THE STUDIES AND IMPROVEMENT OF VENTILATION SYSTEM IN THE PAINT SHOP

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ABSTRACT

There are many types of paint shop and different ventilation designs in the manufacturing industries. All kind of ventilation designs has their own main functions to conform to good manufacturing practices (GMP). This study focuses on manual paint shops because of its great potential for worker exposure. The design goal of industrial ventilation is to protect the worker from carbon contamination in the work place. This suggests installing a system that will reduce exposure below the permissible exposure guideline or an appropriate action level. The professional will design the system to meet this standard. The good spray shop and a good ventilation system defined in the Federal Standard 2000, as a room which the concentration of inborn particles is control to specify limits. Firstly ventilation in the spray shops finishing operation was selected for this study for several reasons. The ventilation systems in spray painting booth have been widely used to control these hazards, but no systematic study of their effectiveness had been undertaken. Secondly, the painting shop alternative coatings, where new uses technology has changed rapidly with the introduction of new material, of which represent toxic hazard. The modified ventilation, developed in the new paint line application method, promised new ways of reducing worker exposure in spray finishing operation. In this book, I shall give my best opinion how to overcome the toxically taken by the operator, through the flow of air to the environment to the filter provided. Of the ventilation noise characteristics, effects and suggested counter measures. In cost benefit analysis (CBA) the cost of remedial measure is weighed against the environmental benefits it creates, Is it worth, in a new scrubber for a plant if the impacts on its surrounding decrease by 10%. The aim of life cycle cost calculation is to ensure that investment decisions are not made solely on the basic of a low purchase price, but that the life cycle operating costs are considered in the equation. Considering the energy and maintenance cost during the life-cycle circle (LCC), the cheapest investment is not always the best. If may, for instance, be profitable to buy a ventilation unit with a heat recovery system, which may increase the unit investment by 50%. The return on the investment in such a case may still be in excess of 20%.

ملخص البحث

هنالك عدة أنواع من معامل الصباغة في الانتاج الصناعي. هذه الدراسة ركزّت على معامل الصباغة باستخدام الرّشّاش، ومدى تعرض العمال لهذه المواد والتي بعضها تعتبر سامة. هنالك عدة أنواع للصباغة بالرش، وكلها تحتاج الى بيئة ملائمة للعمال حيث ان التهوية تعتبر واحدة من أهم العوامل لصحة العمال. التهوية أساسا ممكن أن تحدث طبيعيا أو ميكانيكيا، والتهوية الميكانيكية من الضروري تطبيقها في موقع العمل حيث ان التهوية الطبيعية تكون غير كافية. موقع العمل ومخزن الكيمياويات يجب أن يكون ذو تهوية جيدة ومطابقة للمواصفات القياسية لضمان صحة العمال وسلامتهم. ان ادارة الشركات أدركت أن تحسين عملية الانتاج، واتباع المواصفات القياسية فيما يخص صحة العمال، السيطرة النوعية على الانتاج، والبيئة الصحية للانتاج ممكن أن تكون ذا مردود اقتصادي سريع للشركة. الانتاج ممكن زيادته مع تحسين النوعية وتقليل التلف الناتج من القطع الرفوضة نتيجة عدم مطابقتها للمواصفات. هدف هذه الدراسة كان لانتاج القطع المصبوغة بدون أي نقص (انتاج عالي النوعية أو الجودة) بالعمل سوية كفريق عمل، وهذا جعل شعور العامل أفضل لاحساسه بأنه يشارك المجموعة في هذا الانتاج، وكذلك اعتبار الشركة لهذا التقدم في الانتاج، واعطاء العمال مكافئات على هذا التحسن في العملية الانتاجية. باتباع هذه الطريقة بالإمكان الحصول على سيطرة أفضل على عملية الصباغة بالرش، ولكن هذه التحسينات المقترحة لايمكن تطبيقها حاليا من قبل إدارة الشركات نتيجة الحالة الاقتصادية في المرحلة الراهنة.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Manufacturing Engineering.

……...
A.K.M. Mohiuddin
Supervisor

I certify that I have read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Manufacturing Engineering.

……...
Ahsan Ali Khan
Internal Examiner

I certify that I have read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science in Manufacturing Engineering.

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The dissertation was submitted to the Advanced Engineering and Innovation Centre and is accepted as partial fulfilment of the requirements for the degree of Master of Science in Manufacturing Engineering.

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Hamzah Mohd. Salleh
Director, Advanced Engineering and
Innovation Centre

The dissertation was submitted to the Kulliyyah of Engineering and is accepted as partial fulfilment of the requirements for the degree of Master of Science in Manufacturing Engineering.

……
Ahmad Faris Ismail
Dean, Kulliyyah of Engineering

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Abdul Rashid bin Mohd. Ali

Signature..... Date . …….

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DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

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Affirmed by Abdul Rashid bin Mohd. Ali

…….. ……..
Signature Date

My Beloved parents who have passed away;
Tuan Hajj Mohd Ali Bin Kassim
Puan Hajjah Salmah Binti Kadir
Both wives:
YBhg. Datin Seri Hajjah Khalidah Binti Kayat
(Director –Civil Servan (JPA) Pension Division)
YBhg. Datin Marlia Binti Che Mansor
Pharmacy Klinik KesihatanWilayah Persekutuan
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&
Ereena Mariana

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LIST OF ABBREVIATIONS

G.M.P.	Good Manufacturing Practices
C.B.A.	Cost Benefit Analysis
L.C.C.	Life-Cycle Circle
A.C.G.I.H.	American Conference of Governmental Industrial Hygiene
T.L.V.	Threshold Limit Value
N.A.D	Non-aqueous dispersions
V.P.	Velocity Pressure
C.H.R.A.	Chemical Health Risk Assessment
E.R.	Exposure Rating
P.E.L	Permissible Exposure Limit
S.T.E.L.	Short Term Exposure Limit
M.R.	Magnitude Rating
H.E.P.A.	High Efficiency Particulate Air

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

There are many types of paint shop in the manufacturing industry. In this study, we concentrate on spray painting operations. Manual rather than automatic applications were emphasized in this study because of the greater potential for worker exposure. Spray finishing operations were selected for this study for several reasons. First, industrial finishes employ many substances long recognized as health hazards. Spray booths have been widely used to control these hazards, but no systematic study of their effectiveness had been undertaken. Second, coating technology has changed rapidly with the introduction of many new materials, some of which represent toxic hazards. Last, parallel developments in paint application methods promised new ways of reducing worker exposure in spray finishing operations.

1.2 SPRAY PAINTING METHODS

There are a few types of spray painting methods, which are always carried out in industrial practice. The spray can be generated by compressed air, by hydraulic pressure or by electrostatic forces.

1.3 COMPRESSED AIR METHOD

This may be carried out by hand or automatically. Air is driven across the mouth of a small outlet under such pressure as to draw out and produce an air-paint mist from the jet of the spray gun. In addition, the paint may be fed under pressure to the gun. Two

types of nozzles are used: external mix nozzles and internal mix nozzles. In external mix nozzles combine the compressed air and finishing materials in a chamber opening. This method is the most widely used because of its versatility and low cost while it creates a high quality finish.

1.4 HYDRAULIC PRESSURE (AIRLESS) METHODS

In this method, pressure is applied directly to the paint, which is forced out of a nozzle. The airless spray gun consists simply of a device to hold the orifice and a valve for shutting off the flow. The volume of the material sprayed and the geometry of the spray pattern are determined by the size and the shape of the nozzle. The hydraulic pressure compressed air or an electric motor. Nozzle pressure are very high, may be as high as 200kg/cm² (3000psi). The high pressures associated with the airless method carry with it the hazard of hypodermic injection for persons who may accidentally contact the spray.

1.5 ELECTROSTATIC METHOD (EPOXY POWDER COATING)

In this method, an electrical charge is applied to the atomized coating particles, either by the creation of an ionized zone within the spray cone area, or by imparting a charge to the fluid stream before its release from the spray gun head. The charges, atomized paint particles are attracted to the conductive object being finished by the electrostatic potential between the paint and the object. The atomization can be achieved by the use of air atomizing or airless type equipment, or solely by use of electrostatic means.

1.6 HAZARDS CONTROL BY PAINT SPRAY BOOTHS

In door spray finishing operations are usually within ventilated spray booths. Spray booth is a power ventilated structure provided to enclose or accommodate a spraying operation, to confine and limit the escape of spray, vapor and residue, and to safely conduct or direct them to an exhaust system. They function by directing relatively uncontaminated air past the worker towards the process and into a collection point or exhaust hood. The source of the uncontaminated air may be a tempered fresh air supply or simply general workroom. The air cleaning section of the spray booth not only removes paint mist from the exhaust air, but acts as a means of air distribution within the booth. An arrangement of metal baffles is the simplest form of a cleaner. The baffle-type booth provides a constant flow of air. Mist removal and clean-up difficulties limit its use to low production applications.

1.7 TYPES OF PAINT SPRAY BOOTH

Paint spray booth can operate in two ways:

1. Dry spray booth
2. Water wash spray booth

1.7.1 Dry Spray Booth

Dry filter booths combines low cost with highly efficient paint mist removal, but have the disadvantage their variable airflow is at maximum when the filters are clean, but continuously decreases to a point where the filters need replacement. Like baffle-type booths, the dry filter booth is best suited for low production operations. A spray booth not equipped with a water washing system. A dry spray booth may be equipped with:

- Distributions or baffle plates to promote an even flow of air through the booth or cause deposit of over spray before it enters exhaust duct; or
- Over spray dry filters to minimize dusts or residues entering exhaust ducts; or
- Over spray dry filter rolls designed to minimize dusts or residues entering exhaust ducts; or
- Where dry powder are being spray, with powder collection system so arranged in the exhaust to capture overspread material.

1.7.2 Water Wash Spray Booth

Water wash booth incorporates various combinations of water curtains and spray to scrub the paint mist from the exhaust air. They have the advantage of constant airflow, inherent fire protection. Maintenance may equal or exceed that of the dry-type booths. There are two basic designs of Paint Spray Booths which are normally in use

(i) Side Draft Booth Configurations (Dry and Wash Type)

(ii) Down Draft Booth Configuration (Water Wash Type).

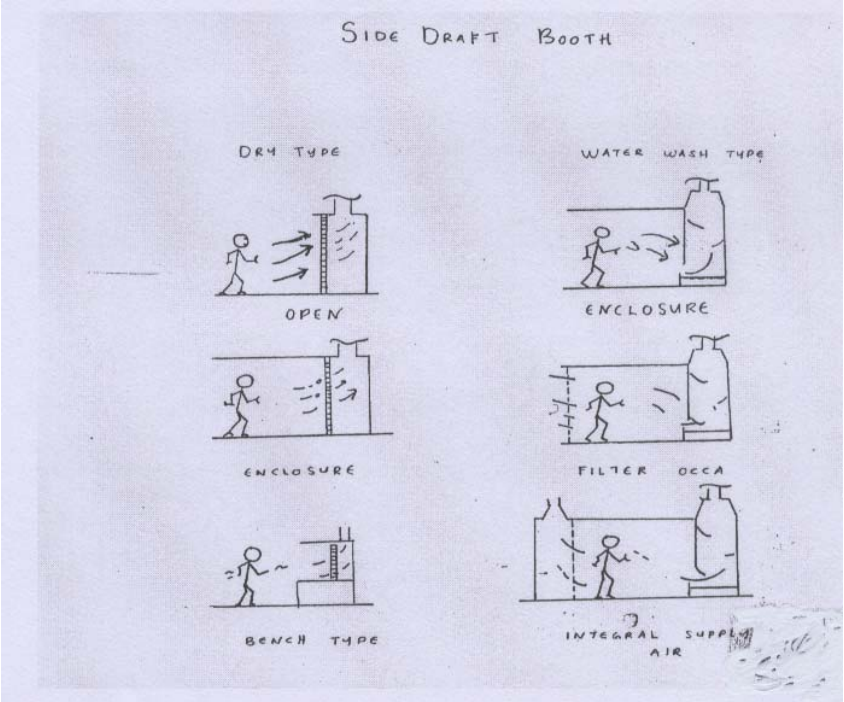

Figure 1.1: Side Draft Booth Configurations (Dry and Wash Type)

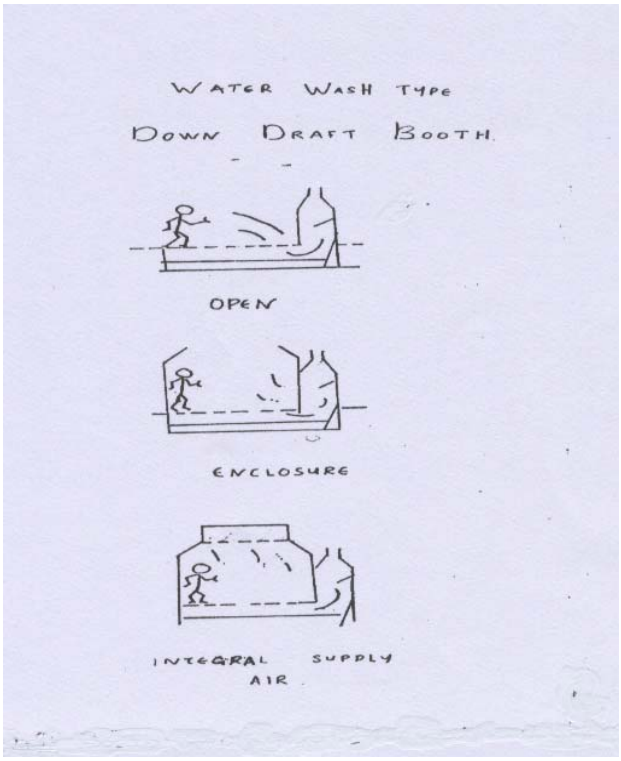

Figure 1.2: Down Draft Booth Configuration (Water Wash Type).

1.7.3 Side Draft Spray Booth

This booth uses a horizontal airflow direction. These booths take advantage of the momentum of spray mist and can successfully be used when painting small to medium sized articles.

1.7.4 Down Draft Spray Booth

This type of booth is used for larger articles, and can maintain adequate airflow on all sides of the object being painted, by rotating the work piece. Down draft spray booths permit greater protection, while allowing more freedom of movement for the painter.

Both side draft and down draft booth vary in sizes, the degree of enclosure, method of air makeup, air velocity and spray control. These variations are illustrated in the following Figures 1.3 to 1.8 (ACGIH standard design):

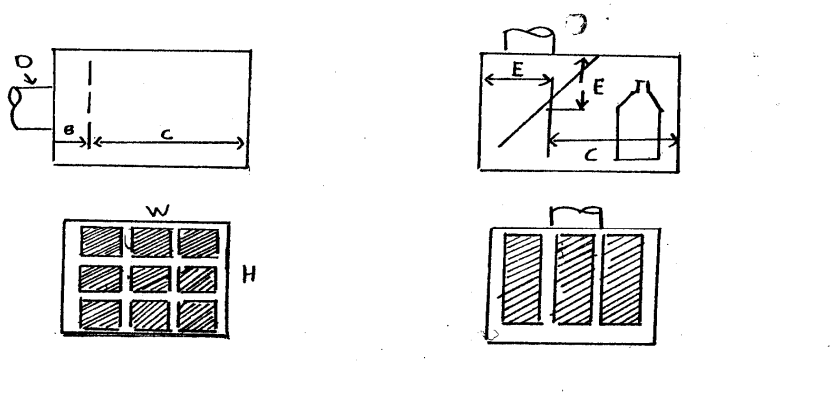

Figure 1.3 Large Paint Booth

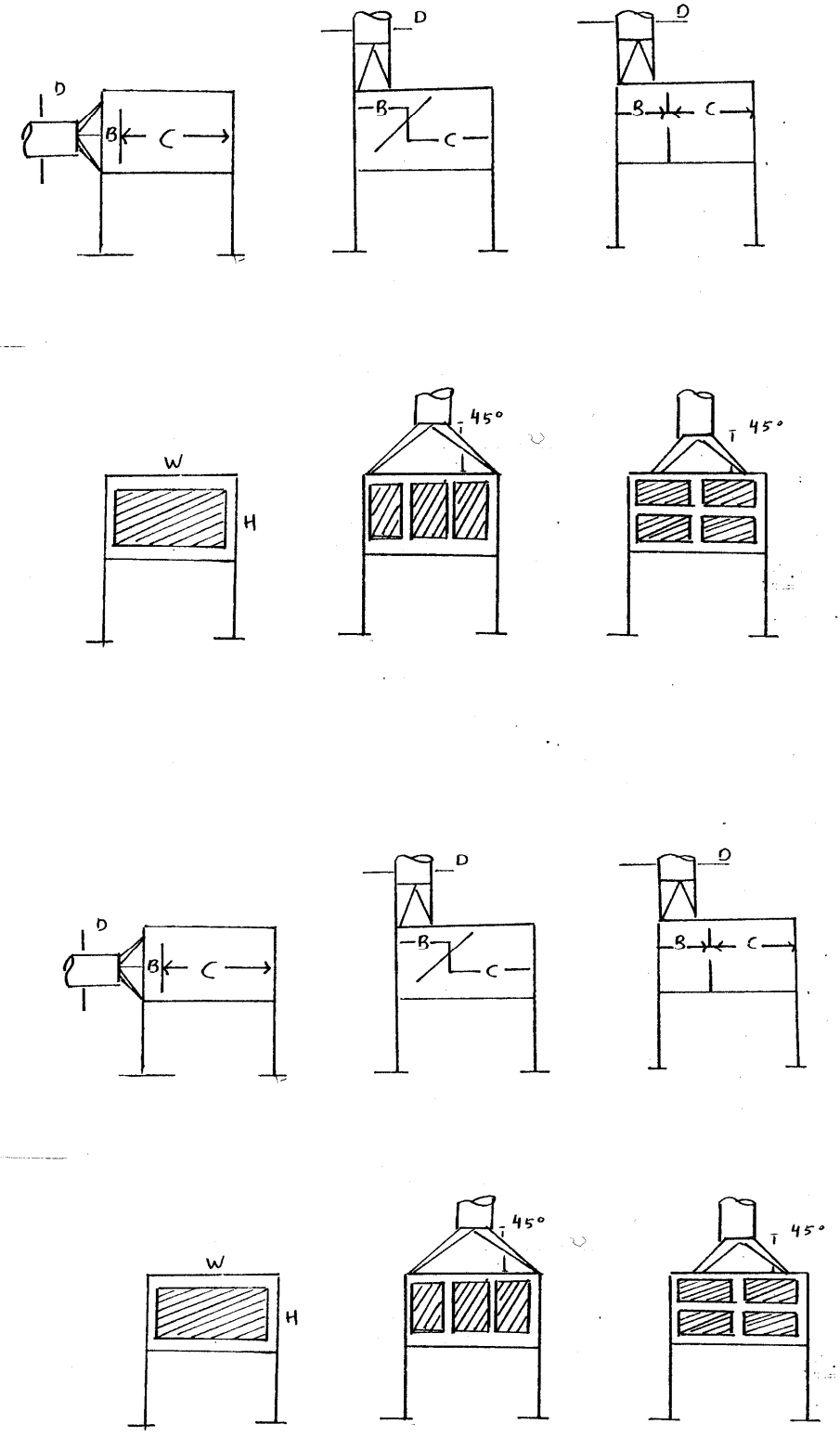

Figure 1.5 Auto Spray Paint Booth

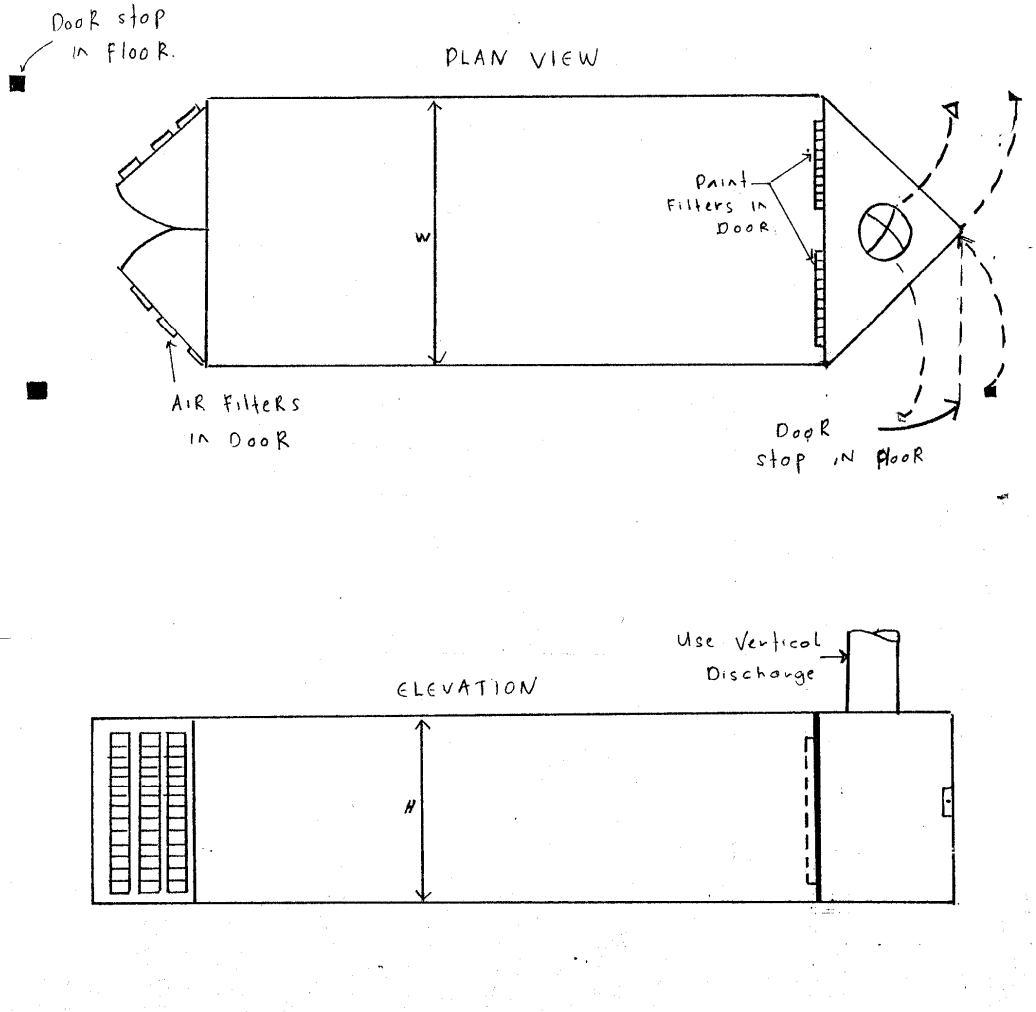

Figure 1.6 Large Drive – Through Spray Paint Booth

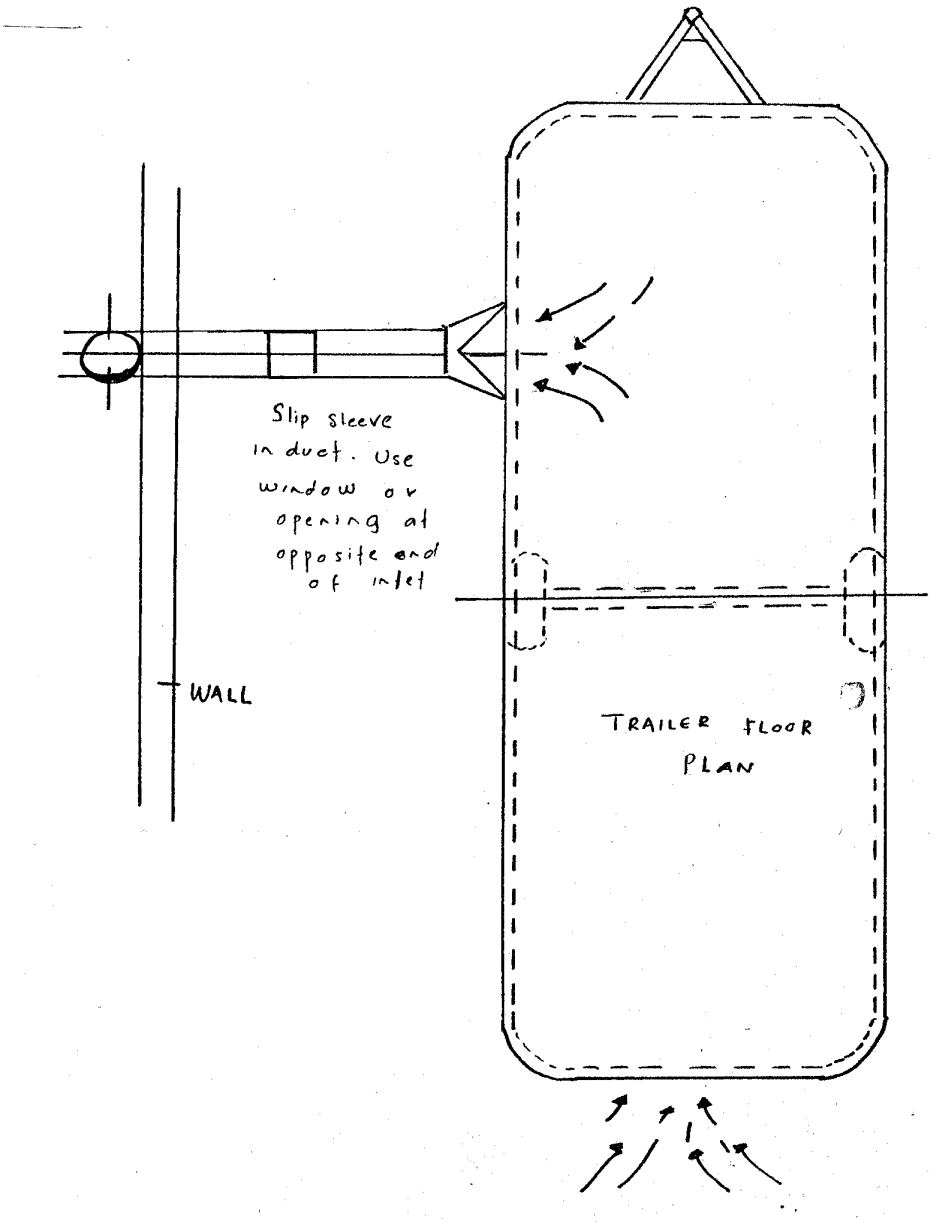

Figure 1.7 Trailer Interior Spray Painting