiring, equipment and lighting located inside and around the booth shall be suitable for the location. (Interior areas are generally rated Class I, Division 1, adjacent exterior areas are generally rated Class I, Division 2) Note: Any emergency lighting within the booth must also meet applicable explosion-proof requirements.

Lightning grounding and static electricity grounding shall be provided in accordance with AFM 88-9, Chapter 3 and **NFPA 70**. No fewer than two grounding conductors will be provided for connection to grounding electrodes at opposite corners of any building. For aircraft paint hangars, electrodes will be provided for each aircraft space approximately 10 feet from centerline of the aircraft space, and will be installed at 50-feet intervals. Spacing of electrodes from wall lines or columns will not exceed 50 feet.

Overhead reel-mounted grounding capability may be appropriate to supplement conventional floor ground receptacles. It is imperative that grounding reels be placed so to not create tripping hazards or entangle air hoses.

3. Lighting

[Ref: **NFPA 33**, **NFPA 70**, & **UFC 3-530-01**]

Selecting the proper lighting for paint booth applications is absolutely critical to help optimize quality of workmanship and productivity. Lighting serves two basic functions: it shows variations in color and it shows variations in texture. The light needs to be bright enough to highlight these variables without being so bright that it produces excessive glare. Additionally, light sources must provide accurate color renditions of all commonly used paint colors. The local BEE should be consulted for guidance on adequate lighting for specific locations. However, general guidance is provided below:

D. Ventilation

[Ref: AFI 91-203, **OSHA 1910.107**]

The actions required to comply with ventilation requirements represents the single greatest challenge and therefore the single greatest expense in designing a paint spray booth. The ventilation system for a paint spray booth is primarily designed to prevent fire and explosion. A well-designed ventilation system will also reduce paint overspray, help reduce the workers' exposure to hazardous materials, and protect the paint finish from dust and other contaminates. Readers are encouraged to refer to "*Industrial Ventilation: A Manual of Recommended Practice for Design*" published by the American Conference of Government Industrial Hygienists (**ACGIH**) for very specific information on paint booth design.

E. Filtration

1. Exhaust Filters

[Ref: **40 CFR 63.5** **40 CFR 63.745**, & UFC 4-211-02]

Although not all Air Force installations are currently required to comply with NESHAP requirements, many have voluntarily chosen to design their new facilities to meet these requirements. It is highly recommended that units investigate the feasibility of designing all new paint booths to meet NESHAP requirements. If the Air Force installation is required to meet NESHAP requirements at a later date, significant additional costs may be needed to redesign or retrofit the facility to accommodate a NESHAP-compliant filtration system. The application for construction or reconstruction must be submitted before actual construction or reconstruction begins. [**40 CFR 63.5**]

The EPA's general requirements for paint filters/arrestors used in new facilities are:

A. Before exhausting it to the atmosphere, pass the air stream through a dry particulate filter system certified using Method 319 to meet or exceed the efficiency data points in the following tables; or

```
Table 1. Three-Stage Arrestor; Liquid Phase Challenge for New Sources

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Filtration efficiency requirement, %	Aerodynamic particle size range, µm
>95	>2.0
>80	>1.0
>65	>0.42

Table 2. Three-Stage Arrestor; Solid Phase Challenge for New Sources

Filtration efficiency requirement, %	Aerodynamic particle size range, µm
>95	>2.5
>85	>1.1
>75	>0.70

B. As an alternative, the agency may elect to pass the air stream through an air pollution control system that meets or exceeds the efficiency data points in Tables 1 and 2, and is approved by the permitting authority. (Note: This alternative reflects a performance based standard rather than specified equipment, thus allowing more flexibility for affected sources to comply with the NESHAP. Performance, not equipment, is the only stated requirement.) [**40 CFR 63.745**]

2. Intake Filters

[Ref: **UFC 4-211-01** & **NFPA 33**]

Effective filtration provided by filters placed upstream of the supply fan and/or in the door plenum plays a key role in preventing airborne particles from entering the booth and contaminating the primer and topcoat. It is recommended that paint booths be equipped with commercially-rated filters with at least a 90 percent efficiency (at 10 microns) rating.

Intake filters that are part of a wall or ceiling assembly shall be listed as Class1 or Class 2 in accordance with ANSI/UL 900, "Standard for Air Filter Units". [**NFPA 33**]

3. Air Velocity

[Ref: **OSHA 1910.107**, **NFPA 33**, & **UFC 3-410-04N**]

A. The air velocity requirement, combined with an adequate amount of total air volume exhausted, serves to dilute the solvent vapor to at least 25 percent of the Lower Explosive Limits (LEL) as defined in **NFPA 325**, *Guide to Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids*). [**NFPA 33**]

B. Use the Painting Operations section in the **ACGIH** *Industrial Ventilation: A Manual of Recommended Practice for Design* to best determine the design volumetric airflow rate [**UFC 3-410-04N**]. The spray booth must be designed so that the velocity over the open face of the booth (or booth cross-section) during spraying operations is not be less than 100 fpm. However, booths actually operating in the range of 75 to 125 linear fpm will be in compliance with **OSHA 1910.94**.

C. Do not re-circulate exhaust air while painting. [**UFC 3-410-04N**]

D. Disruptive drafts (cross-drafts) within any booth should not exceed 100 linear fpm. However, disruptive drafts in smaller booths should be limited to 50 linear fpm or less.

E. A pressure gauge shall be installed to indicate the pressure drop across the filters. This gage shall be marked to show the pressure drop at which the filters require replacement or cleaning. [**NFPA 33**]

4. Air Volume

[Ref: **OSHA 1910.107** & **NFPA 33**]

In addition to air velocity requirements, the total air volume exhausted through the paint booth shall be sufficient to dilute solvent vapor to at least 25 percent of the LEL.

5. Exhaust Air

[Ref: **OSHA 1910.107**, **OSHA 1910.94**, **NFPA 33** & **UFC 3-410-04N**]

A. The fan-rotating element shall be nonferrous or nonsparking or the casing shall consist of or be lined with such material. [**NFPA 33**]

B. All bearings on the rotating element shall be of the self-lubricating type, or lubricated from the outside duct. It is preferred to have bearings outside the duct and booth. [**NFPA 33**]

C. Exhaust ducts will be protected from mechanical damage, properly supported and will normal maintain a separation of at least 18 inches from combustible materials.

D. Each spray booth shall have an independent exhaust duct system discharging to the exterior of the building. If more than one fan serves one booth, all fans shall be so interconnected that one fan cannot operate without all fans being operated

E. Aluminum shall not be used for ventilation ductwork. Exhaust ducts and fasteners shall be constructed of steel. [**NFPA 33**]

F. Exhaust ducts without dampers are preferred; however, if dampers are installed, they shall be designed and maintained so that they will be in a full open position at all times when the ventilating system is in operation.

G. Exhaust ducts shall follow the most direct route to the point of discharge but shall not penetrate a fire wall and directed away from any fresh air intakes. Spray booth exhaust duct terminals must be located at least six feet from any exterior wall or roof and be prevented from discharging in the direction of any combustible construction that is within 25 feet of the discharge point. [**NFPA 33**]

H. Exhaust air should be directed so that it will not contaminate make-up air or create a nuisance.

I. When necessary to facilitate cleaning, exhaust ducts shall be fitted with access doors or other means to allow of cleaning. Inspection doors shall be provided every 9 to 12 feet of running length for ducts up to 12 inches in diameter. [**OSHA 1910.107**]

J. Belts shall not enter the duct or booth unless the belt and pulley within the duct or booth are thoroughly enclosed. [**NFPA 33**]

K. All electric motors driving the exhaust fans must be placed outside booths and ducts. [**UFC 3-410-04N**]

6. Replacement Air

[Ref: **UFC 3-410-04N**]

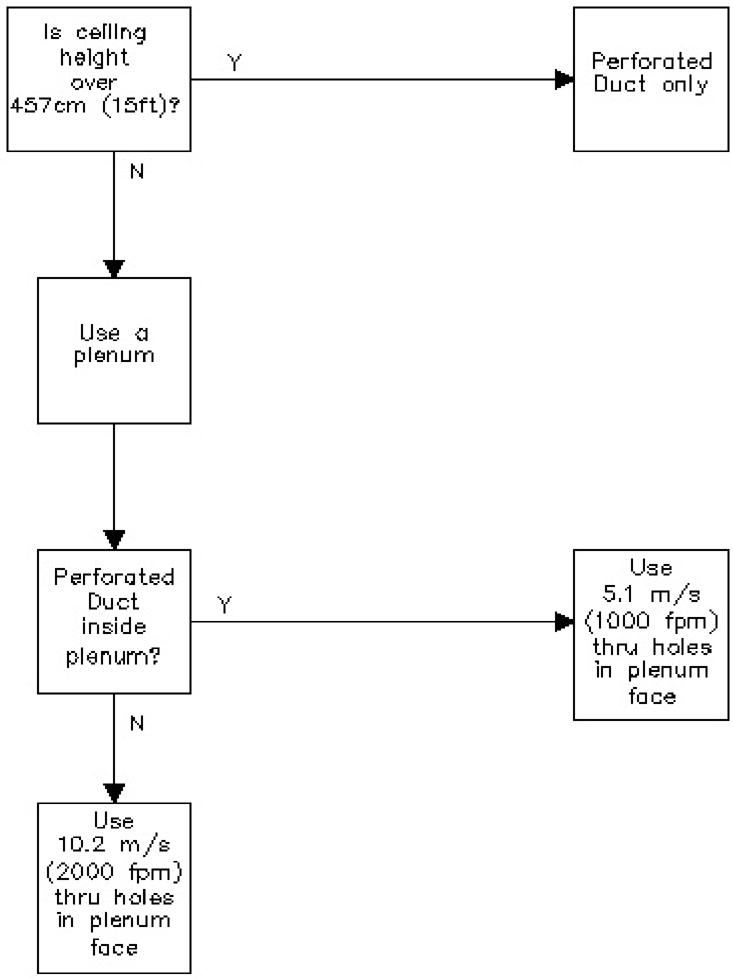
Correct design of the replacement air system (also called "make-up air") in a spray booth is a critical element of the overall design process. Properly designed replacement air will ensure that spray booth has enough air to operate correctly, prevents turbulence or other undesirable air circulation, and eliminates excessive differential pressure on doors and adjoining spaces.

A. The replacement air and exhaust air systems should be designed in produce a slightly negative pressure in the paint booth (-0.02 to -0.06 inches wg). Positive pressure in the booth is undesirable as it can allow HAPs, vapors or mists in the booth to escape through small cracks or voids in the booth. (**UFC 3-410-04N**) (Note: Some documents may specify that positive pressure should be maintained in the paint booth. However, this information is outdated as it fails to consider current mandates that require paint booths to completely contain all harmful materials associated with spray painting)

B. The velocity of replacement air through baffles, filters, etc should not exceed 200 feet/minute. Higher replacement air velocities can create turbulence in the booth that can cause a properly designed exhaust air system to fail to confine and remove vapors or mists.

C. Design the replacement air system in accordance with the decision tree shown in Figure 2. [**UFC 3-410-04N**]

Figure 2. Decision Tree for Replacement Air System Design.



7. Recirculation Replacement Air Systems

[Ref: **OSHA 1910.107**, **NFPA 33**]

A typical recirculation replacement air system uses all or a portion of the exhausted air from the booth to augment the incoming replacement air. The addition of this type of system into the design plans of a paint booth is a very complex and controversial issue, which is generally not recommended. The potential problems associated with recirculation of exhaust air are highlighted in ANSI/AHIA Z9.7 – 1998 (American National Standard for the Recirculation of Air from Industrial Process Exhaust Systems) which states:

> *"The recirculation of exhaust air from an industrial process is a potentially dangerous practice. If done improperly, harmful concentrations of air contaminants can be created in the work environment".*

The standard further states:

> *"The facility owner and manager must understand that a re-circulating process exhaust system requires a higher level of preventative maintenance, including system and component testing, than a conventional process exhaust system for the life of the system."*

Although recirculation systems provide a potential to reduce costs associated with heating and cooling the air in the booth, they clearly create a significant potential for conflicts between environmental, health and fire protection requirements. Unfortunately, current guidance from OSHA and NFPA on this issue is unclear and even contradictory. Although **OSHA 1910.107** and NFPA specifically prohibit recalculating air exhausted from spray areas or discharging exhaust air in such a way that it could contaminate replacement air, recent interpretation rulings by OSHA indicate that the Agency's actual position on this issue is somewhat flexible.

OSHA has generally been lenient in their interpretations if all requirements for recirculated replacement air systems in **NFPA 33** and ANSI Z9.7 have been met. In most of these situations, OSHA's involvement has been limited to issuance of a de Minimus Notice (an infraction that has no immediate or direct relationship on health or safety, and which carries with it no citation or penalty)

Some of the most critical requirements for recirculated replacement air systems in **NFPA 33** and ANSI Z9.7 are listed below. However, all pertinent references should be thoroughly researched before a recirculation type system is considered.

A. Solid particulates shall be removed from the recirculated air.

B. The system must be designed to prevent concentration of vapors in the air stream from exceeding 25 percent of the Lower Flammable Level.

C. To ensure proper air quality, effective occupant protection and satisfactory system performance, a pre-design "Hazard Evaluation" as defined in the OSHA Hazard Communication standard shall be performed, documented, and incorporated into the design process.

D. An approved continuous monitoring device (CMD) system must be installed to continually monitor the concentration of contaminates in all exhaust airstreams.

E. A system must be installed to either sound an alarm and automatically shutdown spray operations or automatically convert the booth to single-pass operation if the concentration of any vapor in the exhaust air steam exceeds 25 percent of the LEL.

If an Air Force installation is considering such a system, it is highly recommended that local Environmental Management, Bioenvironmental Engineering, and Fire Protection functions work in concert to conduct a risk-benefit analysis of these complex systems.

F. Temperature and Humidity Control

[Ref: **T.O. 1-1-8** & UFC 4-211-01]

In some locations, the paint spray booth may require both air conditioning and heating to control temperature and humidity. Painting should be accomplished in a controlled environment that is within a range of 30 to 80 percent relative humidity and a temperature of 60^0F to 80^0F. (**T.O. 1-1-8** & UFC 4-211-01). **T.O. 1-1-8** describes the adverse impact that both low temperatures and high temperatures have on paint characteristics and requires that painting operations be suspended if temperatures drop lower than 50^0 F or raise above 95^0 F. Although the installation of an air conditioning system in a large paint facility can be a significant expense, failing to provide adequate temperature control may result in significant disruptions to painting schedules.

G. Personnel Breathing Air

[Ref: **OSHA 1910.134** , **OSHA 1910.94**,]

Breathing air for abrasive blasting operations may be supplied by either portable or permanently installed systems. However, all systems must meet the following minimum requirements:

A. Compressors used to supply breathing air must be constructed and situated to prevent entry of contaminated air into the air supply system.

B. Compressors used to produce air for supplied air respirators must be capable of meeting Grade D standards described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989. These standards include:

1. Oxygen content (v/v) of 19.5-23.5%
2. Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less
3. Carbon monoxide (CO) content of 10 ppm or less
4. Carbon dioxide content of 1,000 ppm or less
5. Lack of noticeable odor

C. Oil lubricated breathing air compressors require a high temperature or carbon monoxide alarm or both. (If only a high temperature alarm is used, the air supply must be monitored to ensure the breathing air does not exceed 10 ppm of carbon monoxide).

D. The breathing air system must have suitable inline air-purifying sorbent beds and filters.

H. Compressed Air for Operation of Tools and Equipment

[Ref: **T.O. 1-1-8** & **UFC 4-211-01N**]

A. Provide an adequate volume of compressed air to operate shop tools and equipment.

B. Pressure of air should be 125 psi and delivered at 40 to 60 percent humidity.

C. Air must be oil-free to prevent paint contamination.

D. Sufficient air regulators shall be installed in the facility to provide outlet to connect spray guns and other air operated equipment. (Regulators must be capable of providing 15 cfm of air at 80 psi (supply line pressure) with a maximum pressure drop of 10 psi)

E. Air regulators shall be situated at sufficient intervals to allow personnel to limit air hose length to 50 feet (150 feet is permissible to reach the tail surfaces of exceptionally large aircraft)

F. Refer to the following chart to determine minimum size of air compressor piping:

Minimum Size Recommendations [T.O. 1-1-8]

COMPRESSING OUTFIT		MAIN AIR LINE PIPE	
SIZE	CAPACITY	LENGTH	SIZE
1 1/2 & 2 H.P.	6 TO 9 C.F.M.	OVER 50 FT	3/4"
		UP TO 200 FT	3/4"
3 & 5 H.P.	12 TO 20 C.F.M.	OVER 200FT	1"
		UP TO 100 FT	3/4"
		OVER 100 TO 200 FT	1"
5 TO 10 H.P.	20 TO 40 C.F.M.	OVER 200 FT	1 1/4"
		UP TO 100 FT	1"
		OVER 100 TO 200 FT	1 1/4"
10 TO 15 H.P.	40 TO 60 C.F.M.	OVER 200 FT	1 1/2"

I. Fall Protection

[Ref: **EM 385-1-1** and **AFI 91-203**]

Fall protection is requirement in many aircraft paint facilities. Although it is possible to use leveled work platforms to reach upper areas on smaller aircraft, experience has shown that is impossible to adequately access most upper surfaces of large aircraft by these means. Therefore, personnel often must walk on aircraft wings or other surfaces during painting operations, which creates the possibility that they may fall 10 feet or more. In these situations, fall arrest or fall restraint systems are mandatory. Experience has shown that systems which utilize a lifeline, to which safety harnesses can be attached, are the most effective means of accessing upper surfaces of the aircraft during aircraft paint operations. Refer to **EM 385-1-1** and **AFI 91-203** for complete guidance on fall protection requirements.

The most significant facility design requirement centers around the requirement that the lifeline and anchor points must be capable of supporting 5,000 pounds per worker attached to them. The D-rings and snap hooks should be able to withstand a minimum tensile load of 3,600 pounds. This weight requirement necessitates that attention be given to installation of the fall restraint system in the earliest stages of facility design. It is also important to plan for the lifelines placement for access to the aircraft sections. If this requirement is not identified early enough, significant facility design modification may be required to accommodate the fall restraint system.

J. Eyewash Units and Emergency Showers

[Ref: **AFI 91-203**, **OSHA 1910.151**, & ANSI Z358.1-2004]

A. Permanently installed shower and eyewash units shall be provided in areas where harmful materials may be splashed in the eyes or on parts of the body.

B. Emergency shower and eyewash units shall be located in accessible locations that require no more than 10 seconds to reach and shall be within 100 feet of the harmful substance. Contact ground safety manager or BEE for assistance in determining when more stringent criteria is warranted.

C. Permanently installed units and self-contained units installed in fixed locations shall be identified with a highly visible sign. The area around or behind the unit, or both, may be painted with green and white stripes if needed to increase visibility. If highlighted, the painted area will be large enough to be easily identified by the user.

D. Emergency units shall be well lighted. If possible, at least 50-foot candles of illumination should be provided.

E. Units will be connected to a supply of water that is free from contamination and equal in purity to potable water. The water temperature range should be in the range of 60^{O} to 100^{O} Fahrenheit to not discourage the unit's use. In some situations where chemical reaction is accelerated by contact with increased water temperature, the BEE will be consulted for guidance.

F. Eyewash nozzles will be protected from contamination and replaced when necessary.

K. Equipment

An accurate description of all special equipment and support requirements and source of supply (GFE, third-party contracts, etc.) should be included in the Requirements Documents. Not stating equipment requirements early in the design process can significantly impact usable space and result in design changes. If specific requirements are unknown, state so, and a give a general idea of what is expected based on work activities planned. Include special floor and wall space requirement descriptions. Some examples of equipment requiring specific consideration are:

1. Paint Gun Washers

Automatic paint gun washer equipment reduces hazardous waste disposal, reduces air emissions, and also reduces labor required to clean painting equipment and employee exposure to harmful solvents.

2. HEPA Vacuum Sanders

HEPA vacuum sanders are used to reduce the greatest exposure of personnel to chromates, which typically occurs during sanding operations. Various types of permanently installed equipment and/or portable equipment have been successfully used in many facilities. However, the decision on which type of equipment is going to be used must be made early in the design phase to ensure elements such as space requirements, electrical connections, piping, etc are adequately addressed.

3. High Volume Low Pressure (HVLP) paint spray systems

HVLP systems are relatively simple, but highly effective technologies for the application of paint. However, the use HVLP requires additional planning during the design phase of a paint booth. It is essential that the proper size air compressor piping, air regulators, and hoses be used to supply air to HVLP spray equipment. The absolute minimum size of piping or hose used to provide air to a single HVLP spray gun is 3/8 inch. The use of ¼ inch hoses restricts the volumetric airflow causing the painter to increase the PSI to make the gun to work properly. This action negates the performance of the HVLP paint guns and takes them out of compliance with environmental standards.

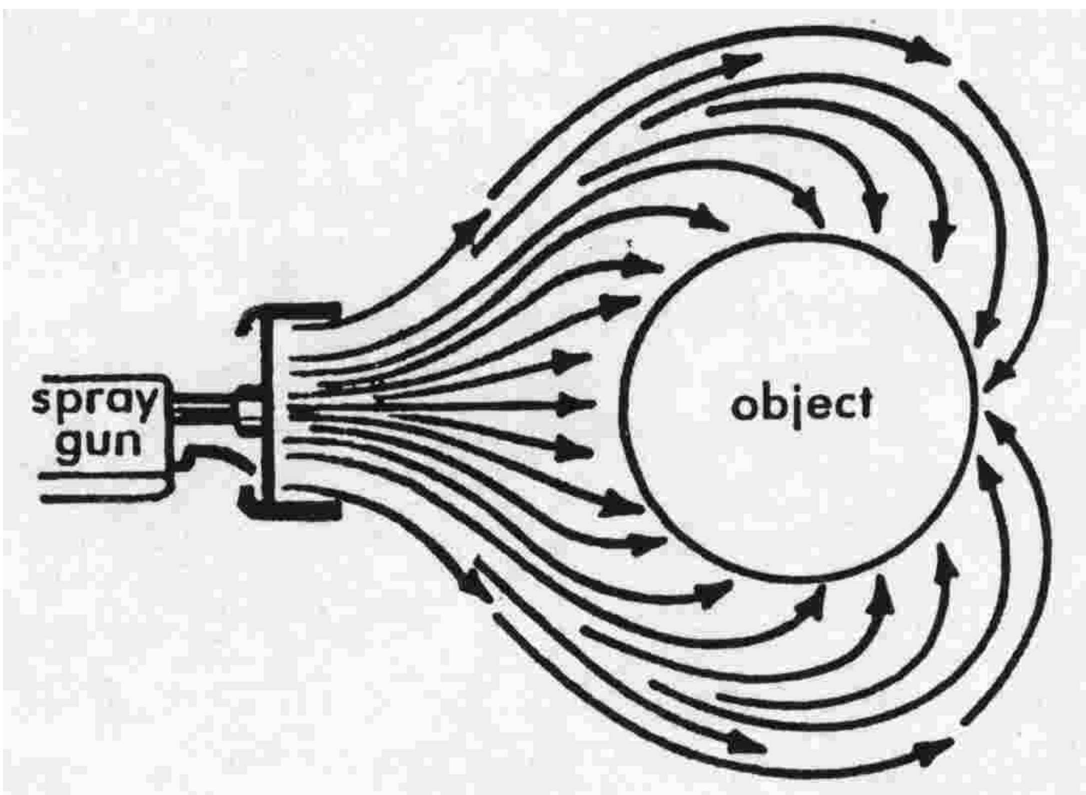
An incorrectly sized compressed air line may not be capable of supplying sufficient pressure and airflow rate.

L. Prefabricated Paint Booths or Inserts

[Ref: **NFPA 33**]

It is highly recommended that some consideration be given to contracting with one of the many manufacturers of insert or stand-alone booths. The advantages of using these type booths are that most of the complex systems such as airflow, lights, sprinkler systems, etc. are pre-engineered. In many previous cases, the procurement and contract installation of these booths into pre-existing hangars or buildings has provided bases with timely, cost effective aircraft spray paint capability. It should be noted that just because a manufacturer of a paint booth insert advertises that the booth meets UL, BOCA, NFPA, and OSHA standards, they are not exempt from the requirements for sprinkler protection or an approved fire extinguishing system. [**NFPA 33**(A.7 – A.7.6) (see local fire department)]

Electrostatic Painting



Section 4

IV. Electrostatic Painting

Although electrostatic paint spray operations provide an opportunity for improved paint transfer efficiency, the introduction of electrically charged equipment into the immediate vicinity of the paint spray process requires additional safeguards. Most requirements applicable to normal paint spray operations also apply to the electrostatic paint spray process. However, requirements that are more stringent exist in some areas. The information below provides information on significant additional requirements that are unique to electrostatic paint spray operations.

A. PAINT BOOTH DESIGN

[Ref. **T.O. 1-1-8**]

The electrostatic paint spray operations should be accomplished in an approved paint facility that meets all the requirements of an approved, enclosed paint facility as described in **Section 3** of this guide, except as noted below. Electrostatic coating application equipment shall be used only in paint hangars or other areas designated and approved by the local base Fire, Safety, Bioenvironmental, and Environmental Office.

B. Ventilation

1. Air Velocity

[Ref. **OSHA 1910.107**, **UFC 4-211-01** & **OSHA 1910.94**]

The minimum maintained velocity required for hand held electrostatic paint spray guns as specified in **OSHA 1910.107** is 60 linear fpm. However, the requirements currently contained in **OSHA 1910.94 TableG-10** are somewhat more lenient and allows a range of 50-75 linear fpm. Due to the minor inconsistencies in these requirements, any unit planning to design a paint booth that will be used exclusively for electrostatic paint spraying should contact their local fire protection and bioenvironmental engineering functions for current guidance. Some assistance can be found in **The Letter of Interpretation 05/17/1976 Electrostatic Paint Spraying**.

2. Air Volume

[Ref. **T.O. 1-1-8** **&** **UFC 4-211-01**]

Minimum air volume requirements for most paint booths used for electrostatic spray are the same as those for booths used of conventional spray operations. However, the air volume requirements for paint booths in which fueled aircraft will be painted with electrostatic paint spray equipment are more stringent. In this situation, the ventilation shall be sufficient to limit vapor concentration to 500 ppm or 20 percent of the LEL, whichever is lower.

C. Fire Protection

[Ref. **UFC 3-600-01**, **ETL 02-15**, & **ETL 98-8**]

A fully functional fire suppression system is required prior to the start of electrostatic painting. Facility fire suppression requirements for electrostatic painting of fueled aircraft are outlined in **UFC 3-600-01**, **ETL 02-15**, and **ETL 98-8**

D. Equipment

[Ref. **OSHA 1910.107**, **T.O. 1-1-8**, & **NFPA 33**]

A. The electrostatic painting equipment used must have been tested and approved by a recognized laboratory for Class I, Division I, Groups C and D locations. [**T.O. 1-1-8**]

B. Electrostatic apparatus shall be equipped with automatic controls, which will operate without time delay to disconnect the power supply to the high voltage transformer and to signal the operator when any of the following occur:

- Stoppage of ventilating fans or failure of ventilating equipment from any cause.
- Occurrence of a ground or of an imminent ground at any point on the high voltage system

C. Transformers, high voltage supplied, control apparatus, and all other electrical portions of the equipment, with the exception of the hand gun itself and its connections to the power supply, shall be located outside of the spray area, or shall meet all electrical requirements. [**OSHA 1910.107**]

D. The handle of the spray gun shall be electrically connected to ground by a conductive material. It shall be constructed so that the operator, in normal operating position, is in electrical contact with the grounded handle by a resistance of not more than 1 megaohm to prevent buildup of a static charge on the operator's body. Signs indicating the necessity for grounding persons entering the spray area shall be conspicuously posted.

E. Electrostatic hand spray apparatus and devices used in connection with coating operations shall be of approved types. The high voltage circuits shall be designed so as to not produce a spark of sufficient intensity to ignite any vapor-air mixtures nor result in appreciable shock hazard upon coming in contact with a grounded object under all normal operating conditions. The electrostatically charged exposed elements of the handgun shall be capable of being energized only by a switch, which also controls the coating material supply. [**OSHA 1910.107**]

F. All electrically conductive objects in the spraying area shall be adequately grounded. This requirement shall apply to paint containers, wash cans, and any other objects or devices in the area. The equipment shall carry a prominent permanently installed warning regarding the necessity for this grounding feature. [**OSHA 1910.107**]

Drying Rooms

Section

5

V. Drying Rooms

A. Drying Areas

[Ref: **OSHA 1910.107**]

The addition of adequate space in the paint facility to provide a separate area to allow freshly painted articles to dry creates a significant opportunity to increase overall productivity within the paint booth. These productivity increases are gained by freeing-up space within the paint booth, thereby allowing personnel to work concurrent projects. However, some relatively stringent requirements must be met before a separate enclosure may be used as a drying area. Drying areas generally fall into two categories: Ambient Temperature and Elevated Temperature.

B. Ambient *Temperature (Air Drying)*

[Ref: **OSHA 1910.107** & **NFPA 33**]

The key requirement for any enclosure used to provide an area to allow freshly painted articles to dry is need for adequate ventilation.

1. The ventilation system shall be capable of maintaining the concentration of any vapors below 25 percent LEL. [**NFPA 33**]

2. In the event adequate and reliable ventilation is not provided such drying spaces shall be considered a spray booth and must meet all applicable requirements governing spray booths.

C. Elevated Temperature Drying

[Ref: **OSHA 1910.107** , **NFPA 33** & **NFPA 86**]

1. All equipment used to elevate the temperature in drying or curing enclosures shall conform to the requirements of **NFPA 86**, *Standard for Ovens and Furnaces*

2. The ventilation system must be capable of maintaining the concentration of vapors below 25 percent LEL. (In the event adequate and reliable ventilation is not provided such drying spaces shall be considered a spraying area and must meet all applicable requirements.)

3. All drying equipment will automatically shut off in the event of failure of the ventilating system.

4. Spray Booths, spray rooms or other enclosures used in the application of flammable and combustibles shall not be used for elevated temperature drying operations unless the additional following conditions are met.

a. A high temperature limit switch shall be provided to automatically shut off the drying apparatus if the air temperature in the spray area exceeds 200^0F (93ºC).

b. Thoroughly ventilate the drying space before the heating system can be started. Maintain a safe atmosphere at any source of ignition.

c. The interior surface of the spray area shall be cleaned regularly to minimized the accumulation of deposits of combustible residues.

d. Spraying apparatus, drying apparatus and the ventilating system shall be equipped with interlocks arranged so that the spraying apparatus cannot be operated when drying apparatus is in operation or is energized. Also, drying apparatus shall be affixed with a permanently attached, prominently located warning sign indicating that ventilation shall be maintained during the drying, curing, or fusing period and that spraying shall not be conducted in the vicinity in such manner as to deposit residue on the apparatus.

e. Interlocks shall be provided to shut down the drying, curing, or fusing operation if entry is made when industrial air heaters are used.

f. Only equipment of a type approved for Class I, Division 2 hazardous locations shall be located within 18 inches of floor level. All metallic parts of the drying apparatus shall be properly electrically bonded on apparatus.

g. Radiant drying apparatus (if used) shall be listed for exposure to flammable or combustible vapors, mists, dusts, residues or deposits.

h. Any containers of flammable or combustible liquids shall be removed from the booth before the drying apparatus is energized.

Corrosion Control Wash Rack

Section
6

VI. Corrosion Control Wash Rack

A. Location/Size

[Ref: **UFC 3-260-01** & **UFC 3-260-02**]

Aircraft wash hangars should be located adjacent to the hangar area or maintenance facilities and contiguous to aircraft parking or access aprons as directed in **UFC 3-260-01**, *Airfield and Heliport Planning and Design*, supersedes AFM 32-1123. Where possible, wash racks should be located near existing facilities where existing utility and pollution control systems are accessible. In sitting wash racks, support facilities such as pump houses and tanks should be located either outside apron clearance distances or below grade. **UFC 3-260-02**, *Pavement Design for Airfields,* addresses configuration and grading criteria for aircraft wash racks locations and design. Wash racks are considered as Type C traffic area.

The type of mission aircraft expected to use it determines the size and configuration of an aircraft wash rack. The dimensions of the largest aircraft plus the clearances shown in Table 6.4, **UFC 3-260-01**, determine the minimum wash rack pavement dimensions. Typical wash rack layouts for heavy bombers, medium bombers, cargo aircraft, fighter aircraft, and helicopters are shown in **UFC 3-260-01**, Figures 6.31 through 6.36.

B. Additional Justification

[Ref: **T.O. 1-1-691** & **AFMAN 32-1084**]

Bases with a large number of aircraft (above 40 medium or large aircraft) or located in a severely corrosive environment (as defined in **T.O. 1-1-691**) are authorized, with proper justification, a corrosion control hangar **and** an aircraft wash hangar. [**AFMAN 32-1084** & **T.O. 1-1-691**]

C. Aircraft Wash Facility Design

[Ref: **AFMAN 32-1084**, **MIL-HDBK-1138**,]

The basic aircraft wash facility as directed in **AFMAN 32-1084**, is equipped with heating, hot, and cold water, electric power, and compressed air. Oil-water separators or other water treatment/disposal systems appropriate for the expected contaminates must be incorporated into the wash facility design. Refer to **MIL-HDBK-1138**, and **AFMAN 32-1084** for guidance on oil-water separators and other water treatment/disposal requirements.

An adequate wash rack facility is one that is available to wash aircraft on a year round basis. This requirement can only be satisfied with any one or more of the following:

- A specially designed corrosion control facility completely enclosed, heated with environmentally controlled ventilation and waste disposal systems, and equipped with all utilities necessary for accomplishing all facets of aircraft corrosion control.
- An environmentally compliant enclosed or covered wash rack.

D. Storage and Mixing Capability for Aircraft Cleaning Compounds

Generally, aircraft wash facilities should be equipped with bulk storage tanks for aircraft cleaning compounds and equipment capable of mixing the detergents with water in the proper dilution ratios and dispensing the solution onto the aircraft. However, in situations where only relatively small quantities of cleaning compounds are expected to be used (i.e. at bases with a limited number of small aircraft), it may be appropriate to omit bulk storage capability from the facility design and incorporate storage space and handling capability for 55-gallon barrels.

E. Pressurized Cleaning Compound Dispensing and Rinse Water Systems

[Ref: **T.O. 1-1-691**]

Pressurized dispensing systems for the application diluted cleaning compounds and rinse water generally improve the overall efficiency of aircraft cleaning operations and typically provide reductions in man-hours expended and quantities of water and cleaning materials used. However, careful consideration must be given to ensure that Pressurized Dispensing Systems installed in the Aircraft Wash Facility do not cause damage to aircraft coatings or structure. All equipment used for this purpose must meet the following requirements: (**T.O. 1-1-691**)

1. Maximum Water/Cleaning solution delivery volume of 4 gallons per minute.

2. Maximum temperature of 210 degrees F.

3. Maximum nozzle pressure of 3000 PSI.

4. Minimum fan spray nozzle angle of 40 degrees.

F. Water Temperature Requirements

[Ref: **T.O. 1-1-691** & **ETL 99-1**]

Hot water capability (130 degrees F plus/minus 10^{o} F) should be included in the design of all new aircraft wash facilities. Studies have shown that the use of hot water during aircraft cleaning operations has the potential to significantly improve the efficiency and effectiveness of the process. Depending on variations in washing method used and cleanliness of the aircraft, water usage reductions of at least 30 percent, and man-hour reductions of at least 20 percent were identified during the studies. Additionally, the use of hot water also contributed to significant reductions in the quantity of cleaning detergents needed to clean the aircraft. Many wash racks are built without hot water, usually CE driven for resource conservation. Allowance Standard 480 authorizes a high pressure/hot water wash cart that will deliver water to the nozzle at 3000 psi/four gallons per minute and with a maximum water temperature of 210F. This can be used as an alternative to having hot water furnished at the facility.

The use of hot water to wash aircraft can decrease water use and better remove grease and oils. Studies have found that cold-water spray just pushes the grease and oil around on the aircraft, whereas a hot-water spray apparently breaks the bond between the grease/oil and the aircraft, flushing the grease and oil. **T.O. 1-1-691** recommends the water temperature of 120 degrees F/49°C to 140 degrees F/60°C.

G. Closed-Loop Water Recycling Systems

[Ref: **ETL 99-1**]

Since the primary objective of aircraft cleaning operations is to remove contaminates, it is crucial that water used for this operation be free of materials that could damage the aircraft substrate or coatings. Aircraft wash facilities are typically connected to the base-wide potable water supply system, so concerns with water quality are not usually an issue. However, deficiencies in water quality become significant factors when closed-loop water recycling systems are included in the design of aircraft wash facilities. Although water recycling systems may appear to be viable options for water conservation and pollution prevention, as detailed in **HQ AFCESA Engineering Technical Letter (ETL) 99-1**, these systems actually concentrate the pollutants into a smaller volume and do not necessarily reduce the quantity of pollutants released into the environment. Additionally, the recycled water can actually promote corrosion on aircraft surfaces through excessive concentrations of chlorides and other corrosion-inducing constituents.

H. Recycling System Water Quality Requirements

[Ref: **ETL 99-1**]

Any base that is considering the installation of a closed-loop water recycling system in their aircraft wash facility should closely examine the discussion contained in **ETL 99-1**. In most situations, bases will discover that a closed-loop water recycling system will not provide expected benefits and should not be used. However, in those limited situations where close-loop water recycling systems are required, only systems capable of meeting the following minimum water quality parameters may be used:

1. Chloride content shall be 400 mg/L maximum (somewhat higher than EPA potable drinking water standard of 250 mg/L).

2. pH shall be between 6.5 and 8.5.

3. Total dissolved solids (TDS) content shall be 500 mg/L maximum.

4. Total suspended solids (TSS) content shall be 5 mg/L maximum.

5. The Langlier Saturation Index shall be slightly above 0.

6. The biological oxygen demand (BOD) concentration shall be 5 mg/L maximum.

7. Adequate disinfection of the water shall be provided to control the growth of micro-organisms in the water.

8. The water hardness shall be between 75 and 150 mg/L as $CaCO_3$.

9. The total petroleum hydrocarbon (TPH) content shall be 10 mg/L maximum

I. Fall Protection

[Ref: **AFI 91-203**]

Adequate fall protection is an absolute, but frequently overlooked, requirement in the vast majority of newly constructed aircraft wash facilities. Although **AFI 91-203** requires that personnel should avoid walking on wet surfaces to the greatest extent possible and directs that separate elevated work platforms and long-handle brushes will be used to the maximum extent possible, experience has shown that is impossible to adequately access most upper surfaces of large aircraft by these means. Therefore, personnel often must walk on aircraft wings or other surfaces during washing operations, which creates the possibility that they may fall 10 feet or more. In these situations, fall arrest or fall restraint systems are mandatory. Experience has shown that systems which utilize a lifeline, to which safety harnesses can be attached, are the most effective means of accessing upper surfaces of the aircraft during aircraft wash operations. Refer to **AFI 91-203** for complete guidance on fall protection requirements.

The most significant facility design requirement centers around the requirement that the lifeline and anchor points must be capable of supporting 5000 pounds per worker attached to them.

This weight requirement necessitates that attention be given to installation of the fall restraint system in the earliest stages of facility design. If this requirement is not identified early enough, significant facility design modification may be required to accommodate the fall restraint system.

J. Wastewater Treatment/Collection

[Ref: **UFC 3-240-03N**, **UFC 4-832-01N**, & **ETL 99-1**]

Some type of wastewater treatment/collection capability is typically required for all aircraft wash facilities. In most cases, an oil-water separation unit which utilizes conventional gravity separation is sufficient to remove free oils. However, any emulsified oil which may be present cannot be removed via gravity separation. Additionally, an infinite number of variables, such as washing equipment and procedures, types and amounts of solvent or detergent, the temperature of the washwater, the size, and type of aircraft, and characteristics of the raw water all contribute to the washwater effluent characteristics. Therefore, it is essential that testing and analysis be conducted to verify actual wastewater characteristics prior to designing any treatment/collection system. Wastewater treatment/collection systems must be designed and installed in accordance with many different specific references. Some of the most significant references are: **UFC 3-240-03N**, **UFC 4-832-01N**, and **ETL 99-1**.

The vast array of very specific design requirements for wastewater treatment/collection systems exceeds the scope of this Facilities Guide and will not be addressed in detail. Therefore, it is recommended that the local civil engineering function be consulted.

K. Lighting Types

Explosion-proof lighting fixtures will be used in the wash rack. Lighting Fixtures appropriate for Class I, Division 2, Group D area classifications are the most commonly used categories of fixtures.

L. Eyewash Units and Emergency Showers

[Ref: **AFI 91-203** & ANSI Z358-1]

1. Permanently installed shower and eyewash units shall be provided in areas where harmful materials may be splashed in the eyes or on parts of the body.

2. Emergency shower and eyewash units shall be located in accessible locations that require no more that 10 seconds to reach and shall be within 100 feet of the harmful substance

3. Permanently installed units and self-contained units installed in fixed locations shall be identified with a highly visible sign. The area around or behind the unit, or both, may be painted with green and white stripes if needed to increase visibility. If highlighted, the painted area will be large enough to be easily identified by the user.

4. Emergency units shall be well lighted. If possible, at least 50-foot candles of illumination should be provided.

5. Units will be connected to a supply of water that is free from contamination and equal in purity to potable water.

Abrasive Blasting Booths

Section

7

VII. Abrasive Blast Booths

A. General Information

[Ref: **OSHA 1910.1000**, **T.O. 1-1-8**, UFC 4-211-02& **T.O. 1-1-691**]

Refer to Chapter 4 of **UFC 4-211-02** for information on abrasive blast booths Since PMB provides an exceptionally effective capability to remove coatings from support equipment, it is highly recommended that this capability be included in all new corrosion control facilities.

The concentration of respirable dust or fumes in the breathing zone of the abrasive-blasting operator or any other worker shall be kept below the levels specified in **OSHA 1910.1000**. Also, the dusts created during the abrasive blasting process may be combustible or explosive which makes it crucial that abrasive blast booths, including the exhaust system and all electric wiring, conform to the requirements of *American National Standard Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying.*

B. Exhaust Filters

[Ref: **40 CFR 63.5** **40 CFR 63.745**, & **UFC 4-211-01N**]

Another key requirement of the ventilation system is its ability to reduce the amount of hazardous air pollutants (HAPs) (e.g., chromium, cadmium, lead, etc.) that are released into the atmosphere. The National Emission Standards for Hazardous Air Pollutants for Source Categories: Aerospace Manufacturing and Rework Facilities (commonly called the Aerospace NESHAP) require that filters be installed in the ventilation system to control the inorganic HAP emissions before they are exhausted to the atmosphere. Although not all Air Force installations are currently required to comply with NESHAP requirements, many have voluntarily chosen to design their new facilities to meet these requirements. It is highly recommended that units investigate the feasibility of designing all new paint booths to meet NESHAP requirements. If the Air Force installation is required to meet NESHAP requirements at a later date, significant additional costs may be needed to redesign or retrofit the facility to accommodate a NESHAP-compliant filtration system. The application for construction or reconstruction must be submitted before actual construction or reconstruction begins. [**40 CFR 63.5**]

The EPA's general requirements for paint filters/arrestors used in new facilities are:

A. Before exhausting it to the atmosphere, pass the air stream through a dry particulate filter system certified using **Method 319** to meet or exceed the efficiency data points in the following tables; or

Table 1. Three-Stage Arrestor; Liquid Phase Challenge for New Sources

Filtration efficiency requirement, %	Aerodynamic particle size range, µm

>95	>2.0
>80	>1.0
>65	>0.42

Table 2. Three-Stage Arrestor; Solid Phase Challenge for New Sources

Filtration efficiency requirement, %	Aerodynamic particle size range, µm
>95	>2.5
>85	>1.1
>75	>0.70

B. As an alternative, the agency may elect to pass the air stream through an air pollution control system that meets or exceeds the efficiency data points in Tables 1 and 2, and is approved by the permitting authority. (Note: This alternative reflects a performance based standard rather than specified equipment, thus allowing more flexibility for affected sources to comply with the NESHAP. Performance, not equipment, is the only stated requirement) [**40 CFR 63.745**]

C. Breathing Air

[Ref: **OSHA 1910.134** , **OSHA 1910.94**]

Breathing air for abrasive blasting operations may be supplied by either portable or permanently installed systems. However, all systems must meet the following minimum requirements:

A. Compressors used to supply breathing air must be constructed and situated to prevent entry of contaminated air into the air supply system.

B. Compressors used to produce air for supplied air respirators must be capable of meeting Grade D standards described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989. These standards include:

6. Oxygen content (v/v) of 19.5-23.5%
7. Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less
8. Carbon monoxide (CO) content of 10 ppm or less
9. Carbon dioxide content of 1,000 ppm or less
10. Lack of noticeable odor

C. Breathing air couplings must not be compatible with outlets for nonrespirable worksite air or other gas systems. There should be multiple connection ports for airline respirator hoses to allow worker mobility.

D. Oil lubricated breathing air compressors require a high temperature or carbon monoxide alarm or both. (If only a high temperature alarm is used, the air supply must be monitored to ensure the breathing air does not exceed 10 ppm of carbon monoxide).

E. The breathing air compressor must minimize moisture content so that the dew point is 5.56 degrees Celsius (10 degrees Fahrenheit) below the ambient temperature.

F. The breathing air system must have suitable inline air-purifying sorbent beds and filters.

G. It is suggested that the air-line compressor also be positioned in an area that draws from cool air and not from heated sources. Air-line respirators approved with a vortex tube will substantially reduce the temperature of the air supplied to the respirator in cases where the supplied air is from a high temperature environment.

D. Prefabricated Abrasive Blast Booths

It is highly recommended that some consideration be given to contracting with one of the many manufacturers of prefabricated abrasive booths. The advantages of using these type booths are that most of the complex systems such as airflow, media reclamation, etc. are pre-engineered. In many previous cases, the procurement and contract installation of these booths into pre-existing hangars or buildings has provided bases with timely, cost effective abrasive blast capability.

Paint Mixing Rooms

Section

8

VIII. Paint Mixing Rooms

A. General Information

[Ref: **NFPA 33**, **UFC 4-211-02** & AFI 91-203]

A paint mixing room, separate from the paint booth, is commonly incorporated into the design of a corrosion control facility. Refer to **UFC 4-211-02** for information on Paint Mixing rooms

B. Basic Requirements

[Ref: **NFPA 33** & AFI 91-203]

Virtually all construction and design requirements applicable to spray booths are equally applicable to paint mixing rooms. This includes requirements for general construction, explosion-proof electrical and lighting fixtures, personal breathing air, eyewash units and emergency showers. Therefore, the reader should refer to Section 3 of this guide for this information. However, there are some unique requirements applicable only to paint mixing rooms which are listed below:

C. Prefabricated Mixing Rooms

It is highly recommended that some consideration be given to contracting with one of the many manufacturers of prefabricated mixing rooms. The advantages of using these type rooms are that most of the complex systems such as airflow, electrical, lighting, etc. are pre-engineered. In many previous cases, the procurement and contract installation of these rooms into pre-existing hangars or buildings has provided bases with timely, cost effective safe paint mixing area capability.

Flammable & Combustible Materials Storage

Section
9

IX. Flammable and Combustible Materials Storage

A. Flammable and Combustible Liquids Storage General Information

[Ref: UFC 4-211-02]
Some type of capability to store the flammable and combustible liquids associated with corrosion control processes must be incorporated into the design of most corrosion control facilities. This storage capability can be achieved either through the use of approved storage cabinets within the facility; specially designed rooms within the facility; or a separate building detached from the main facility.

B. Requirements for Different Types of Storage

[Ref: **AFI 91-203** & **NFPA 30**]

1. Storage Cabinets within the Facility

[Ref: **AFI 91-203** & **29 CFR 1910.106**]

A. All cabinets must be listed/approved for the applicable class of storage (Locally constructed cabinets shall not be used).

B. Storage in cabinets must be limited to no more than 120 gallons of Class I, Class III or Class IIIA liquids in a single cabinet. (Note: The combined capacity limit is reduced to 60 gallons if only Class I and Class II liquids are being stored in a single cabinet.) [**29 CFR 1910.106**]

C. No more than three cabinets may be located in the same industrial fire area. (Note: Additional cabinets (not more than three), may be located in the area if they are separate by the other cabinets by at least 100 feet)

2. Inside Storage Rooms

[Ref: **AFI 91-203**, **NFPA 80**, **NFPA 30**, & **29 CFR 1910.106**]

A. Must be constructed to meet the specifications of NFPA 251 and the fire-resistive rating applicable to their use.

B. Openings to other rooms will have noncombustible liquid sills or ramps at least 4 inches in height, or as an alternative; the floor in the storage will be at least 4 inches lower than the surrounding floor. An additional alternative to the sill or ramp is an open-grated trench inside the room draining to a safe location. [**29 CFR 1910.106**]

C. Floors will be liquid-tight where walls meet the floor. [**29 CFR 1910.106**]

D. Self-closing fire-rated doors meeting the requirements of **NFPA 80** will be used.

E. Where other portions of the building or other properties are exposed, windows will be protected as required by **NFPA 80**.

F. Class I liquids shall not be stored in a building having a basement or pit where flammable vapors can travel, unless the area is provided with ventilation that will prevent accumulation of flammable vapors. [**NFPA 30**]

G. The room must be sized to provide at least one clear 3-foot wide aisle within the room. [**29 CFR 1910.106**]

H. Electrical wiring and equipment located in inside storage rooms used for storing Class I liquids shall be suitable for Class I, Division 1 hazardous locations. [**AFI 91-203**]

I. Installed fire suppression systems shall be approved per requirements in MIL-HDBK-1008.

Note: If dispensing of liquids will be conducted within the room, significant additional ventilation and electrical requirements must be met. Refer to **AFI 91-203** for specific requirements.

3. Detached Building

[Ref: **NFPA 30 & NFPA 80**]

A. Must be one-story and devoted principally to the handling and storing of flammable and combustible liquids.

B. Must have a 2-hour fire-rated exterior wall having no openings within 10 feet for stored material. [**NFPA 30**]

C. Must be constructed to meet the specifications of NFPA 251 and the fire-resistive rating applicable to their use.

D. Self-closing fire-rated doors meeting the requirements of **NFPA 80** shall be used in all exterior walls.

E. Construction design of exterior walls shall provide ready accessibility for fire-fighting operations through provision of access openings, windows, or lightweight noncombustible wall panels.

F. Where Class 1A liquids are stored in containers larger than 1 gallon, the exterior wall, or roof shall incorporate deflagration venting.

G. Curbs, scuppers, special drains or other suitable means shall be provided to prevent the flow of liquids under emergency situation into adjacent areas. If a drainage system is used, it must have sufficient capability to carry the expected discharge of water from fire protection systems and hose systems.

H. Electrical wiring and equipment located in inside storage rooms used for storing Class I liquids shall be suitable for Class I, Division 1 hazardous locations.

I. Installed fire suppression systems shall be approved per requirements in MIL-HDBK-1008.

Note: If dispensing of liquids will be conducted within the building, significant additional ventilation and electrical requirements must be met. Refer to AFOSH 91-501 for specific requirements.

4. Temperature-Controlled Storage

[Ref: **AFI 91-203**, **MIL-PRF-85285**, **MIL-PRF-23377** & **T.O. 1-1-8**]

Virtually all materials associated with corrosion control processes must be protected from extremes in temperature. The complex formulations of multi-component solvent-borne and water-borne primers and topcoats used on aircraft and support equipment are especially unable to tolerate either excessively low temperatures or excessively high temperatures. The absolute minimum and maximum temperatures most of these materials can tolerate is 35^0 F. to 115^0 F. (Note: The acceptable storage ranges for some materials may be different, so it is necessary to refer to the military specification applicable to the product being stored)

Although minimally acceptable storage temperatures are provided in most military specification documents, long-term storage at these temperatures could potentially adversely affect the material's application, adhesion or cure characteristics. Therefore, it is highly recommended that every effort be made to provide optimum storage temperature capability in the range of 50^0 F. to 90^0 F (**AFH 32-1084**), Corrosion Control Utility Storage section). This temperature range is also the minimally acceptable temperature range for the application of most primers and topcoats used on aircraft and support equipment. (Note: Storing primers, topcoats, thinners, etc within this temperature range will ensure they are immediately suitable for application and will not require extended warm-up or cool-down periods) Additionally, the volatility of flammable or combustible liquids is increased by heat and when stored at temperatures higher than their flashpoints, they present significantly greater hazard.

Appendix 1: Aircraft Corrosion Control Facility Design Requirements

Requirement Type	Requirement Guidance Reference	Summary of Need
Fall Protection	**AFI 91-203**, EM 385-1-1, Section 5 and Section 21	Required if tasks must be preformed where worker might fall ten feet or more
Hangar Dimensions	UFC 4-211-02, AFH 32-1084	Minimum clearance from aircraft wings, tail, and nose to walls or doors is 10 feet. Minimum clearance for uppermost surface of aircraft (vertical fin, radome, etc) to ceiling is 5 feet. However, additional clearance in all directions may be required to accommodate maintenance stands or other types of support equipment
Hangar Floor	UFC 4-211-02	Painting is prohibited. Use white dry shake floor hardener as a topping on the floor slab
Compressed Air and Quick Disconnect Fittings	UFC 4-211-02	Separate oil-free shop and breathing air shall be provided. Quick disconnect or other types of fittings shall not be compatible with each other
Hangar Ceiling	UFC 4-211-02	Water-resistant gypsum ceilings
Hangar Doors	UFC 4-211-02	Each door leaf shall be motor-operated unit with a release mechanism to provide a means of movement in the event of a power failure
Sidewalls	UFC 4-211-02	Smooth surface, light colors. All pipes and I-beams should be behind furred out walls to keep walls smooth
Hangar Heating	UFC 4-211-02and T.O. 1-1-8	60–90 degrees at 30-80 percent relative humidity. Each bay shall be on a separate heating zone.
Ventilation	UFC 4-211-02, ACGIH	Design ventilation system to furnish 100% filtered air at a horizontal laminar flow velocity of 100 fpm across the entire cross-section area of the hangar

Requirement Type	Requirement Guidance Reference	Summary of Need
		bay.
Recirculated Air	NFPA 33 and UFC 4-211-02	Each spray area shall be provided with mechanical ventilation that is capable of confining and removing vapors and mists to a safe location and is capable of confining and controlling combustible residues, dusts, and deposits. The concentration of the vapors and mists in the exhaust stream of the ventilation system shall not exceed 25 percent of the lower flammable limit.
Exhaust Filters	Aerospace NESHAP	If unit/base is classified as "major source" three-stage filtration is required.
Lighting	UFC 4-211-02	Avoid the use of explosion-proof overhead fixtures by providing sealed, ventilated space above finished ceiling.
Hangar Sprinklers	UFC 3-600-01, NFPA 409	IAW NFPA 409, Sprinkler heads shall be of the 175 degrees F, quick response type.
Electrical	UFC 4-211-02	Shall meet NFPA 70 explosion-proof, All wiring in rigid metal conduit, Type M1 cable, or in metal boxes or fittings containing no taps, splices, or terminal connections
Water Resistant	AFH 32-1084	Need to be able to wash, Alodine planes and handle water treatment
Grounding	AFI 91-203	All metal parts of spray booths, exhaust ducts and piping shall be electrically grounded
Sprinklers	AFI 91-203	NFPA Standard 13. Must be able to clean sprinkler heads daily
Exhaust Ducts	AFI 91-203	Exhaust ducts must be located at least 18 inches from combustible materials. Non spark producing fans must be used
Flammable Storage Noise	OSHA 1910.106, OSHA 1910.107	Flammable material storage areas for painting bays shall be a separate

Requirement Type	Requirement Guidance Reference	Summary of Need
	NFPA 33	freestanding building IAW 29 CFR 1910.107.Work area noise levels shall be no greater than 85 dbA for an eight-hour work period in the painting or stripping work areas.
Flammable Storage	OSHA 1910.106, OSHA 1910.107 NFPA 33	Flammable material storage areas for painting bays shall be a separate freestanding building IAW 29 CFR 1910.107.
Fall Restraints	EM 385-1-1 AFI 91-203	Fall protection is required for workers working in elevated locations on open-sided floors and platforms and near floor and wall openings.

Appendix 2: References and Resources

Note for Internet documents listed below that are located on the Construction Criteria Base (CCB) site at http://www.ccb.org Users without access to CCB should contact HQ AFCEE Design Group at (210) 536-3547 to obtain a CCB password.

Reference Document	***Title***
40 CFR 63.5	National Emission Standards for Hazardous Air Pollutants (NESHAP) for Source Categories: Aerospace Manufacturing and Rework Facilities
40 CFR 63.745	Primer and Topcoat Application Operations
ACGIH Industrial Ventilation: A Manual of Recommended Practice for Design 26th Edition	Industrial Ventilation A Manual of Recommended Practice 26th Edition
AETCI 21-106	Corrosion Control
AFI 32-1024	Standard Facility Requirements
AFMAN 32-1084	Facility Requirements
AFI 32-7040	Air Quality Compliance.
AFI 32-7041	Water Quality Compliance
AFI 32-7042	Solid and Hazardous Waste Compliance
AFI 32-7061	The Environmental Impact Analysis Process
AFI 32-7062	Air Force Comprehensive Planning
AFI 48-145	Occupational and Environmental Health Program
AFI 91-203	Air Force Consolidated Occupational Safety Instruction
Construction Criteria Base	CE On-line Construction Criteria Base
EM 385-1-1	Safety and Health Requirements
ETL 02-15	Fire Protection Engineering Criteria – New Aircraft Facilities
ETL 98-8	Fire Protection Engineering Criteria – Existing Aircraft Facilities

ETL 99-1	Treatment and Disposal of Aircraft Washwater Effluent
ETL 99-4	Emergency Lighting and Marking of Exits
Executive Order 12856	Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements
Executive Order 12088	Federal compliance with pollution control standards
Executive Order 12902	Energy Efficiency and Water Conservation at Federal Facilities
http://www.thomasregister.com/	Thomas Register Homepage
Method 319	Determination of Filtration Efficiency for Paint Overspray Arrestors
MIL-HDBK-1005-16	Wastewater Treatment System Design Augmenting Handbook
MIL-HDBK-1005-17	Nondomestic Wastewater Control and Pretreatment Design Criteria
UFC 3-410-04N	Industrial Ventilation
MIL-STD-3007	Unified Facilities Criteria and Unified Facilities Guide Specifications
UFC 4-310-02N	Environmental Control Design of Clean Rooms
MIL-HDBK-1190	Facility Planning and Design Guide
National Archives and Records Administration.	Electronic Code of Federal Regulations
NEC 516 (See Base CE office for NECs)	National Electric Code
NESHAP	National Emission Standards for Hazardous Air Pollutants (NESHAP)
NFPA 101 (See Base Fire Department for NFPAs)	The Life Safety Code
NFPA 13	Standard for the Installation of Sprinkler Systems
NFPA 30	Flammable and Combustible Liquids Code
NFPA 251	Standard Methods of Tests of Fire Endurance of Building Construction and Materials
NFPA 325	Guide to Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids
NFPA 33	Standard for Spray Application Using Flammable or Combustible Materials
NFPA 34	Standard for Dipping and Coating Processes Using Flammable or
NFPA 69	Standards on Explosion Prevention Systems

NFPA 70	National Electrical Code
NFPA 80	Standard for Fire Doors and Fire Windows
NFPA 86	Standards for Ovens and Furnaces
OSHA 1910.1000	Air Contaminants: Toxic and Hazardous Substances
CFR 1910.106	Flammable and Combustible Liquids
OSHA 1910.107	Spray Finishing Using Flammable and Combustible Materials
OSHA 1910.134	Respiratory Protection: Personal Protective Equipment
OSHA 1910.22	General Requirements: Walking-Working Health Standards
OSHA 1910.94	Ventilation
T.O. 1-1-8	Application and Removal of Organic Coatings, Aerospace and Non-aerospace Equipment
T.O. 1-1-691	Cleaning and Corrosion Prevention and Control, Aerospace and Non-Aerospace Equipment
UFC 4500	Uniform Fire Code
UFC 3-240-03N	Wastewater Treatment Systems Augmenting Handbook Operation and Maintenance
UFC 3-260-01	Air Field and Heliport Planning and Design
UFC 3-260-02	Airfield Geometric Design
UFC 3-410-04N	Industrial Ventilation
UFC 3-520-01	Interior Electrical Systems
UFC 3-530-01	Interior and Exterior Lighting and Controls
UFC 3-600-01	Fire Protection for Facilities Engineering, Design, and Construction
UFC 4-211-02	Aircraft Corrosion Control and Paint Facilities
UFC 4-310-02N	Design Clean Rooms
UFC 4-832-01N	Design Industrial and Oily Wastewater Control
UL 900	Test Performance of Air Filter Units

UMC 1107	Uniform Mechanical Code

Appendix 3: Lessons Learned

1.0 Purpose

The purpose of this section is to highlight selected lessons learned during the design, construction, and operation of corrosion control facilities that have been previously built. These lessons can be a good tool for guidance in the design of new and renovated facilities. By not repeating these mistakes, we hope to be able to design better facilities that will meet the needs of Air Force, state, local, and federal regulatory agencies. Eliminating the need for modifications to new or renovated facilities could potentially save millions of dollars.

The following are actual situations and problems encountered on existing corrosion control facilities.

1.1 Situations Encountered

Situation 1: Complex computer control panels were installed on the outside of the paint booth to regulate the operation of virtually all aspects of the booth. The paint booth operated well for three years, and then error codes began to appear on the computer control panel, which lead to the booth becoming non-operational. Corrosion Control personnel are not trained in diagnosing the meaning of these error codes and what to do to fix the problems. It took over a month to get company-certified personnel to travel to the base. Once they arrived, it took two days just to diagnosis the error codes, because after only three years, the computer software used by the computer control was outdated.

Remedy: If a paint booth is controlled by a complex computer control panel unit, it is recommended that an extended service agreement with the supplying company be purchased at the time the facility is built. Also, current computer control panels can have an inexpensive modem installed that would allow the users to connect a laptop computer to the control panel, dial the service company where a technician can hook-up to the system remotely to diagnose the problems. This will save downtime and cost incurred by eliminating the requirement to have a service technician travel to the site.

Situation 2: A paint booth insert was modified to allow space for the tail of a C-130 to fit in the building. However, the overhang of horizontal stabilizers was not considered during the design phase. As a result, although the aircraft can be positioned in the paint hangar, the tail still cannot be painted because the horizontal stabilizers obstruct access to the tail area.
Remedy: Ensure that all dimensions of the largest aircraft to utilize the facility are taken into consideration during the design phase of the booth. The measurements should include adequate additional space for maintenance stands and work areas.

Situation 3: No safety harnesses were installed in the facility to allow painting of the upper surfaces of the aircraft. The aircraft is only painted on the sides as far as the maintenance stands will allow. Upon return to the aircraft's home base, the upper portion of the aircraft is painted on the wash rack.

Remedy: Safety harnesses should be installed in all corrosion control facilities to ensure the safety of all personnel while working on the aircraft. If safety harness assemblies are added into the design phase of the project, it will eliminate the need for added cost in rework to later install the safety system. Attached safety harnesses will allow for proper complete aircraft paints and eliminate the need to paint portions of aircraft outdoors or in unauthorized hangars. **AFOSHSTD 91-100**, *Aircraft Flight Line – Ground Operations and Activities*, paragraph 8.2.5 states that *"Whenever it becomes necessary to perform required tasks where a worker can fall 10 feet or more, fall protection will be used."* See **AFOSHSTD 91-31**, *Personal Protective Equipment,* for more information on fall protection equipment. **EM 385-1-1, Section 5 and Section 21,** addresses fall restraint requirements.

Situation 4: Aircraft are prepped and painted in the same area. This increases the chances of paint becoming contaminated. Keeping the facility dust and dirt free is almost impossible.

Remedy: Design the facility to have separate prep and paint areas. A wall should separate these areas.

Situation 5: The air compressor that was purchased for use in the facility will not accommodate all workers using DA sanders and other air tools at the same time.

Remedy: Research what size compressor will be needed to accommodate all facility requirements. It is also important to ensure that the building is wired to accommodate the proper size compressor.

Situation 6: The Spray Booth Insert was purchased on an AF Form 9. Therefore, it is not considered real property and CE will not work on it.

Remedy: In some cases, it may be possible to coordinate the purchase of this type of equipment with the local CE function to ensure it is designated as real property and eligible for CE support to accomplish required repairs and routine maintenance. Also, it is highly recommended that a maintenance contract with the manufacturer be considered.

Situation 7: The ventilation system design places all the source air inlets at the top of the hangar, above the front hangar door opening. There are no inlet air supply sources near the mid-fuselage height to create a linear airflow from the back of the aircraft to the front of the hangar.

Remedy: **OSHA 1910.107 (b)(5)(i)** states, *"The spraying operations except electrostatic spraying operations shall be so designed, installed and maintained that the average air velocity over the open face of the booth (or booth cross section during spraying operations) shall be not less than 100 linear feet per minute. Electrostatic spraying operations may be conducted with an air velocity over the open face of the booth of not less than 60 linear feet per minute, or more, depending on the volume of the finishing material being applied and its flammability and explosion characteristics. Visible gauges or audible alarm or pressure-activated devices shall be installed to indicate or insure that the required air velocity is maintained. Filter rolls shall be inspected to insure proper replacement of filter media."*

Situation 8: Exhaust ports are located below the hangar air intakes. This situation can create a potential for contaminated air to be recirculated through the facility, which may increase the solvent concentrations above the lower LEL limits creating a potential fire hazard.

Remedy: AFOSH Standard 161-2, *Industrial Ventilation*, paragraph 2.b. (6), notes that *"the air supply intake or process exhaust must be located to prevent contaminates being brought back into the facility."* **OSHA 1910.107(d)(9)** states, *"Air exhaust from spray operations shall not be directed so that it will contaminate makeup air being introduced into the spraying area or other ventilation intakes, nor directed so as to create a nuisance. Air exhausted from spray operations shall not be recirculated."*

Situation 9: Corrosion hangar is not designed to sweep airborne paint material toward the exhaust outlet.

Remedy: **OSHA 1910.107**(b)(1) states, *"Spray booths shall be substantially constructed of steel, securely and rigidly supported, or of concrete or masonry except that aluminum or other substantial noncombustible material may be used for intermittent or low volume spraying. Spray booths shall be designed to sweep air currents toward the exhaust outlet."*

Situation 10: The hangar design does not stop deposits of combustible residue on electrical equipment. Electrical equipment is located is the spraying area.

Remedy: **OSHA 1910.107(c)(5)** states, *" Unless specifically approved for locations containing both deposits of readily ignitable residue and explosive vapors, there shall be no electrical equipment in any spraying area, whereon deposits of combustible residues may readily accumulate, except wiring in rigid conduit or in boxes or fittings containing no taps, splices, or terminal connections."*

Situation 11: None of the exhaust ventilation systems for the main aircraft hangar have a pressure differential manometer.

Remedy: **OSHA 1910.107** (b)(5)(i) states, *"The spraying operations except electrostatic spraying operations shall be so designed, installed and maintained that the average air velocity over the open face of the booth (or booth cross section during spraying operations) shall be not less than 100 linear feet per minute. Electrostatic spraying operations may be conducted with an air velocity over the open face of the booth of not less than 60 linear feet per minute, or more, depending on the* *volume of the finishing material being applied and its flammability and explosion characteristics. Visible gauges or audible alarm or pressure-activated devices shall be installed to indicate or insure that the required air velocity is maintained. Filter rolls shall be inspected to insure proper replacement of filter media."*

Situation 12: No air conditioning was installed in the facility which results in not allowing for paints that require climate and humidity controls can be sprayed in this facility, therefore F-22, B-2 and C-17s are not painted.

Remedy: Air-conditioning, heating, and humidity controls should be included in the design of a Corrosion Control facility. The temperature of surfaces being painted should be considered in any painting decision since it is a major factor in the performance of the paint. For paint spraying, drying and storage reference T.O. 1-1-8 and manufacturer's instructions for recommendations. It is always recommended by the paint manufacturers that temperatures should be maintained at certain levels to ensure good adhesion.

Situation 13: A corrosion control facility was built and accepted with the following significant discrepancies: This resulted in aircraft corrosion prevention schedules falling behind. In order to get the facility to meet code, it was estimated that $1.4 million addition funds would have to be acquired from some source. These are costly mistakes that should have been noticed during the design phase of the facility. Improvement projects were expected to take 9 to 12 months.

- Paint booth walls were not water resistant or smooth and continuous without edges to prevent depositing of paint residue. Also, piping and electrical conduit in paint booth was exposed, which could lead to flammable overspray build-up. (**UFC 4-211-01NF**)
- Paint booth did not have triple-stage paint exhaust filters (Aerospace NESHAP)
- Lights and other electrical items in paint booth were not explosion-proof (**UFC 4-211-01NF)**
- Paint booth bays did not have separate ventilation systems (Increases energy consumption and does not allow one bay to work if one is malfunctioning)
- Emergency exit signs were not illuminated. **ETL 99-4**, para 6.2.1 states *"Use LED exit signs with illuminated letters displayed on an opaque background."*

Remedy: All of these problems could have been avoided if requirements in referenced documents had been followed.